SEDIMENTOLOGY, STRATIGRAPHY AND PETROGRAPHY OF THE PERMIAN-TRIASSIC COAL-BEARING NEW LENTON DEPOSIT, BOWEN BASIN, AUSTRALIA

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Abstract

The Bowen Basin is one of the most intensely explored sedimentary basins in Australia and hosts one of the world's largest coking coal deposits. This study focuses on the Lenton deposit in the north-central part of the Bowen Basin and targets the Rangal Coal Measures, which are the youngest (245 Ma), most areally extensive and least structurally deformed coal measures in the study area. Six lithofacies were identified from detailed bed-by-bed logging of two cores and stratigraphically-upward comprise peatmire deposits of the Permian Blackwater Group overlain unconformably by braided fluvial strata of the Triassic Rewan Group. Coal-bearing strata of the Blackwater Group form a large-scale drying up sequence showing a change from permanent to seasonal waterlogged conditions related to the onset of regional uplift. Sedimentation was then terminated and a regional erosion surface formed by uplift related to the Hunter Bowen Orogeny. This, then, was overlain by braided fluvial strata of the Triassic Rewan Group.

Résumé

Le bassin de Bowen est l'un des bassins sédimentaires les plus étudiés en Australie et abrite l'un des plus grands gisements mondiaux de charbon à coke. Cette étude porte sur le dépôt Lenton situé dans la partie centre-nord du bassin de Bowen et, plus précisément, sur le houiller Rangal, le dépôt de charbon le plus jeune (245 Ma), le plus vaste et le moins structurellement déformé de la zone d'étude. Six lithofacies ont été identifiés à partir de descriptions détaillées (lit-par-lit) de deux carottes. De la base au sommet de la séquence étudiée, ces lithofacies sont constitués de dépôts de tourbière du Permien du Groupe de Blackwater surmontés, de manière discordante, par des dépôts de rivières en tresses du Trias Groupe de Rewan. Les couches houillères du Groupe de Blackwater forment une séquence indiquant une tendance d’assèchement vers le haut tel que démontré par un changement de conditions saturées en eau en permanence à des conditions que périodiquement saturées. Cet assèchement serait lié au début d’une période de soulèvement régional et aurait été suivi de l’arrêt de la sédimentation, et finalement par la formation d’une surface d’érosion d’échelle régionale associée au soulèvement lié à l'orogénèse Hunter Bowen. Durant le Trias, cette surface d’érosion a été recouverte par des dépôts de rivières en tresses du Groupe de Rewan.

Extended Abstract

The Bowen Basin is one of the most intensely explored sedimentary basins in Australia and hosts one of the world's largest coking coal deposits. This study focuses on the Lenton Coal deposit that occurs in the north central part of the Bowen Basin and targets the Rangal Coal Measures, which are the youngest (245 Ma), most extensive and least structurally deformed of the three groups of Permian coals (Blackwater Group) currently being targeted for coking coal resources in the Bowen Basin.

Based on visual observations and detailed bed-by-bed logging of two cores, six lithological facies have been identified in the Lenton deposit study area: (a) medium-to coarse-grained sandstone, (b) interbedded siltstone and mudstone, (c) interlaminated siltstone and sandstone, (d) carbonaceous siltstone and mudstone, (e) coal and (f) volcanic ash. Stratigraphically-upward, these comprise peatmire deposits of the Permian Blackwater Group composed of (c), (d), (e) and (f) overlain unconformably by braided fluvial strata of the Triassic Rewan Group composed of (a), (b) and (c). Based on lithological and coal petrographic data, coal-bearing strata of the Blackwater Group form a large-scale (decameter) drying-upward sequence. In addition, drying upward occurs also on the scale of individual coal seams (up to several meters). Recurring short-term episodes were probably related to lowered local groundwater levels, most likely driven by climate change. The longer-term drying-upward trend, on the other hand, is interpreted to be related to uplift associated with the Hunter-Bowen Orogeny. Uplift eventually terminated deposition of the Blackwater Group and formed an erosional unconformity overlain by sandstone-rich braided fluvial strata of the Triassic Rewan

Group. Fluvial conditions were then gradually replaced by an extensive floodplain and the accumulation of a thick paleosol succession, likely caused by a permanent diversion (avulsion) of the channel system away from the Lenton deposit area.

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First and foremost, I want to thank Dr. Bill Arnott for his time, patience, guidance and supervision throughout this project. I have greatly benefitted from his infinite enthusiasm and knowledge and he has made me a better geologist by providing me with this opportunity.

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Chapter 1: Introduction

1.1 Introduction to the Bowen-Gunnedah-Sydney Basin

The Bowen Basin is part of an interconnected group of Permo-Triassic sedimentary basins including the Sydney and Gunnedah basins that stretch for ~2000 km along the eastern side of Australia. The Bowen-Sydney-Gunnedah Basin system, or simply basin system, formed at temperate to polar latitudes along the Panthalassan margin of Gondwana during the Late Paleozoic (Frank et al., 2008) and became a major depocenter during a period of regional extension between the latest Carboniferous to Early Permian (Fielding et al., 2001).

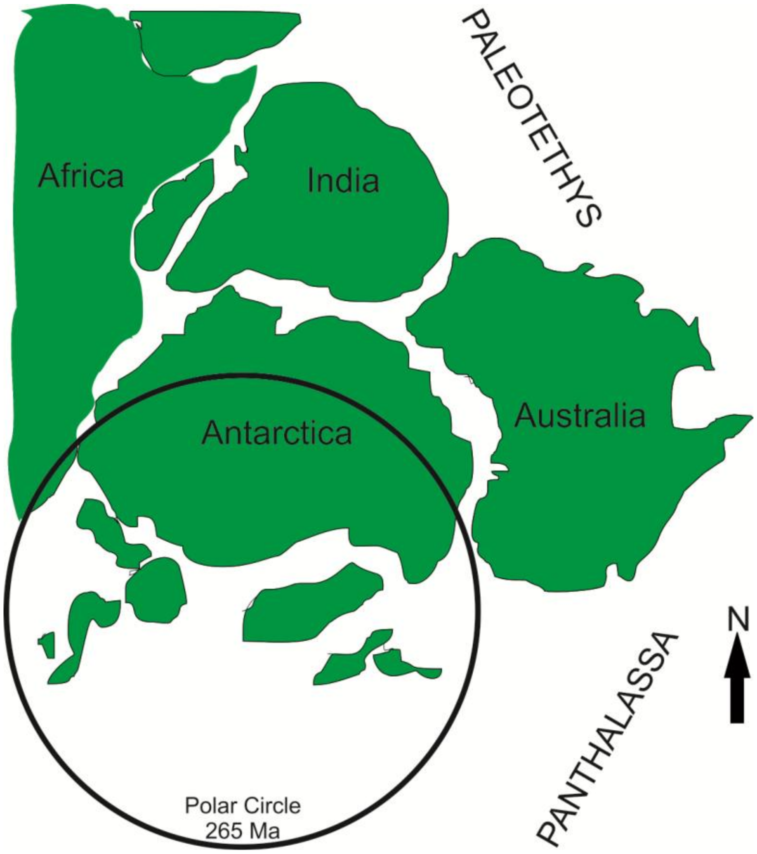


Figure 1: Paleogeopgraphic map for the Early Permian showing the location of Africa, Antarctica, Australia, and India (modified from Frank et al., 2008). The polar circle represents the zone from the South Pole to 60 degrees latitude at 265 Ma (Powell and Li, 1994).

As far back as the Cambrian, eastern Australia was an active plate margin. During the Middle to Late Devonian (Korsch et al., 2009a), convergence was related to a subduction system consisting, from west to east, of a magmatic arc, a forearc basin and an accretionary wedge (Leitch, 1975; Murray, 1987; Korsch et al., 1990; Korsch et al., 1992; Korsch et al., 2009a). Eastward migration of the subduction system during the Late Carboniferous formed a convergent system that dominated the tectonic setting of the eastern part of Gondwanaland throughout the Permian and into the Cretaceous (Korsch et al., 2009a). The cessation of subduction resulted in an eastward migration of the magmatic arc towards New Zealand during the Late Cretaceous (~85 Ma) which at this time was still attached to Australia (Korsch et al., 1992). Geological evidence of the Permian-Cretaceous convergent plate margin is preserved in the form of fragmented pieces (located in New Caledonia and New Zealand) associated with rifting (due to seafloor spreading) created by the opening of the Tasman Sea in the Late Cretaceous/ Early Tertiary (Korsch et al., 2009a).

During the Early Permian, the Bowen Basin began as an extensional back-arc element (magmatic arc), caused by the rifting of the paleo-Pacific and paleo-Australian plates during the break-up of Pangea (Michaelsen et al., 2001; Veevers, 2005). The basin formed in response to far-field stresses associated with the west-dipping subduction of the Panthalassa oceanic plate beneath the margin of East Gondwanaland, located to the east of the East Australian Rift System (Korsch et al., 2009b). This produced the New England Orogen, the easternmost tectonic unit in eastern Australia, which consists of arc- and arc-related rocks formed during the Devonian to Cretaceous. The subsidence history of the Bowen-Gunnedah-Sydney basin system comprises a complex assemblage of tectonic processes including volcanism, mechanical extension, thermal cooling, thrust-related flexuring of the lithosphere during foreland loading and dynamic platform tilting (Korsch et al., 2009a).

The initial Early Permian basin forming event, termed the Denison Event, occurred when mechanical extension stretched the back-arc continental crust to form the major Early Permian East Australian Rift System (Korsch et al 1998, 2009a), which resulted in the formation of a series of half grabens in the west (Korsch et al., 2009a, 2009b). Concurrently, the eruption of a thick volcanic pile originating from crustal extension resulted in the deposition of associated volcaniclastic sediments in the Taroom Trough to the east (Korsch et al., 2009a, 2009b).

In the late Early to Mid-Permian, the cessation of extension was followed by a period of slower subsidence that resulted in cooling, thermal relaxation and ultimately lithospheric uplift (MacKenzie, 1978; Fielding et al., 1990). The thermal relaxation phase was then interrupted in the latest Early to Late Permian by renewed rapid subsidence that lasted for ~35 My, and is termed the Late Permian to Middle Triassic foreland basin phase (Korsch et al., 2009a). It is during this foreland basin phase that the sedimentary strata of interest, the Blackwater Group and the Rewan Group, were deposited. Several mechanisms can generate rapid tectonic subsidence including mechanical rifting, foreland subsidence, passive crustal loading and transtension associated with strike-slip faults (Korsch et al., 2009b). In this case a combination of foreland subsidence and passive crustal loading were the mechanical drivers for subsidence.

During the Mid-Permian, extension was replaced by compression associated with renewed plate convergence. This led to the development of a major west directed retroforeland thrust belt in the New England Orogen (Korsch et al., 1990; 1997), and the formation of a major foreland basin to the west in the Bowen and Gunnedah basins, where an up to 8 km-thick foreland basin-fill accumulated (Korsch et al., 2009a; 2009b). In the Late Permian to Early Triassic, basin subsidence, which previously had been driven mostly by dynamic processes, became dominated by static flexural loading associated with the foreland sedimentary pile (Korsch et al., 2009a). This reactivated bounding faults in the Denison Trough in the Late Permian to Middle Triassic, which then led to tectonic inversion and the development of compressive structures, referred to as the Hunter-Bowen Orogeny. This episode spanned a period of ~35 My (ca 265-230 Ma) although the upper age limit is poorly constrained (Collins, 1991; Korsch et al., 1992). Short-lived unconformities, including the one between the Blackwater Group and the Rewan Group in the study area, were produced by a series of contractional events during the Hunter-Bowen Orogeny and were common during sedimentation associated with the foreland basin phase (Korsch et al., 2009b).

In the Middle Triassic, the retroforeland thrust front in the New England Orogen eventually propagated westwards into the Bowen basin system resulting in uplift and termination of sedimentation (related to the Goondiwindi Event, see below)(Korsch et al., 2009a, 2009b). Following the cessation of thrusting, a protracted episode of non-deposition/erosion lasted for ~30 My and produced a major peneplain on which the basal units of the Early Jurassic Surat Basin were deposited (Korsch et al., 2009a).

The Surat Basin was related to the resumption of subsidence caused by dynamic platform tilting due to corner flow in the asthenospheric wedge above a subduction zone (Korsch et al., 2009a). Subsidence was later terminated by uplift and reactivation of earlier structures associated with the early Late Cretaceous Moonie event (see Deformational Events).

Deformational Events in the Bowen-Sydney-Gunnedah Basin System

There were three extensional and nine compressive deformation events that occurred in the Bowen-Sydney-Gunnedah basin system. The first extensional event occurred in the Early Permian and initiated subsidence in the Bowen, Sydney and Gunnedah basins, followed by two additional extensional events in the Early Cretaceous and in the Eocene. The compressive events occurred in the Early Permian (Cattle Creek Event), mid-Permian (Aldebaran Event), Late Permian (Baralaba Event and Bellata Event), Early Triassic (Brumby Event and Clematis Event), Middle Triassic (Showgrounds Event and Goondiwindi Event) and early Late Cretaceous (Moonie Event) (Korsch et al., 2009b). The Cattle Creek, Baralaba, Bellata, Brumby, and Showgrounds events were all relatively minor and did not result in major changes to the basin system.

In contrast, the Aldebaran Event marked the start of the development of the retroforeland thrust belt (Hunter-Bowen Orogeny) that spanned the mid-Permian to the Middle or Late Triassic. During this tectonic episode structural styles differed on opposite sides of the basin whereby the eastern side was subjected to much more intense structural deformation owing to proximity to retroforeland thrusting (Korsch et al., 2009b). Another major compressive event is termed the Clematis Event, which was associated with a significant regional unconformity caused by the Early Triassic reactivation of faults in the Denison Trough and regional uplift in the Taroom Trough (Korsch et al., 2009b). The Clematis Event was associated with plate convergence and the development of a westward-propagating, retroforeland thrust belt (Korsch et al., 2009a).

The Late Triassic Goondiwindi Event was the most important and complex event in terms of the tectonic development of the region (due to uplift and erosion) producing different geometries in different parts of the basin, transforming Early Permian extensional faults into thrusts in addition to creating new thrust faults (Korsch et al., 2009b). It is interpreted to be related to the closure of an oceanic back-arc basin and the accretion of the island arc to the Australian continent (Sivell and McCulloch, 1997). The final contractional event in the basin system was the Moonie Event, which occurred within an overall extensional regime associated with the break-up and fragmentation of the Gondwanaland part of Pangea (Korsch et al., 2009b). Continental extension commenced during the Early Cretaceous Whitsunday Event (Korsch et al., 1998) and culminated in the Late Cretaceous with the onset of seafloor spreading in the southern Tasman Sea at 84 Ma (Veevers et al., 1991) and the rifting of continental fragments from Australia (Korsch et al., 2009b). Immediately following the deposition of the Early Jurassic- Early Cretaceous Surat Basin, a compressive deformational event reactivated many earlier structures in the Bowen Basin and underlying basement (Korsch et al., 2009a).

1.2 The Bowen Basin

Hosting economic accumulations of coal, natural gas, coal seam gas and precious metals, the Bowen Basin is one of the most intensely explored sedimentary basins in Australia (Baker et al., 1993). Shallow Permian coals are easily exploited in both the Sydney and Bowen basins due to uplift and erosion of the foreland basin stratal pile (Middleton, 1983). The study area is located in the northern part of the Bowen Basin, which hosts one of the world's largest bituminous and coking coal reserves. The eastern side of the Bowen Basin was severely deformed during the Triassic, however, mineable reserves are still present on the limbs of folds or on protected tectonic shelves (Mallet et al, 1995). In the central and northwestern parts of the Bowen Basin, shallow coal deposits are generally undeformed due to their distal position to Triassic thrust fronts. In addition, they are located far from Cretaceous igneous intrusions that not only structurally deformed the coal but also caused it to be thermally degraded. The large reserves of shallow coal present in the Bowen Basin have been developed largely for the export market.

The Bowen Basin is the northernmost basin in the Permian-Triassic Bowen-Gunnedah-Sydney Basin system and is located between latitudes 20˚S and 26˚S and longitudes 147˚30'E and 150˚30'E (Figure 2) (Hawthorne, 1975). The basin is roughly lens-shaped and extends 550 km south from its apex at Collinsville and is approximately 250 km across where it plunges beneath the Cretaceous-Jurassic Surat Basin of southern Queensland (Staines and Koppe, 1979).

Figure 2: Location of the Bowen Basin in east-central Australia (GeoScience Australia, 2008)

1.2.1 Regional Structural Context

The Bowen Basin is bounded by basement highs to the east (Eungella-Cracow Mobile Belt, South Coastal Structural High, New England Fold Belt), west (Springsure Shelf, Nebine Ridge), northwest (Anakie High) and southwest (Walgett Shelf) (Baker et al., 1993) and to the south is overlain by the Jurassic-Cretaceous Surat Basin sequence (Fielding et al., 1990). The Galilee Basin, another Permo-Triassic coal basin, is interpreted to be stratigraphically equivalent to the Bowen Basin , and is located across the Springsure Shelf to the west (Allen and Fielding, 2007a; 2007b).

The Taroom and Denison troughs are the two major north-northwest-trending depocenters in the Bowen Basin and are located on the eastern and western side of the basin, respectively (Staines and Koppe, 1979). These two depocenters are separated by a medial intrabasin high called the Comet Shelf (a north-northwest splay of the Nebine Ridge), which is a basement high with no surface expression (Baker et al., 1993).

A major boundary fault separates the northeastern most part of the Bowen Basin from the Eungella-Cracow Mobile Belt. Here the Bowen Basin contains up to 10 km of immature sedimentary and deformed volcanic rocks (Staines and Koppe, 1979). Compressive deformation and widespread volcanism to the east of the Eungella-Cracow Mobile Belt formed the hinterland that supplied much of the volcaniclastic sediment that fills much of the northeastern part of the Bowen Basin (Michaelsen et al., 2001).

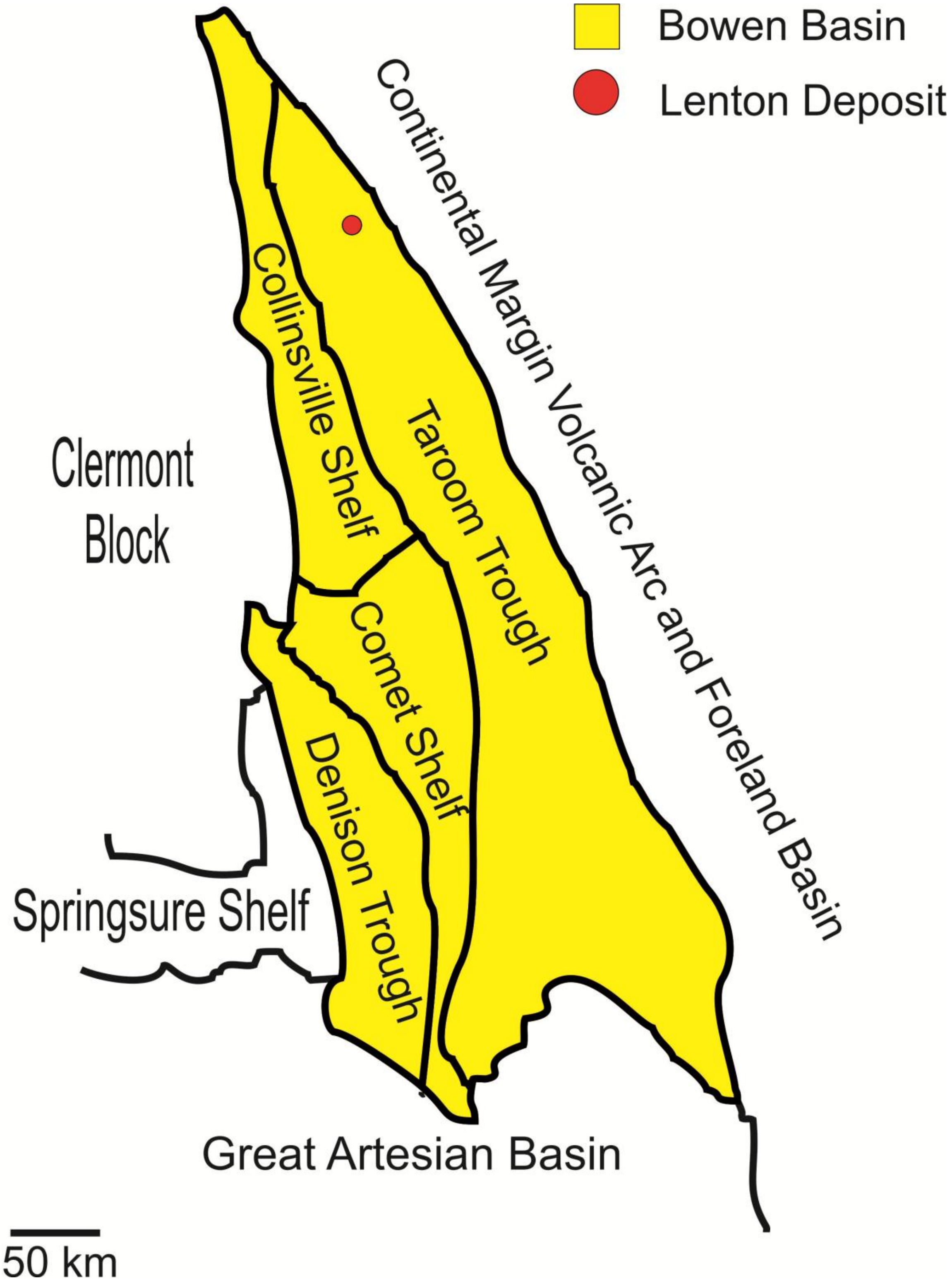


Figure 3: Tectonic elements within and surrounding the Bowen Basin (modified from Ahmad and Zaigham, 1993). The Great Artesian Basin is part of the same basin system as the Jurassic-Cretaceous Surat Basin. The Lenton deposit, which forms the basis of this work, is shown in the northeastern part of the Bowen Basin.

1.2.1.1 Nebo Synclinorium

The Lenton project area is located on the western flank of the Nebo Synclinorium. The Nebo Synclinorium is the northern extension of the Taroom Trough separated by an area of intense folding and faulting known as the Folded Zone (Baker et al., 1993), but formerly termed the Dawson Tectonic Zone (Derrington, 1962). North-northwesterly trending major thrust faults mark the western edge of this deformed zone. The Nebo Synclinorium is severely deformed, but less so than adjacent areas in the northern Bowen Basin (Staines and Koppe, 1979). Moreover, the northern end of the Nebo Synclinorium is less deformed than the southern part, but in both areas fold axes trend north-northwest, and therefore subparallel to the Triassic thrust fault systems (Traves and King, 1975). The Nebo Synclinorium has been previously described as large, elongate, low-amplitude domes, anticlines, and synclines (Dickins and Malone, 1973). Evidence that folding originated in the foredeep during the Late Permian and Early Triassic, is present as tighter folds compared to those in the overlying Triassic succession. This characteristic tight folding, however, does not extend west of the Jellinbah-Burton Range Fault system (Hawthorne, 1975).

During the Permian, the Bowen Basin was an area of long-term regressive shallow marine-lacustrine and terrestrial sedimentation (Mallet et al., 1995). Peat accumulated during much of this period, initially as isolated smaller deposits along the margins of the basin, but by the Late Permian covered much of it (Mallet et al., 1995). Tectonic shelves and platforms created the ideal environment for the deposition and preservation of coal, as they represented long lasting expansive topographically elevated areas that promoted peat accumulation by protecting the peat from the influx of external clastic sediment.

The cessation of peat accumulation coincided with the Permian-Triassic boundary event marking the single largest global mass extinction of terrestrial plants (Michaelsen, 2002). In the Bowen Basin, the long-lived (9 My), cold climate, peatmire ecosystem collapsed as 95% of the peat-producing plants became extinct as a result of extreme environmental change (Michaelsen, 2002). There is no noticeable change in the thickness, lateral extent or spatial distribution of coal seams or coal types prior to the extinction event indicating that it occurred very rapidly (McLoughlin et al., 1997).

1.2.2 Bowen Basin Coals

Coal is formed through the accumulation, burial and maturation of peat within a reducing environment. Peat formation occurs within shallow water environments (Diessel et al., 2000a, 2000b) with low oxygen levels. The relationship between the rate of accumulation and the water table must be balanced in order for peat to form. If the water table is too high (caused by high rates of subsidence) the peat drowns and peat formation terminates (Martini and Glooschenko, 1985). Conversely, if the water table is too low, peat becomes oxidized and peat formation ceases (Miall, 1996). When there is a balance between accommodation space and basin subsidence, the conditions for the formation of thick coal seams are met (Diessel et al., 2000a).

Rates of peat accumulation vary depending on the climate and vegetation type (Warwick, 2005). Maximum rates of peat accumulation have been found to be about 0.1 mm annually in cold climates to over 5 mm in tropical environments (Diessel et al., 2000a). Thicker peat deposits occur in areas of more rapid subsidence, however, these areas are generally more areally restricted compared to areas of slower subsidence (Ferm et al., 1979), inferring that widespread coals indicate slow rates of regional subsidence.

The formation of peatmires depends on the amount of available accommodation space. These peats require low topographic relief, favourable water-table position and a stable environment in which the peats can accumulate (Bax, 2007). The most common areas for peat to form are abandoned channels and floodbasin lakes; each having a distinct coal geometry. The type of plants that form the peats are also important in determining the type of coal formed. Relict features of the plants are preserved within the coals and the study of these features is known as maceral analysis. Macerals are the building blocks of coals, similar to minerals in rocks, and are analyzed using optical microscopy for reflectance, fluorescence and colour. Macerals are categorized into three kinds: vitrinite (associated with permanently waterlogged peats), inertinite (low or fluctuating water table within peats) and liptinite (moderate water table within peat). The reflectance of macerals, particularly vitrinite, is used to determine the burial temperature to which organic material has been subjected.

Although, coal seams in the Bowen Basin are extensive, only four seam groups are considered economic. These four groups (groups I, II, III, and IV) were described previously by Hawthorne (1974) but in 1980 another group was added to include uneconomic coal strata that occur between groups III and IV, and is termed group IIIA (Anderson, 1985).

1.2.2.1 Group I Coals

These are the oldest coals in the Bowen Basin and are confined to extensional basins. Group I Coals include the non-marine Reids Dome Beds, Capella Formation, Cullin-la-Ringo Formation and the Lizzie Creek Volcanics. These fault-bounded formations generally occur in the southwestern section of the Denison Trough, although uncommon outliers also occur in the volcanic sequence along the eastern margin of the Bowen Basin (Mallet et al., 1995).

1.2.2.2 Group II Coals

Group II Coals were formed in a shallow to marginal marine environment, where deposition was centered in early rift basins (Mallett et al, 1995). Thinner coal sequences occur widely through the rest of the basin. This group is made up of the Collinsville Coal Measures in the north and the Blair Athol Coal Measures in the south.

1.2.2.3 Group III Coals

During the Late Permian rapidly rising sea level, and accordingly transgression, occurred but then was followed by regression. Peat accumulation occurred during the regressive episode, which initially commenced in the north part of the basin and later spread further southward, resulting in the deposition of coal measures over much the basin (Mallett et al., 1995). Group III Coals are made up of the freshwater Moranbah Coal Measures in the north that transition southward into the marine-influenced German Creek Formation

(Mallett et al., 1995). These coal measures conformably overlie marine strata, and in turn, are overlain by tuffaceous coals of Group IIIA.

1.2.2.4 Group IIIA Coals

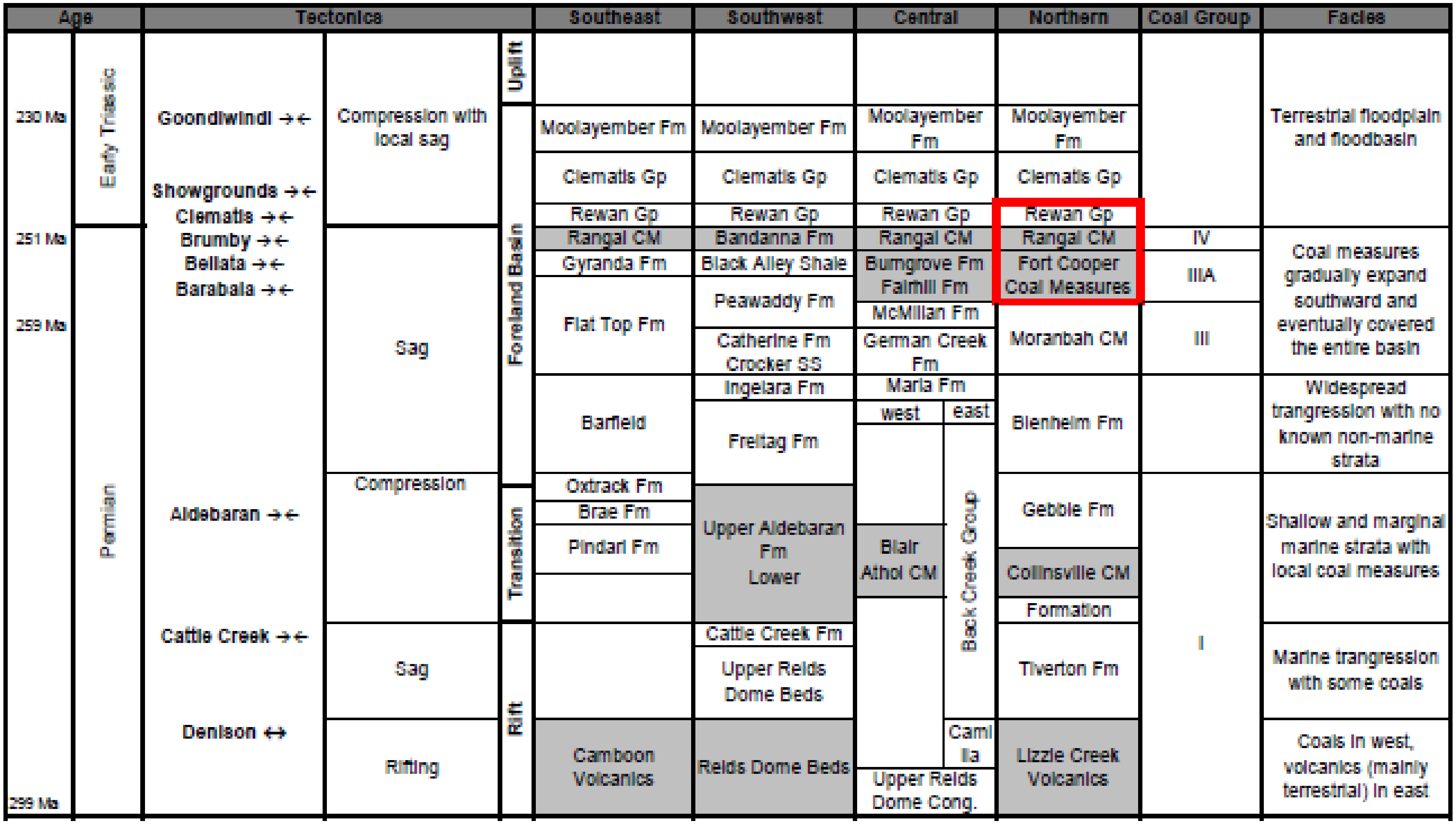
Group IIIA Coals are made up of the non-economic Fort Cooper Coal Measures. These coals formed during a time of high volcanic activity and as a consequence are rich in detrital mineral material (high ash content).

1.2.2.5 Group IV Coals

These are the youngest economic coal seams in the Bowen Basin extending along the northeastern margin of the Bowen Basin. Group IV coal measures are termed the Rangal Coal Measure in the central and northern areas, and the Barabala Coal Measures in the south (Mallet et al., 1995). In the northern and central part of the Bowen Basin Group IV coals are deposited on top of the Fort Cooper Coal Measures but in the south overlie non-marine sandstones, siltstones and mudstones of the Burngrove Formation (Mallet et al., 1995)

Throughout most of the Bowen Basin, the base of the Rangal Coal Measures (RCM) is marked by the widespread occurrence of low ash coal. This suggests an abrupt cessation of volcanism and input of volcanic ash and other detrital sediment following the Fort Cooper Coal Measures. The final major eruption forms the basin wide Yarrabee Tuff Bed (Matheson, 1990), which terminates deposition of the Fort Cooper Coal Measures, and thus this marks the base of the Rangal Coal Measures. The top of Group IV Coals is taken to be where the colour of the strata changes from a greenish-grey to grey. This boundary marks the base of the Rewan Group, a terrestrial alluvial and fluvial deposit consisting of siltstone, mudstone and sandstone (Mallett et al., 1995).

In the northern Bowen Basin, Triassic faulting and folding associated with the Nebo Synclinorium controls the distribution of the Group IV coal measures. The coal measures dip eastward or westward into the syncline, resulting in duplication and consequent thickening of the system occurs along a number of major north and north-northwest directed thrust faults related to Triassic compression (Mallett et al., 1995). It is these duplicated and hence thickened sections that are the primary target for coal exploration in the Lenton area.



Age		Tectonics			Southeast	Southwest	Central		Northern	Coal Group	Facies
	Early Triassic			Uplift							
230 Ma		Goondiwindi →←	Compression with local sag	Foreland Basin	Moolayember Fm	Moolayember Fm	Moolayember Fm		Moolayember Fm		Terrestrial floodplain and floodbasin
		Showgrounds →←			Clematis Gp	Clematis Gp	Clematis Gp		Clematis Gp		
		Clematis →←			Rewan Gp	Rewan Gp	Rewan Gp		Rewan Gp		
251 Ma	Permian	Brumby →←	Sag		Rangal CM	Bandanna Fm	Rangal CM		Rangal CM	IV	Coal measures gradually expand southward and eventually covered the entire basin
		Bellata →←			Gyranda Fm	Black Alley Shale	Burngrove Fm Fairhill Fm		Fort Cooper Coal Measures	IIIA	
		Barabala →←			Flat Top Fm	Peawaddy Fm	McMillan Fm		Moranbah CM	III	
259 Ma						Catherine Fm Crocker SS	German Creek Fm				
					Barfield	Ingelara Fm	Maria Fm		Blenheim Fm		Widespread trangression with no known non-marine strata
						Freitag Fm	west	east			
		Aldebaran →←	Compression	Transition	Oxtrack Fm	Upper Aldebaran Fm Lower		Back Creek Group	Gebbie Fm	I	Shallow and marginal marine strata with local coal measures
					Brae Fm		Blair Athol CM		Collinsville CM		
					Pindari Fm				Formation		
		Cattle Creek →←	Sag	Rift		Cattle Creek Fm			Tiverton Fm		Marine transgression with some coals
						Upper Reids Dome Beds					
		Denison ↔	Rifting		Camboon Volcanics	Reids Dome Beds	Upper Reids Dome Cong.	Camilla	Lizzie Creek Volcanics		Coals in west, volcanics (mainly terrestrial) in east
299 Ma											

Table 1: Bowen Basin stratigraphic summary (modified from Mallett et al., 1995). Grey shaded areas indicate the presence of coal measures. Ages from Michealsen et al. (2001) and Veevers et al. (1994), tectonic events from Korsch et al., 2009a, 2009b, 2009c. The study area is highlighted in red.

1.3 Area of Study

1.3.1 Location and Access

New Hope Exploration Pty Ltd and New Lenton Coal Pty Ltd, both subsidiaries of New Hope Coal Australia, own the Lenton exploration area. The exploration area encompasses four different tenements: EPC766, EPC865, EPC1675 and ML 70337. The Lenton deposit is located approximately 120 km southwest of Mackay, Queensland, Australia (Figure 4). It is located directly west of the Burton Mine, which produces thermal and coking coal for the export market. Access to the Lenton exploration area is via the Suttor Development Road and the North Goonyella Access Road. Within the project area, access is by dirt roads, fence lines and a power line easement.

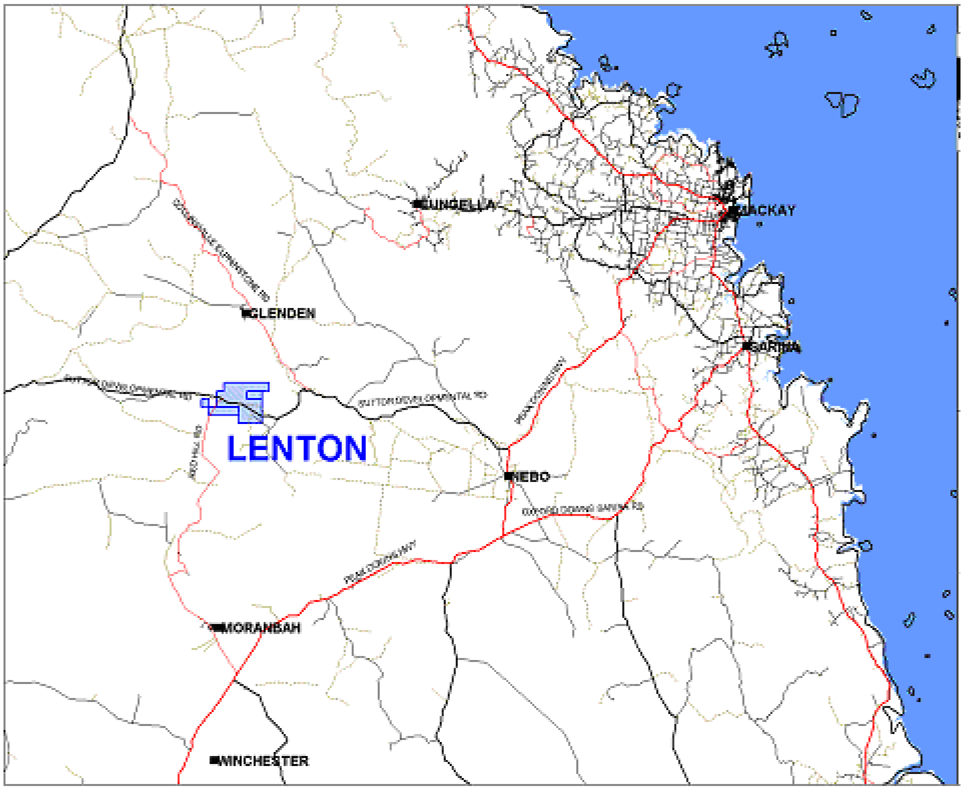


Figure 4: Location of the Lenton exploration area.

The area covered by these tenures is generally flat grazing country to the northeast, south and east. In the northwestern section of EPC766 the terrain becomes slightly more rugged with scattered surficial basaltic boulders. Prominent sandstone ridges of the Triassic Clematis Group border the tenures to the east, north and southwest (O'Reilly, 2005). The Isaac River flows from north-northeast to south-southwest and is located along the eastern side of the tenure area. Ephemeral creeks, which are tributaries to the Isaac River, flow in a west-northwest to east-southeast direction. These creeks and rivers drain from the Triassic ranges located to the northwest of the tenements.

Exploration in the Lenton area was designed to target open-cut thermal, coking and PCI (pulverized coal injection) coal deposits for the export market. The area is located on the western edge of the Nebo Synclinorium, where large thrust faults have duplicated and thereby tectonically thickened the Rangal Coal Measures. Coals are cleaner (lower detrital content) on the western limb of the Nebo Synclinorium, because of higher rates of subsidence and deposition on the eastern side. As a consequence coals on the western edge of the Nebo Synclinorium are currently being targeted as a high priority for exploration.

Figure 5: Regional locality plan for Lenton and the areal distribution of identified coal resources (O'Reilly, 2005).

1.3.2 Previous Work

Early exploration in the Lenton deposit suggested that underground resources in the northern area of the tenements were promising. Exploration in recent years has been focused on determining the extent, continuity and quality of these underground resources. A recent 2D mini-SOSIE seismic survey (July 2009) was designed specifically to target and define the underground resources directly to the north of the already defined open-cut deposit. Confirmation drilling is currently underway in order to upgrade the resource from indicated to inferred status, based on the Joint Ore Reserves Committee (JORC) requirements (the Australian equivalent of the National Instrument 43-101 requirements).

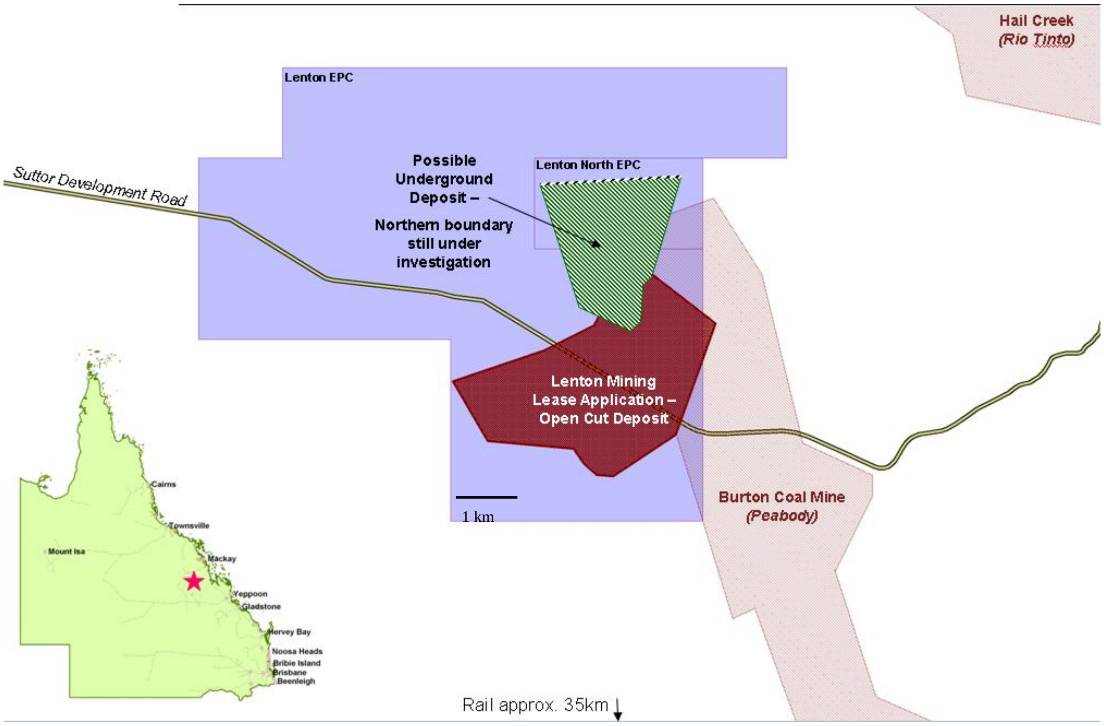


Figure 6: Location diagram with possible location for underground resources.

1.3.3 Structural Framework

The Lenton deposit occurs in a structurally complex area. It is bounded by the Burton anticline to the east and the Burton Thrust Fault to the west. Rangal Coal Measure strata occur on the western limb of the Burton anticline, whose eastern limb hosts the Burton Mine. The Burton Thrust Fault is a regionally extensive east-side-up fault that trends north-northwest with a vertical displacement of up to 600 m.

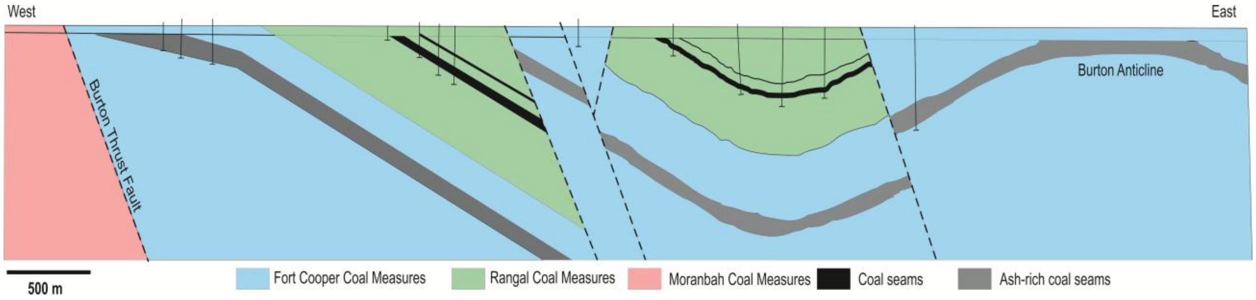


Figure 7: Cross-section of the New Lenton deposit area showing the location of structural elements including the Burton Thrust Fault and the Burton Anticline. Black vertical lines correlate to drill hole locations. Cross-section is located just south of geophysical log cross-section A--A' in Figure 42.

To date, there have been two structural analyses of the area: one based on a regional photogeological survey and the other on two site specific seismic surveys and accompanying lithological data completed in 2003 and 2004. A third structural analysis; is currently being conducted by New Hope Coal and is based on work completed after 2004, including seismic surveys in 2005, 2009 and 2010, as well as geophysical logs, core and chip data.

1.3.3.1 Photogeological Survey

A photogeological survey of the area was completed in August 2002 as a research and development project (Coupard, 2002). This technique involved the use of two (1964) aerial photograph mosaics with an approximate scale of 1:82000, good quality LandSat images from Geoimage Pty Ltd. (1:50000), and published geological maps (1:250000) to create a photogeological interpretation map to aid in coal exploration. This method proved to be good in identifying four major structural zones but was less useful in identifying small-scale structures:

i. The Northern/Eastern zone, which is characterized by open basin and dome type folding within strata of Clematis Group. Folding was then cross-cut by northwest, north-northwest and west-southwest trending faults.
ii. The Central zone contains the coal bearing deposits. It consists of broad gentle folds with their fold axis trending between north to north-northeast and fractures trending northeast-northwest. The north to north-northwest trending Burton Thrust Fault defines the western edge of this structural zone.
iii. The Southern zone occurs in the Burton Range syncline, which trends east-southeast in the west and south-southeast in the east and plunges towards the southeast. At the project boundary, however, it is thought that the plunge of the fold reverses.
iv. The Western zone is characterized by relatively flat-lying, undeformed strata with very few fractures.

1.3.3.2 Seismic Surveys

Four 2D mini–SOSIE seismic surveys have been completed on the Lenton tenures. (Velsies, 2003; Velsies, 2004; Velsies, 2005; and Velsies, 2009) The first three were designed specifically to target the open-cut resources in the mining lease area; these surveys were completed in 2003, 2004 and 2005. The fourth survey was designed to target underground resources in the exploration areas and was completed in 2009. The absence of unconsolidated overburden as well as thin and uniform weathering throughout the area created the ideal environment for seismic surveys. These conditions resulted in excellent data quality in all four of the surveys.

The 2D mini-SOSIE technique used a compact (70 kg) Wacker Rammler surface energy source to generate the seismic energy pulse. Seismic reflections are then recorded by 120 geophones placed at 8 m intervals along the line; 60 behind and 60 in front of the shot point. Coal is much less dense than the surrounding strata (~1.4g/cm^3 vs. 2.2g/cm^3) and causes a marked reduction in the propogation speed of seismic energy. Based on average sonic velocity of 3000 m/s, depth to the discontinuity (where sonic velocity changes) is given by:

Vertical depth of discontinuity = (measured travel time/2)*3000m/s

Once all of the data has been collected it is then stacked; a process that involves compiling (stacking) all of the data from each geophone to create a continuous image from which the depth and continuity of the coal seam can be interpreted. This stacked data is then processed and refined to generate images that can be used for interpreting trends and structures in the subsurface.

In 2003, 5.6-line kilometers of seismic data were shot along two east-west-trending lines. Similar surveys were completed in 2004; consisting of 6.6 km (over three east-west lines) and 2005; consisting of 8.8 km (over two east-west lines). The focus of the 2003 and 2004 surveys was to define the continuity of the coal seams and identify any structural features present. The objective of the 2005 survey, on the other hand, was to define the Burton Thrust Fault.

In 2009, a much larger 2-D seismic survey was completed. This survey involved 32.6 line-kilometers of seismic data collected over five lines. Unlike previous surveys three lines were oriented north-south and beyond the northern boundary of mining lease area along the estimated top of the coal. The other two lines are extensions of previous seismic lines and are oriented east-west. The results of this survey have been combined with older surveys to create a map of the Lenton area with the interpreted thickness of overburden above the Leichhardt Seam. The overburden thickens to the north of the mining lease area, and as such the northern part of the study area most likely represents underground resources. Thinner overburden to the south suggests that these coals can be exploited by less expensive open-cut techniques. To the west of the potential resources the Burton Thrust Fault downthrows strata and as a consequence dramatically increases the depth of the RCM by up to 600 m. The deep coals to the far north and west of the exploration area are unmineable based on the limitations of current underground mining technologies.

In order to assess the accuracy of this model, confirmation drilling has been designed to specifically target several of the features described above. This drill program was also designed to determine if the quality of the coal degrades or improves as depth increases. The previous and current drilling programs are outlined in the next section.

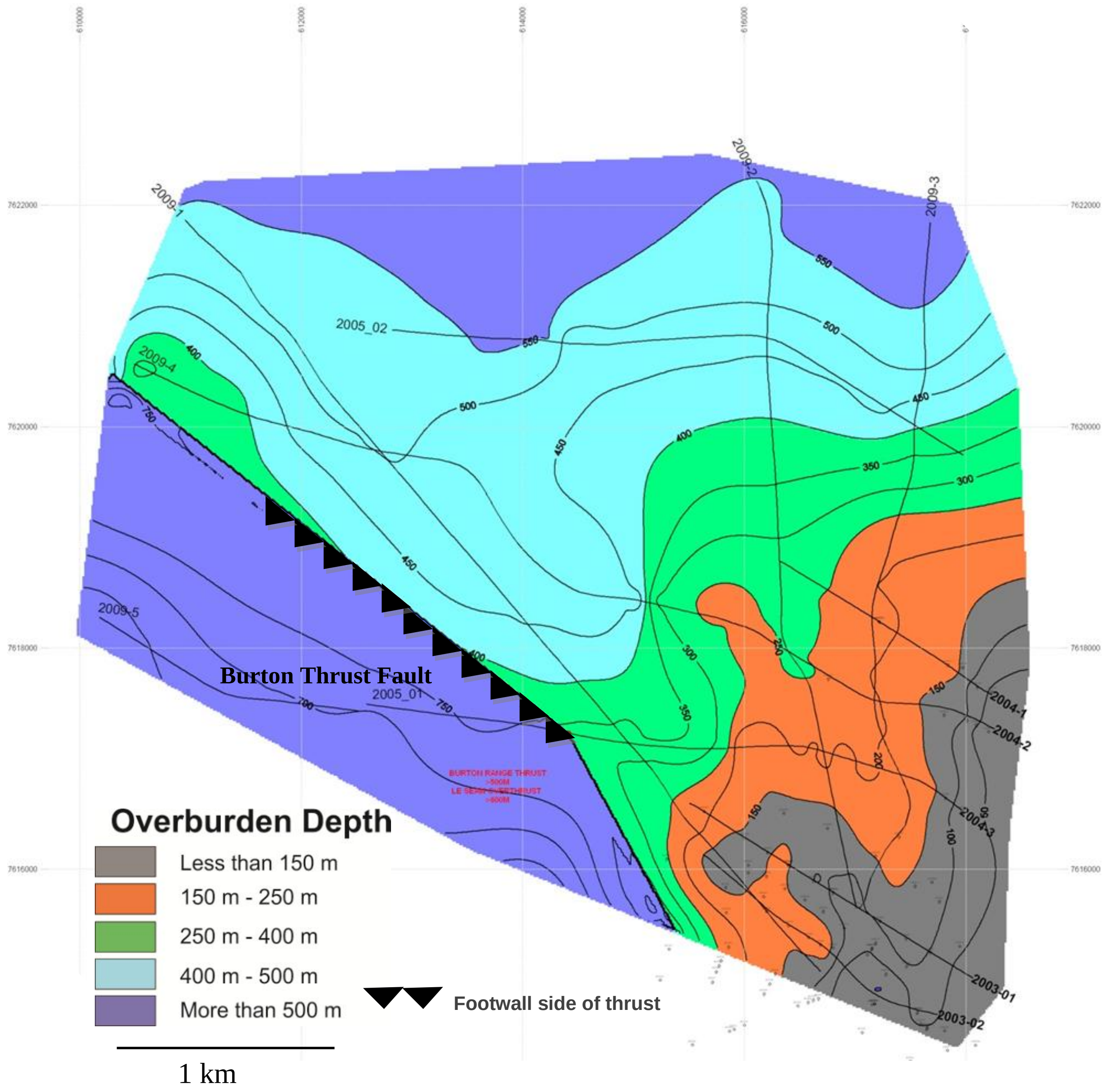


Figure 8: Thickness of overburden to the Leichhardt Seam. Contour interval is 50 m. Each of the seismic lines are shown.

1.3.4 Stratigraphy

The Bowen Basin is composed of sedimentary rocks that were deposited during the Permian and Triassic.

Figure 9 shows a generalized stratigraphic section for the basin. The study area is situated in the northern part of the Bowen Basin and comprises the following stratal units (listed from oldest to youngest):

- The Blackwater Group
    - Moranbah Coal Measures (MCM)
    - Fort Cooper Coal Measures (FCCM)
    - Rangal Coal Measures (RCM)
- Rewan Group

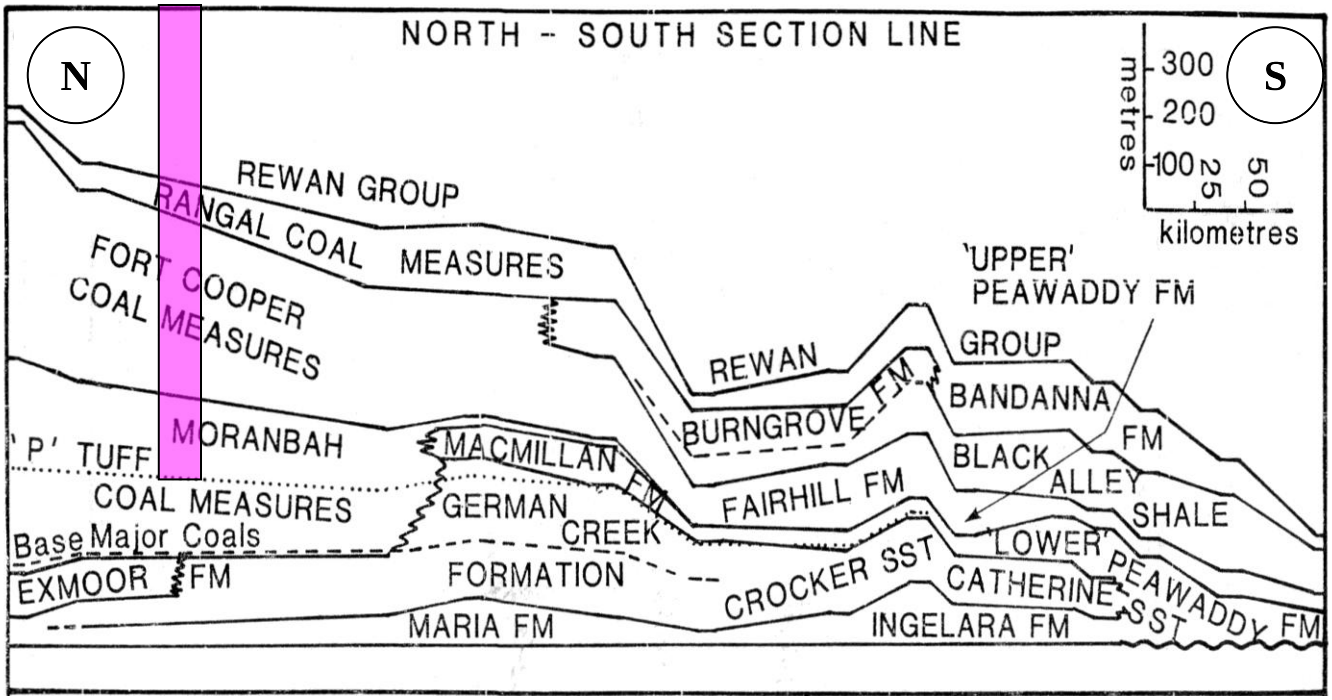


Figure 9: From north to south, the stratigraphic nomenclature of the Bowen Basin. The pink bar indicates the stratigraphic interval intersected in this study (modified from: Falkner and Fielding, 1990)

1.3.4.1 Permo-Triassic

1.3.4.1.1 Moranbah Coal Measures (MCM)

The MCM were formed in the Mid-Late Permian during the foreland loading episode in the Bowen Basin. These coals were deposited on the Collinsville Shelf under conditions that varied from a marine-influenced, nearshore marine environment in the German Creek Formation to dominantly fluvial floodplain environments further to the north in the MCM (Mutton, 2003). Coals in the MCM are high quality, and hence economically important. In the Lenton project area they occur at great depths (>800m) making them, at least with current underground technologies, unmineable.

1.3.4.1.2 Fort Cooper Coal Measures (FCCM)

The FCCM is the oldest Late Permian unit intersected at Lenton and consists mainly of a 100 m-thick sandstone-dominated succession. The Girrah Seam, consists of a 24 m-35 m thick coal intercalated with mudstone and siltstone, which if wholly mined would be uneconomic, due to its high detrital (ash) content. However, there are distinct plies within the Girrah seam that may be economic to mine at shallow depths using open-cut extraction methods. The FCCM are capped by a regionally continuous tuff layer, termed the Yarrabee Tuff.

1.3.4.1.3 Rangal Coal Measures (RCM)

The RCM are the principal coal-bearing interval in the Lenton study area. The contact between the RCM and the FCCM is taken at the top of a low-gamma sandstone/conglomerate sequence marking the top of the FCCM. Similarly the top of the RCM is the Sagittarius Sandstone at the base of the Rewan Group (see below). The RCM are the uppermost unit in the Blackwater Group, which is developed throughout much of the northern part of the Bowen Basin. At Lenton the RCM have been sub-divided into nine stratigraphic units (O’Reilly, 2005). These units are:

1. Interval between the base of the Vermont Lower Seam and the top of the FCCM

2. Vermont Lower Seam
3. Vermont Upper Seam
4. Carbonaceous interburden horizon between the Leichhardt Seam and the Vermont Seam
5. Leichhardt Seam
6. Leichhardt Upper Seam
7. Interval between the Burton Rider Seam and the Leichhardt Upper Seam
8. Burton Rider Seam
9. Interval between the base of the Sagittarius Sandstone and the top of the Burton Rider Seam

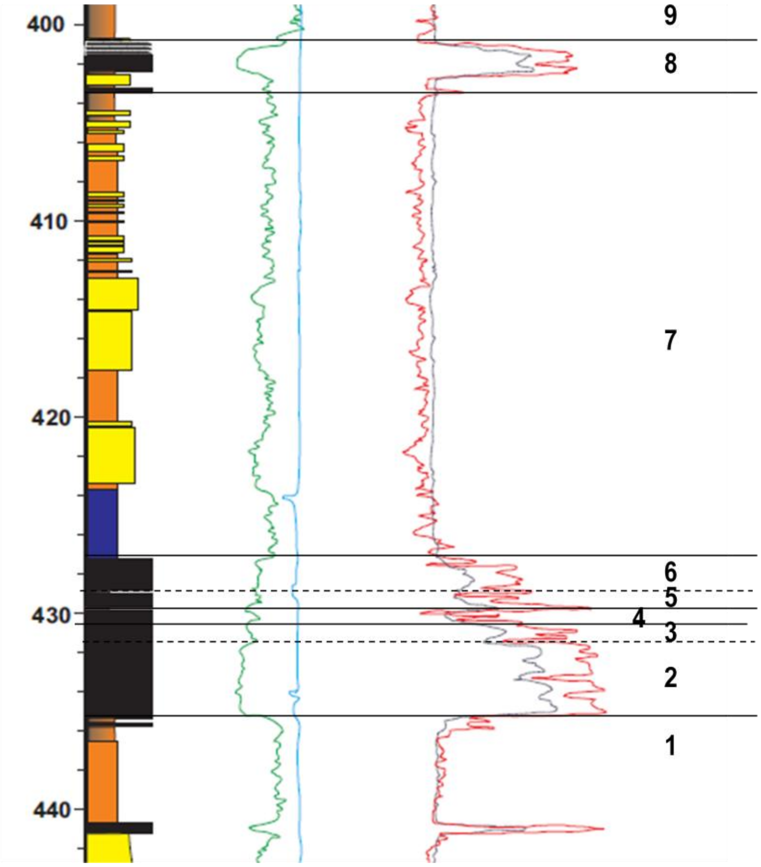


Figure 10: Divisions of the Rangal Coal Measures in the New Lenton area as proposed by O'Reilly (2003).

Unit 1- Floor of the Vermont Seam

This is the basalmost stratigraphic unit in the RCM and lies between the base of the Vermont Seam and the top of the FCCM. The top of the FCCM is marked by a relatively thin (~20 cm) interbedded sandstone/ conglomerate that can be easily identified on geophysical logs by its anomolously low gamma value. In the northern part of the exploration area, a thin (less than 5 cm) ash bed, which is interpreted to be correlative with the Yarrabee Tuff Bed, is taken to mark the top of the FCCM. Unit 1 ranges from 2.0 m- 5.0 m thick and is composed of fine-to medium-grained sandstone overlain abruptly by a dark brownish-grey slightly carbonaceous mudstone.

Unit 2- The Vermont Lower Seam

This is the lower ply of the 3.5 m-6.0 m Vermont Seam. It comprises a relatively bright, low ash, high yield coal. The seam is thickest (between 3.0 m and 4.0 m) at the northernmost end of the study area, but thins to between 2.5 m and 3.5 m elsewhere. The Vermont seam is the principal coal-bearing unit in the Lenton area and can be upgraded to produce a 7% or 8% ash, low phosphorus blend to hard coking coal (O'Reilly, 2005).

No distinctive marker separates the Upper and Lower Vermont seams. During field logging the contact is marked by a decrease in gamma ray counts whereas laboratory results indicate a difference in the swelling properties (crucible swelling number) of the coal between the Upper and Lower Vermont seams.

Unit 3- Vermont Upper Seam

This is the upper ply of the 3.5 m-6.0 m thick Vermont Seam. It is composed of a dull, high ash, low yield coal. The thickness of the Vermont Upper Seam is typically between 1.0 m and 1.5 m in the northern end of the study area and thickens to between 1.5 m and 2.0 m towards the southeast. In the southwestern area the Vermont Upper Seam is generally less than 1.0 m thick.

Unit 4- Leichhardt-Vermont Interburden

A 0.5 m-3.0 m unit consisting of carbonaceous mudstone, carbonaceous siltstone and inferior coal generally separates the Leichhardt Seam and the Upper Vermont Seam. This unit thickens from 0.5 m-1.0 m in the northern areas to 1.0 m-1.5 m in the southeast and 2.0 m-3.0 m in the southwest. This interburden unit is informally referred to as BV2 and has no economic potential due to its high ash and impurity content combined with low carbon content.

Unit 5- The Leichhardt Seam and Unit 6- The Leichhardt Upper Seam

The Leichhardt Seam directly underlies the Leichhardt Upper Seam and is a 0.3 m-1.0 m thick relatively clean, bright coal. In some areas, the Leichhardt Upper Seam is less than 0.3 m thick and it is included with the Leichhardt Seam to form a single combined seam, known to occur in the southeastern sections of the tenure area. In all other areas these two seams are separated by a thin (up to 10 cm thick) carbonaceous mudstone layer. Where occurring alone, the Leichhardt Upper Seam is between 0.3 m and 2.6 m thick and comprises mostly carbonaceous siltstone, carbonaceous mudstone and inferior coal. In the northern part of the exploration area the seam is generally between 1.5 m and 2.0 m thick and then thins progressively to the south. In the southwestern area the seam thickens from 1.0 m-1.5 m in the east to 2.0 m-2.5 m in the west (O'Reilly, 2005).

Unit 7- Burton Rider Seam- Upper Leichhardt Seam Interburden

This stratigraphic unit separates the Burton Rider Seam and the Leichhardt Upper Seam and is generally between 17 m and 40 m thick (averaging 24 m) (O'Reilly, 2005). The major constituent of this unit is cross-stratified siltstone interbedded with fine- to medium-grained sandstone with minor mudstone laminae. The medium-grained sandstone typically forms lenticular bodies up to 5 m thick.

Unit 8- The Burton Rider Seam

The Burton Rider Seam is generally between 1 m and 2 m thick and comprises bright clean coal. The upper section of the Burton Rider Seam (0.2m-1.0m) has been known to contain calcite-filled cleats. This calcified coal is easily identified in core and typically abruptly overlies the bright clean coal.

Unit 9-Roof of the Burton Rider Seam

This interval marks the top of the Burton Rider seam. It is generally between 10 m and 25 m thick and is composed mostly of interbedded siltstone and mudstone with local lenticular sandstone bodies up to 3 m thick. Carbonaceous content decreases stratigraphically-upward beginning where the lithology changes from a bright clean coal to carbonaceous rock. This boundary can be easily identified on geophysical logs, especially density logs where it is marked by a dramatic increase (in density).

1.3.4.1.4 Rewan Group

This is the youngest Permo-Triassic unit at Lenton and forms most of the overburden in site-specific open-cut mining operations. Two formations make up the Rewan Group; the Sagittarius Sandstone and the Arcadia Formation. The Sagittarius Sandstone is a terrestrial floodplain deposit consisting of interbedded greenish-grey siltstone and sandstone as well as chocolate-brown mudstones (Staines and Koppe, 1979). It is overlain abruptly by the Arcadia Formation, which consists of distinctively reddish-brown mudstone with which the Rewan Group is most commonly associated. The boundary between these two formations is defined by a prominent colour change; from a greenish-grey sandstone (Sagittarius Sandstone) to a reddish-brown mudstone (Arcadia Formation). In the Lenton area, the Arcadia Formation is only present in the northern areas, owing to post-depositional erosion in the south.

The distinctive greenish-grey colour of the Sagittarius Sandstone Formation is due to the occurrence of a suite of chlorite-zeolite diagenetic minerals, resulting from distinct depositional and diagenetic changes (Mallet et al., 1995). These early diagenetic minerals formed when the rapid disappearance of peat swamps contributed to a reduction of organic content in the sediments. The lack of organic material is associated with the global Permian-Triassic boundary mass extinction event when more than 95% of all peat forming plants died (Michaelsen, 2002) and is a distinctive feature of the Sagittarius Sandstone. The chlorite-zeolite assemblage with its distinctive greenish-grey colour does not form in coal-bearing strata because of the high carbon dioxide content and the otherwise clay-carbonate suite of minerals, with its grey colouration.

The boundary between the Rewan Group and the RCM has been difficult to define in the Lenton area. In nearby regions, this horizon is marked by the change from greenish-grey sandstone to grey sandstone. This definition can be problematic because of its subjectivity and the fact that it occurs at stratigraphic levels regionally. At Lenton, the base of the Rewan Group is marked by the base of the last thick coal-barren sandstone unit, generally located between 10 m and 25 m above the Burton Rider Seam (O'Reilly, 2005).

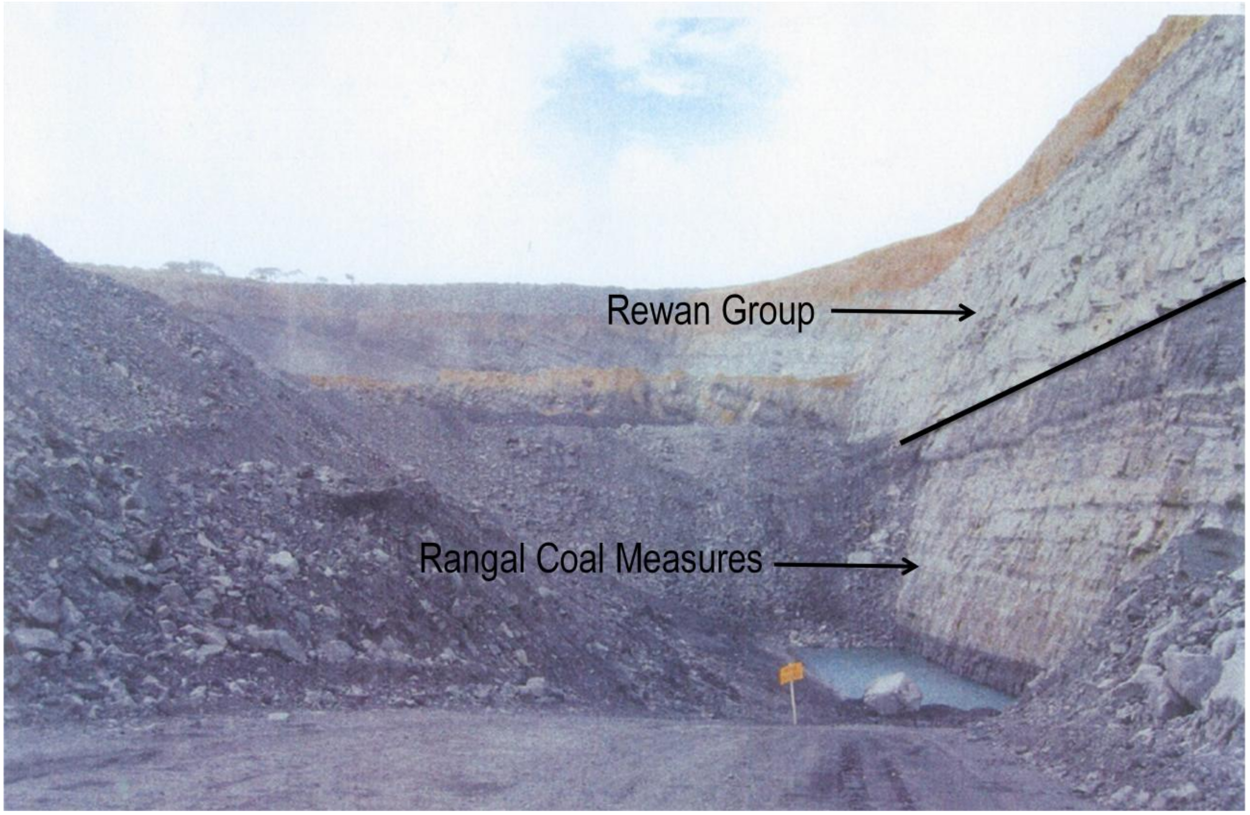


Figure 11: Contact between the Rangal Coal Measures and the Rewan Group in the Burton Mine highwall located immediately to the east of the New Lenton deposit area.

1.3.4.1.5 Permian-Triassic boundary

The contact at the top of the Rangal Coal Measures and base of the Rewan Group marks a very important boundary in the geological record, the Permian-Triassic boundary. This boundary has been associated with a global mass extinction of 95% of peat forming plants (Michaelsen, 2002), 80-90% of marine genera (Raup, 1979; Erwin, 1993a, 1993b, 1993c; Brayard et al., 2011) and 70% of all vertebrates (Benton, 1988; King, 1991; Maxwell, 1992). The cause of this extinction is still uncertain, however, numerous factors have been suggested including supernovi, declining numbers of marine provinces, salinity changes, volcanism, extraterrestrial impact and global anoxia (Yin et al., 1984; 1989; Jablonski, 1986a, 1986b; Yang et al., 1987; Holser and Magaritz, 1987; Maxwell, 1989; Hallam, 1991; Wignall and Hallam, 1992; Wignall, 1993; Erwin, 1991; 1993a;

1993b; 1993c; 1994). More recently, it has been suggested that this mass extinction is part of a complex interconnected web of causality resulting in increase of global temperatures of about 8 degrees Celsius (Joachimski et al., 2012). This temperature increase has been attributed to Siberian Traps volcanism (Sobolev et al., 2011), destabilization of methyl hydrates (Retallack and Jahren, 2008) and increased methane in the oceans resulting in global anoxia (Luo et al., 2010).

1.3.4.2 Cenozoic

Unconformably overlying the Permo-Triassic sedimentary pile is an up to 10 m layer of Quaternary alluvium. The unconformity between the Triassic and Cenozoic strata is caused by erosion of the Triassic sediments, which were estimated to be up to 10 km thick. In most places, these strata are overlain by relatively thin (~10 m) Holocene strata. This alluvium is composed mostly of clay, but in areas where the alluvium is over 10 m thick basal sand and gravel bands are common (O'Reilly, 2003).

1.3.4.3 Weathering

The base of the modern weathering profile varies but generally is of the order of 15-30 m below the surface. In areas close to the Isaac River and the thicker Quaternary section, the depth of weathering increases and can be as much as 40 m. In the western part of the exploration areas, west of the Burton Thrust Fault, there is a 10-20 m-thick basalt that crops out of the surface.

1.4 Study Objectives and Methodology

1.4.1 Objectives

The objectives of this study are to describe the constituent lithofacies of Permo-Triassic strata in the Lenton study area, and to interpret their environments of deposition. In addition, the lateral and vertical assemblages of lithofacies will be used to reconstruct the spatial and temporal evolution of this economically important sedimentary system.

1.4.2 Methodology

Fieldwork was conducted over a period of 13 months, starting in November 2008 and ending in December 2009. Work was done on an 18 day-on and 9 day-off rotation. There was considerable downtime between the months of November 2008 and June 2009 due to delays related to weather, breakdowns and logistics. A total of 15 holes were drilled and geophysically logged during the 2008-2009 field season. Of these, two holes were fully-cored drill holes, totalling 684 m, and used to help interpret the sedimentological and depositional conditions in the study area. From these two fully-cored drill holes, thirteen mudstone samples were taken and analysed for major and trace element geochemistry using x-ray fluorescence (XRF) at the University of Ottawa. Seventy-two coal samples were sent to the Australian Coal Industry Research Laboratories for detailed coal petrology while an additional 13 samples of varying lithologies were taken and analysed using optical microscopy. A two-dimensional seismic survey was completed in June and July of 2009, which covered 32.9 line kilometres over 5 lines.

1.5 Statement of Contributions

Sedimentary rocks in the Bowen Basin have been the subject of a large number of site-specific studies, which in most cases are unpublished company reports. There have been several regional sedimentological and stratigraphic analyses of the Bowen Basin (e.g. Koppe, 1978; Staines and Koppe, 1979; Mallet et al., 2005), but most of the available literature is related to the Moranbah Coal Measures (e.g. Archibald, 1983; Devey and Murray, 1983; Johnson, 1984; Michaelsen and Henderson, 2000; and others) and only a few have described the Rewan Group and the Rangal Coal Measures (Fielding et al., 1992; Michaelsen and Henderson, 2000). Small-scale sedimentary features within the strata have been seriously under-studied, or at least under-published. The present study is the first to fully analyze and interpret the sedimentological and depositional conditions during deposition of the Rewan Group and Rangal Coal Measures within the Lenton exploration area.

Chapter 2- Facies Descriptions and Interpretations

2.1 Introduction

Based on visual observations in two cores, six lithological facies have been identified in the Lenton deposit study area: (a) medium-to coarse-grained sandstone, (b) interbedded siltstone and mudstone, (c) interlaminated siltstone and sandstone, (d) carbonaceous siltstone and mudstone, (e) coal and (f) volcanic ash. Cores are 6.5 cm wide and 229.5 and 454.5 m long and are located in the northern part of the exploration area (Figure 6). Stratigraphic logs are located in Appendix 1.

Facies		Description	Interpretation
1	Medium-to coarse-grained sandstone	Cross-stratified, 1-150 cm thick, scour based, fining upward sequences with common sideritized rip up clasts at the base of the unit	Deposited in a braided fluvial environment where channel fills are initiated by erosion
2	Interbedded siltstone and mudstone	10- 70 cm thick units of interbedded green siltstones and brown mudstones with common root traces and mottling features	Paleosols formed in seasonally waterlogged environments
3a	Graded sandstone to siltstone	2-30 cm thick, fine-grained sandstones overlain by cross-stratified, thinly interlaminated sandstone and siltstone with common pinstripe laminated carbonaceous detritus	Deposited in a shallow, freshwater floodplain lake
3b	Graded sandstone to siltstone	Up to 30 cm thick, high angle cross-stratified, fine-grained sandstone with carbonaceous debris concentrated along the bottomset	Deposited by a slow-moving flow in a channel flanked by vegetated overbank
4	Carbonaceous siltstone and mudstone	Up to 50 cm thick, very thinly bedded carbonaceous siltstone and mudstone	Marsh deposits
5	Coal	0.5- 5.0 m thick coal beds composed predominantly of vitrinite and inertinite	Long-lived, regionally extensive peat system
6	Volcanic Ash	Up to 10 cm thick, whitish-grey clay bands	Deposited by wind-blown volcanic ash

Table 2: Summary of facies descriptions and interpretations for the New Lenton deposit.

Grain size, sorting and shape classifications are based on Lewis (1984), Compton (1962) and Powers (1953), respectively. The classification scheme of McKee and Wier (1953) is used to define bed thickness (very thinly bedded (1-3 cm), thinly bedded (3-10 cm), medium bedded (10-30 cm), thickly bedded (30-100 cm) and thickly bedded (>100 cm)). In addition, based on set thickness, cross-stratification is described as small- (1-5 cm) or large-scale (>5 cm).

2.2 Facies 1 (F1) – Medium-to coarse-grained sandstone

2.2.1 Description

Strata of F1 consist of 1-150 cm thick units of greenish-grey, moderately well-sorted, typically medium- and coarse-grained sandstone. Units are typically scour-based (cm deep) and fine upward from coarse-grained sandstone with common clasts at the base to medium- or fine-grained sandstone at the top. Strata of Facies 1 sharply overlie interbedded siltstone and mudstone (F2) or interbedded sandstone and siltstone (F3) (see below), and in turn are sharply overlain by strata of F2 or gradationally by F3. Common sideritic mudstone and siltstone clasts occur near the base of units and range from lensoid to elliptical, in length from 1-10 cm (pebble to cobble), and form a moderately organized fabric oriented sub-parallel to bedding. In addition, rare irregularly shaped clasts that range up to 15 cm in diameter are observed. Internally, these clasts consist of contorted and/or convoluted layers of siltstone and medium-grained sandstone. At their base units consist of medium-to coarse-grained size cross-bedded sandstones sets 1-10 cm thick. Upward sets thin to 1-4 cm thick. The large-scale cross-stratification is succeeded upward by medium-grained cross-laminated sandstone sets 1-5 cm thick (where present). Some small-scale cross-stratified sets climb at shallow (less than 10^{o}) angles. Framework grains range in shape from sub-rounded to sub-angular and are composed predominantly of volcano-lithic fragments (~50-70%) and quartz (~ 20-40%) with minor feldspar (<10%).

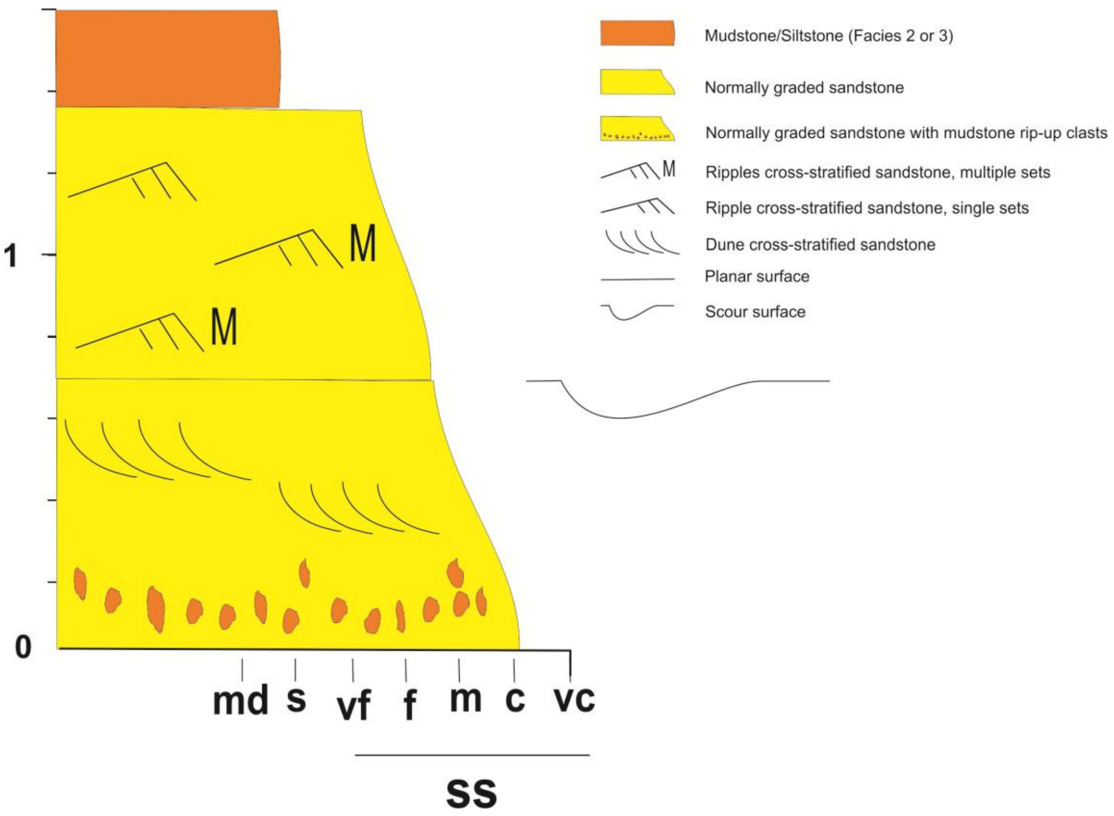


Figure 12: Idealized stratigraphic column of Facies 1.

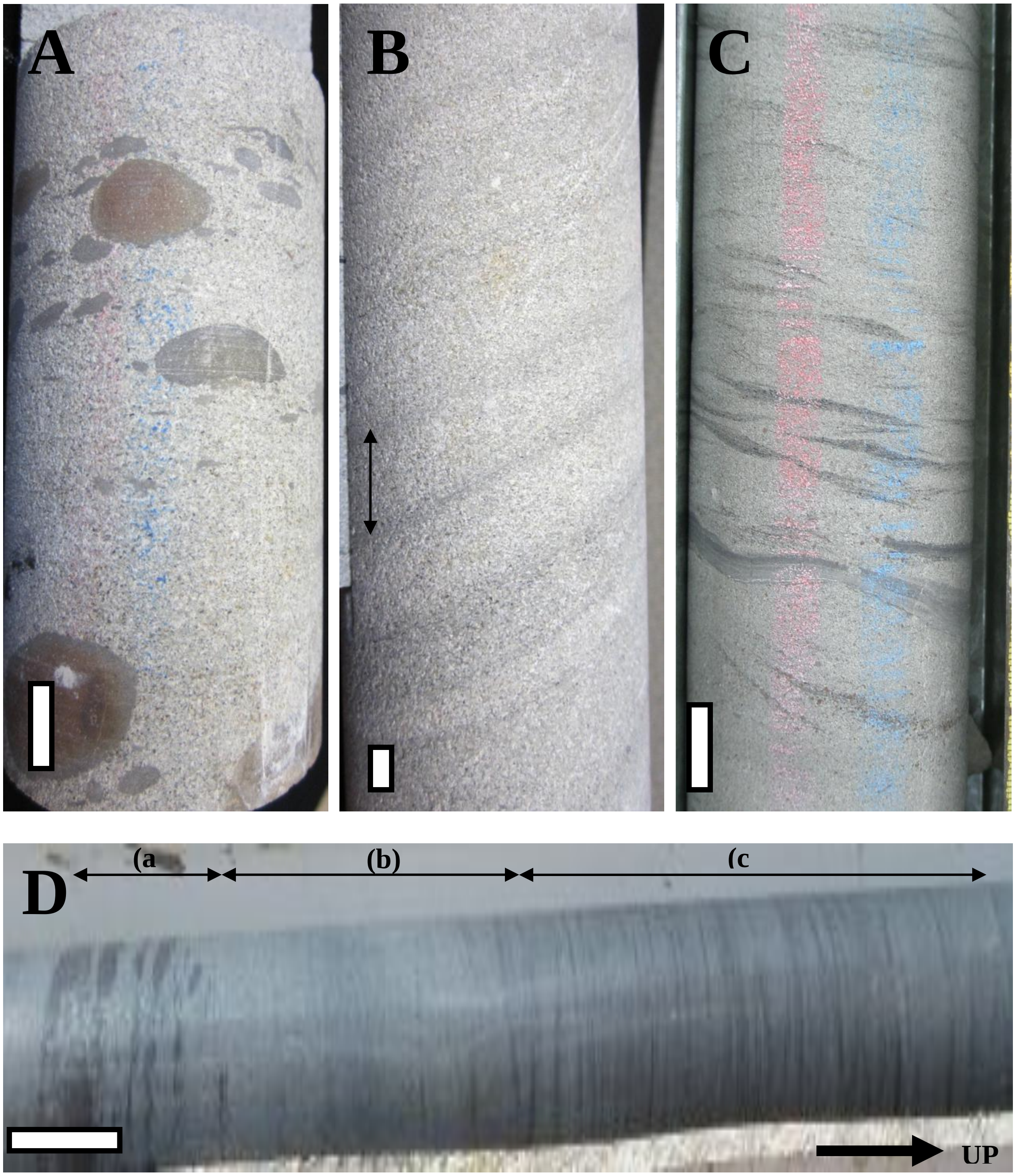


Figure 13: F1 sandstone (A) dispersed sideritized mudstone clasts. Note the subparallel orientation of the clasts, which typically occur near the base of sandstone units and are concentrated in bands up to about 50 cm thick. (B) coarse-grained, large-scale cross-bedded strata of Facies 1. Note the discrete cross-beds that grade upward from coarse- to medium-grained sandstone (arrow indicates a single cross-bed). (C) Medium- to coarse- grained, normally graded, small-scale cross-laminated strata of Facies 1. (D) Complete upward-fining channel fill succession consisting of (a) dune-cross stratified coarse grained sandstone with sideritized mudstone clasts, (b) dune cross-stratified medium- to coarse- grained sandstone overlain by (c) ripple cross-laminated fine-grained sandstone. Note that white bars are 1 cm long in (A), (B) and (C) and 5 cm long in (D).

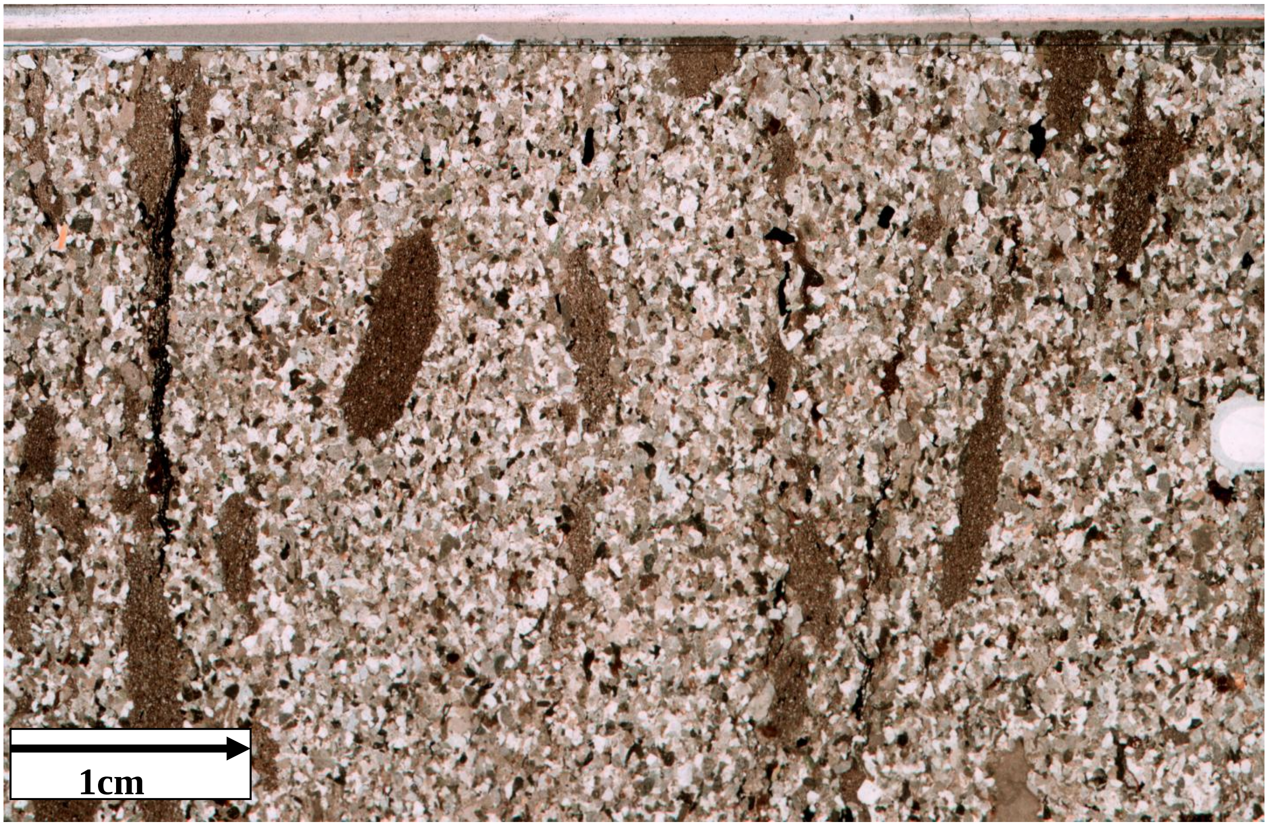


Figure 14: Photomicrograph of coarse-grained sandstone of facies 1. Note the sub-parallel orientation of the sideritized rip-up clasts along the base of the stratification.

2.2.2 Interpretation

Based on grain size, thickness of sets and thickness (cross-bedded) of cross-stratification, coarse-grained, cross-bedded strata of F1 are interpreted to be deposited by migrating unidirectional subaqueous dunes. The average set thickness of about 5 cm suggests a formative dune height on the order of 15 cm (Bridge and Tye; 2000). Moreover, if it is assumed that dune height scales with flow depth, which according to Bridge and Tye (2000) ranges between about 6 and 10, suggests that the dunes formed in an open channel flow on the order of 90 and 150 cm deep. Coarse, dune cross-stratified sandstones are usually overlain by medium-grained, cross-laminated sandstone. These latter strata are interpreted to be deposited by the migration of lower energy unidirectional current ripples, and suggest an upward decrease in flow speed and most probably flow depth too.

The medium and coarse grain size and ubiquity of dune and ripple cross-stratification suggest deposition in a high energy fluvial system (cf. Miall, 1992). However, abundant and in places irregularly shaped mudstone and siltstone rip-up clasts suggest minimal transport and therefore local derivation from areas of low energy suspension deposition. Also, because the clasts are sideritized (iron is in its reduced state, most probably Fe^{2+}) indicates bacterially mediated disaerobic to anoxic aqueous conditions in the shallow subsurface (Mozley, 1989; Coleman et al., 1993; Baker et al., 1996). The early diagenetic precipitation of siderite instead of thermodynamically more favourable pyrite (Berner, 1981; 1984) indicates a lack of available sulfur, which in turn suggests meteoric (freshwater) pore fluids and also a period of limited volcanic activity, which again would limit the availability of sulfur.

The sharp based, decimeter to 1.5 m thick units that make up F1 are interpreted to be channel fills initiated by erosion, which commonly involved the scouring of laterally adjacent areas of fine-grained deposition. Once the channel formed, and based on dune scaling ratios and also measured thicknesses of upward fining successions, channels were only of the order of a few meters deep. When flow depths were at their greatest, and most probably flow speed too, coarse-grained sand dunes formed on the channel floor. As channels filled, flow speed diminished and dunes were replaced by finer-grained lower energy ripples. The shallowness of the flows, the paucity of mudstone layers (F3) and the abundance of traction transport sedimentary structures, namely ripples and dunes, suggests that strata of F1 are part of an areally extensive braided fluvial system.

In the ancient braided fluvial sedimentary record it is difficult to differentiate channel fill from braid bar deposits, unless the margins of the channel can be defined, as both are dominated by dune cross-stratification (Skelly et al., 2003). Since observations in this study are confined to core, channel margins cannot be defined and as a consequence strata of F1 cannot be accurately differentiated into braided bar and braided channel deposits. However, large-scale high-angle cross-stratification is commonly associated with the braid bar and the remainder of the braided channel is composed of meter-scale, trough and planar-tabular, dune cross-stratified bar deposits (Sambrook Smith et al., 2009). Furthermore, using the Parana, South Saskatchewan, Wisconsin and Jumuna rivers as modern analogues for braided fluvial systems it can be estimated that 15-20% of the stratal succession is made up of braid bar deposits and the remaining 80-85% is attributed to the channel component (Sambrook Smith et al., 2009). However, it is important to note that this may be a grossly oversimplified estimation because there is much uncertainty about the parts of fluvial systems that become preferentially preserved in the geological record (Miall, 1996). Nevertheless, although greatly oversimplified, the work of Sambrook-Smith (2009) gives the best estimate for the proportion of fluvial deposits within a braided fluvial system.

2.3 Facies 2 (F2) – Interbedded siltstone and mudstone

2.3.1 Description

Strata of F2 are typically abruptly overlain or overlie strata of F1 or F3. Units consist of 10-70 cm thick units of interbedded greenish-grey siltstone and chocolate brown mudstone. Siltstone grains are well sorted, range in shape from sub-rounded to rounded, and consist predominantly of quartz and volcano-lithic fragments with minor feldspar. Small-scale cross-stratified beds generally less than 2 cm thick are observed rarely. Mudstones are unlaminated (massive) and composed of clay- and silt-sized particles. Mudstones are also relatively soft and are non-fissile. The contact between siltstone and mudstone units is generally sharp, but locally is obscured by 5-20 cm thick zones with extensive green and brown coloured mottles and common root drab-coloured root haloes. Although rare, some strata show horizontal colour banding, this absence most probably is the result of intense mottling. Siderite is common and occurs as dispersed 2-30 cm diameter concretions or less commonly is concentrated along horizons near the base of siltstone and sandstone units.

2.3.2 Interpretation

Based on three distinctive and recurring features, namely root traces, soil horizons and glaebules, mudstones and siltstones of F2 are interpreted to be paleosols (Retallack; 2001), which are the remnants of ancient soils that were either buried by deposition or preserved at the surface and no longer undergoing soil forming processes. The characteristics and composition of a paleosol depends on physical and chemical conditions at the time of formation, which then provides insight for paleoenvironment reconstruction. Glaebules, for example are three-dimensional nodules embedded in a matrix of soil materials (Brewer and Sleeman, 1969), which in this case are interpreted to be the siderite nodules. More appropriately, these nodules are carbonate soil concretions formed by microbiologically mediated chemical processes through the action of organism stimulated reactions within the sediment (Curtis and Coleman, 1986; Raiswell; 1988).

Root traces are commonly surrounded by a greenish-grey halo that extends into the paleosol matrix, and are termed drab-haloed root traces (Retallack, 1999). This feature forms in waterlogged soils where bacterial activity forms local reducing conditions around roots and burrows and along cracks while the centers remain oxidized.

The top of the paleosol horizon is recognized as the surface from which the roots penetrate downward and its basal contact is generally gradational (Retallack, 1999). In this study, although rootlets are absent, the drab-haloed root traces are considered to mark the paleosol horizon associated with the fossilized “O” (organic) soil horizon.

The common greenish-grey colour and mottling of the mudstones are common features of waterlogged soils (Bouma, 1983; Blume and Schlichting, 1985) and are the product of an early diagenetic process termed gleization, one of the 17 soil-forming processes identified by the Soil Taxonomy and the World Soil Reference Base (Bockheim and Gennadiyev, 2000). Gleization is the process of forming reduced iron minerals such as drab-coloured clays, siderite and pyrite, and is commonly associated with early anoxic diagenetic environments, specifically those that are waterlogged or buried (Retallack, 1999). Gleization occurs when bacterial activity reduces oxidized minerals like Fe^{3+} in anoxic stagnant water on the surface and/or shallow subsurface. The activity of microorganisms is required because the chemical reduction of oxide and oxyhydrate minerals is very slow at typical Earth surface temperatures and pressures (Retallack, 1999). Microorganisms thrive in vegetated areas explaining why gleyed soils are commonly enriched in fossilized plant material and hence are common in coal measures (Hughes et al., 1992; Retallack, 1991; 1994; 1995). Gleization results in the reduction of iron from the ferric state (Fe^{3+}), generally associated with red, yellow and brown coloured minerals (Hurst, 1977), to the ferrous state (Fe^{2+}), generally associated with grey or green coloured minerals (Retallack, 1999). Due to the fact that ferrous iron is much more soluble than ferric iron, gleyed horizons or spots are generally more depleted in iron compared to their ferric counterparts (Retallack, 1999).

Gleyed soils show little evidence of bioturbation, and tend to have well preserved relict structures (stems, leaves, roots) associated with the accumulation of organic debris (i.e. peats, fens and bogs) (Retallack, 1999). The soils associated with these types of environments are generally acidic (low pH) due to the presence of organic acids associated with the decomposition of plant material; however, this can be altered by a local source of alkalinity (limestone, dolostone, mafic minerals, etc.). Easily weathered minerals also tend to persist in gleyed soils because mineral weathering is retarded by the low rates of water circulation associated with these local waterlogged environments (Retallack, 1999).

At the opposite end of the spectrum, paleosols that have been highly oxidized are known as “redbeds”, which are generally reddish-brown in colour but can become a bright fire-engine red if they undergo sufficient oxidation (Retallack, 1999). The degree of redness is due to the nature and grain size of the iron and hydroxide minerals formed by the oxidation of iron-bearing minerals in the parent material. Generally these soils undergo a change from goethite ($FeO(OH)$, brown) to hematite (Fe_2O_3, red) as they become progressively more oxidized (Retallack, 1999). In seasonally wet areas the depositional environment alternates between oxidizing and reducing conditions, resulting in an alteration of the gley-coloured reduced beds and red-coloured oxidized beds.

F2 paleosols show the alternation of greenish-grey (gley) and brown-coloured (oxidized) beds commonly associated with seasonal waterlogging. This suggests that the parent soils formed under a seasonal climate characterized by a melt season with ponded surface water conditions, which left the soils gleyed, followed thereafter by a dry season when the soil drained and became oxidized. Drab-haloed root traces (see Figure 15) suggests that, in addition to being waterlogged, the soil must have been sufficiently dry at times to support surface vegetation. Collectively, these features are consistent with similar features reported from temporarily waterlogged environments where chemical conditions alternated between strongly reducing and strongly oxidizing (Retallack, 1983, 1991, 1997).

The oxidation state of paleosols is important for reconstructing the chemical processes and the associated depositional environment in which the soil formed. Soil type depends on five main environmental factors including climate, parent material, time, topographic relief and organisms (Retallack, 1999). In some cases, paleosols provide important insight into large-scale events that occurred during their formation. In this study area, for example, the stratal section traverses the Permian-Triassic boundary, which marked a global mass extinction event (Michaelsen, 2002) and a major change in global flora and fauna (Smith, 1995; Retallack, 1999; Retallack and Krull, 1999). Studies across the boundary report a profound change in peat forming vegetation from *Glossopteris*- and

Gangamopteris-dominated communities to *Sphagnum* and coniferous vegetation, a consequence of which was a hiatus of coal synthesis during the Early Triassic (Hawke et al., 1999; Retallack, 1999; Michealson, 2002). In the Lenton area the coal gap occurs at the transition from coal-rich strata of F4, F5 and F6 (Blackwater Group) to the overlying coal-barren strata of F1, F2 and F3 (Rewan Formation). This transition is also suggested by a subtle change in stratal characteristics as rocks in the Blackwater Group are grey in colour, whereas those in the Rewan Formation have a slight greenish hue, which gets progressively more deeply coloured stratigraphically upward.

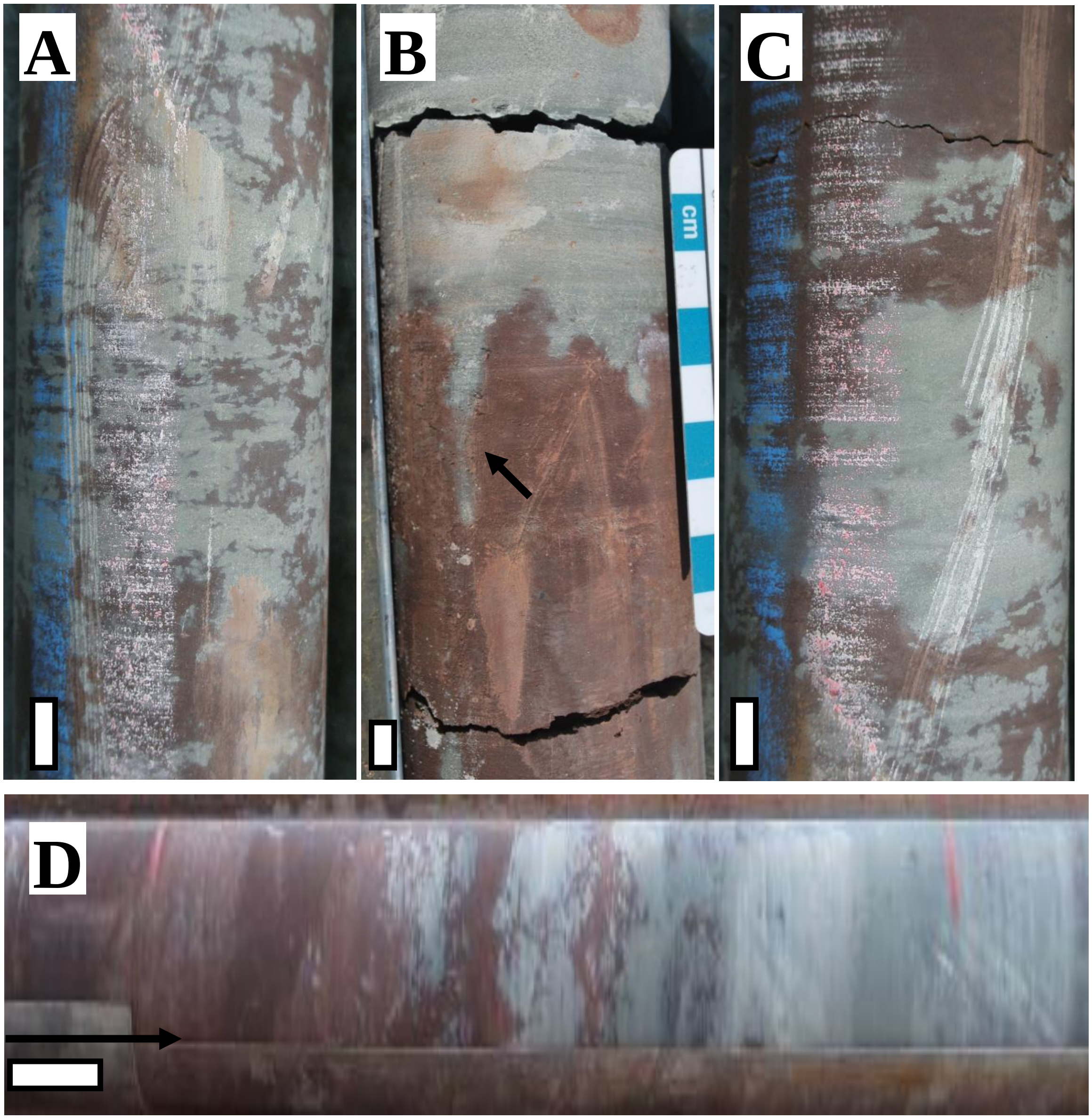


Figure 15: Mottling features in core LEN241PC taken at depths 158.70 m, 177.0 m and 161.00 m, respectively. Blue and red chalk lines are used to orient the core. Scale bars in A, B and C represent 1 cm. (A) A mottled oxidized red siltstone and reduced green mudstone, the irregular mixing is created by differential chemical reduction of plant material within the soil. (B) Drab-haloed root trace (shown by arrow) penetrating downward into oxidized mudstone. (C) Close-up of the transition between the siltstone (red) and mudstone (green) rock types. (D) Upward transition from oxidized siltstone (red) to reduced (green) mudstone, note transition occurs over a span of about 25 cm. Scale bar is 5 cm.

2.4 Facies 3 (F3) – Graded sandstone to siltstone

Small-scale cross stratification of Facies 3 occurs as two end member kinds, termed Facies 3A and 3B.

2.4.1 Description Facies 3A

F3 commonly gradationally overlies F1 and is abruptly overlain by F2. Strata consist of fine-grained sandstone that in most cases is overlain gradationally by thinly interlaminated siltstone dominated sandstone/siltstone. Beds range from 2 to 30 cm thick. The basal part of the bed consists of moderately well sorted, fine-grained, small-scale cross-stratified sandstone in sets 1-5 cm thick. The upper part of the bed is characteristically darker coloured and made up of pinstripe laminated black carbonaceous detritus and very well-sorted siltstone. Cross-stratification is commonly observed as symmetrical concave-downward, convex-upward sets up to 5 cm thick.

The colour of the bed varies from predominantly grey where near a coal-bearing unit, to predominantly green farther away. Bed bases are mostly sharp and locally scoured. These beds are commonly intercalated with structureless beds less than 10 cm thick that grade upward from fine-grained sandstone to siltstone. Sideritic blebs (up to 0.5 mm) are commonly dispersed in the fine-grained sandstone part of the bed.

2.4.2 Interpretation Facies 3A

Low-angle and concave and convex-upward cross-stratification in sandstones of facies F3A is interpreted to be formed by small-scale oscillatory wave ripples. The common occurrence of siderite, which indicates early diagenetic precipitation under reducing and most probably meteoric conditions, suggest that the overlying water body where the waves formed was probably a shallow, freshwater floodplain lake.

Intercalated graded, structureless sandstone beds are interpreted to be deposited by density currents, specifically moderately concentrated hyperpycnal flows. These flows were generated by highly concentrated sediment plumes associated with the overspill of water and sediment from nearby fluvial channels during flood. Suspended sediment from the flooding rivers and that mobilized by overland flow, then flowed into an adjacent floodplain lake. Here it formed a hyperpycnal flow that moved downslope and eventually deposited fine-grained sand as the current waned.

2.4.3 Description Facies 3B

Facies 3B is more common and makes up about 85% of F3, but like Facies 3A it is commonly intercalated gradationally with F1 (medium- to coarse grained sandstone) and abruptly with F2 (interbedded siltstone and mudstone). Sharp-based beds of Facies 3B consist of fine-grained cross-stratified sandstone that occurs in units up to 30 cm thick. Unlike F3A, cross-stratification is consistently high angle ($>10^o$) and in sets up to 3 cm thick. In addition, carbonaceous debris is concentrated on the lower part of the foreset and along the bottomset.

2.4.4 Interpretation Facies 3B

High-angle, cross-stratified sandstone with concentrated layers of carbonaceous debris along the bottomset and lower foreset is interpreted to have been deposited by low-energy unidirectional current ripples. The low energy allowed finely communuted organic debris to become trapped in the ripple’s lee side separation bubble, where it then settled preferentially on the lower part of the foreset and along the bottomset. This fine detritus was then buried by the next gravity-driven sand transporting avalanche event. This suggests that avalanching was most probably episodic (ie. non-continuous) and therefore consistent with low energy conditions. The abundant organic debris in the sandstones indicates that these ripples were likely deposited by a slow-moving flow in a channel, most likely flanked by vegetated overbank (Hossain et al., 2002).

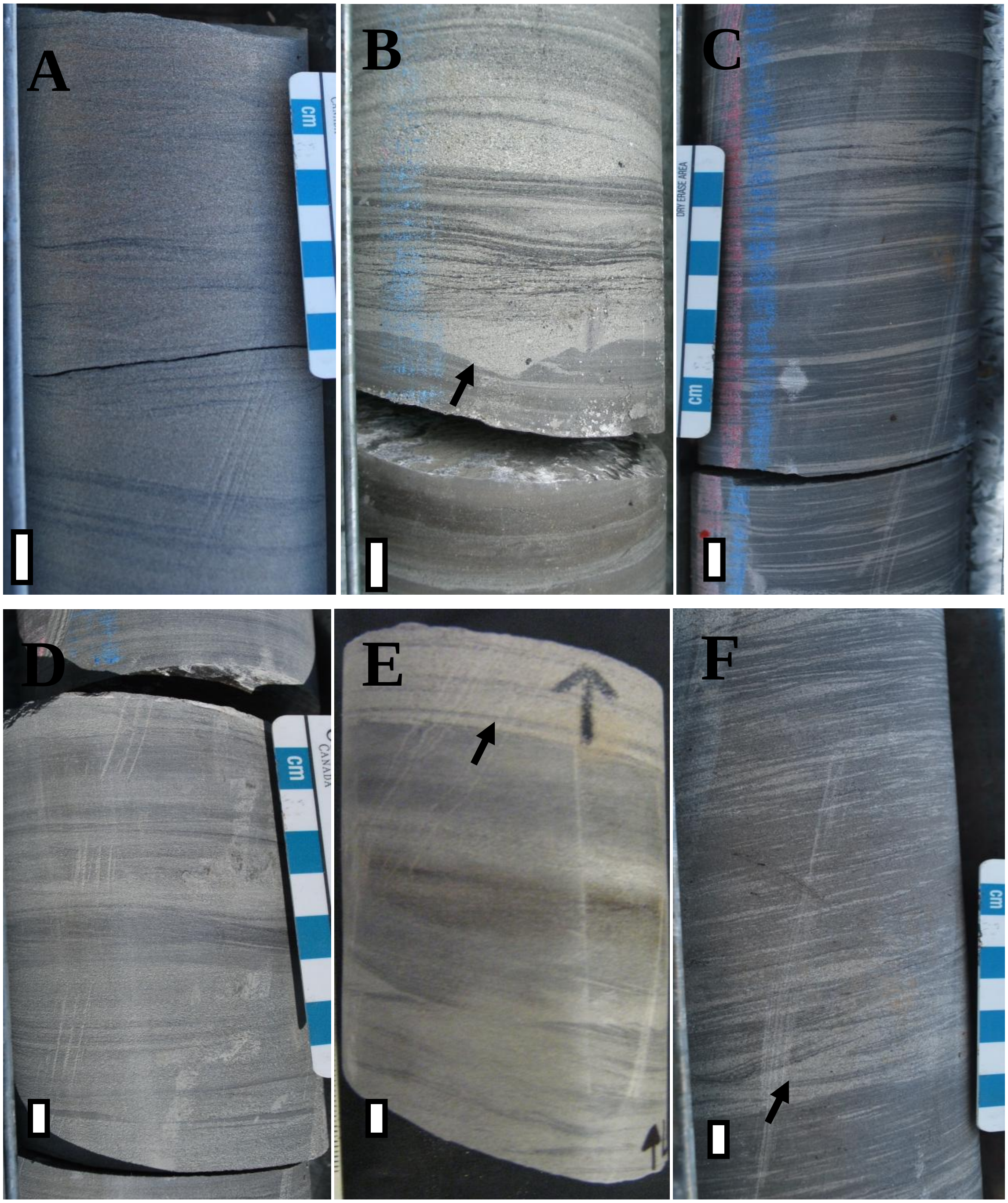


Figure 16: Interstratified sandstone and siltstone from LEN240PC and LEN241PC, all scale bars are 1cm. (A) F3B small-scale (ripple) cross-stratified fine-grained sandstone. Note the concentration of carbonaceous debris (black bands) along the bottomsets (B) F3A scour-based, medium-grained cross-stratified sandstone, which grades abruptly upward into fine-grained sandstone (C) F3A pinstripe interlaminated siltstone and fine-grained sandstone, which occasionally are ripple cross-stratified (D) F3A low-angle cross-stratified fine-grained sandstone. (E) F3A fine-grained, small-scale, low angle, cross-stratified sandstone at the base that grades upward into finer grained siltstone, which then is overlain abruptly by coarse-grained sandstone (arrow) (F) F3B fine-grained sandstone grading up to pinstripe laminated siltstone

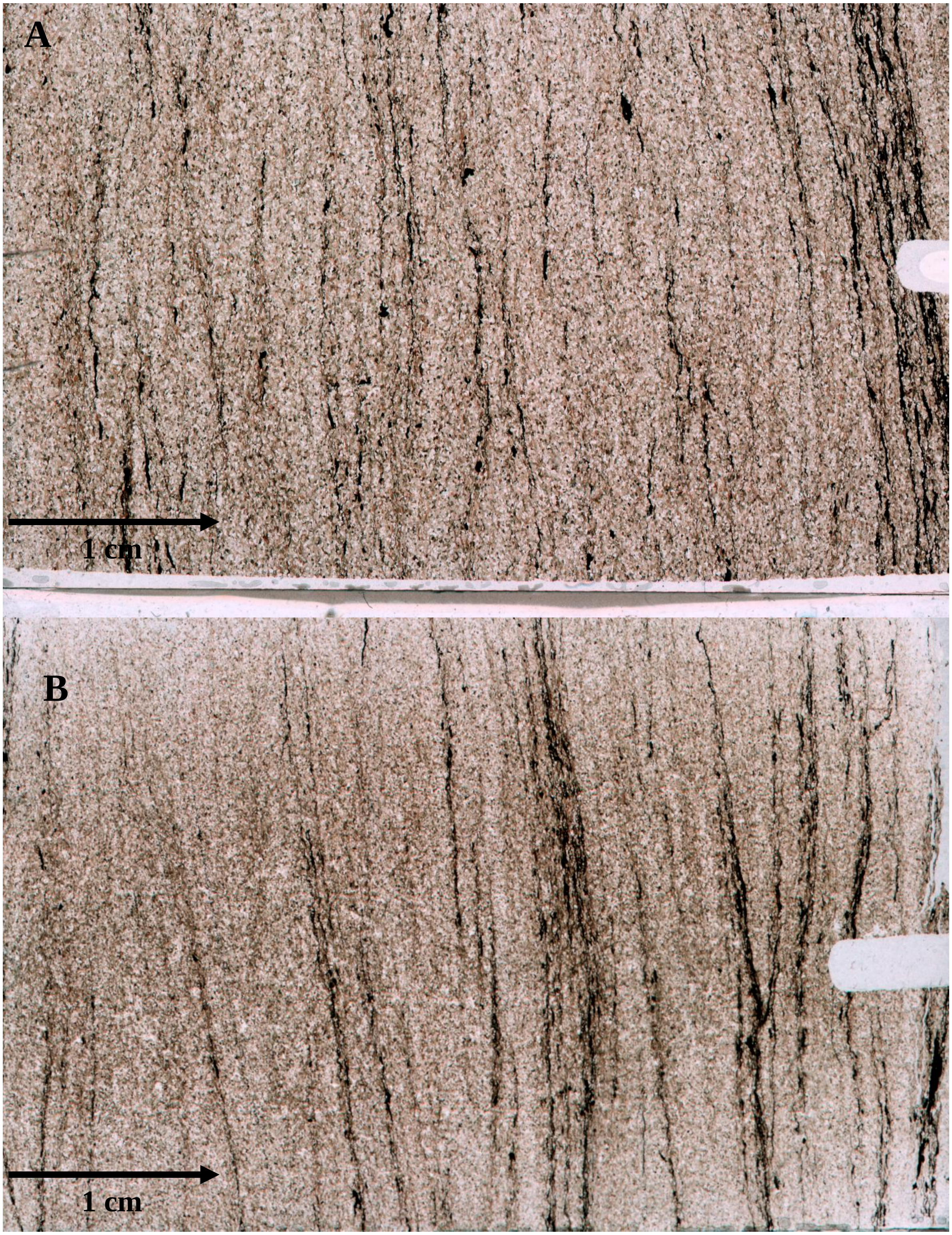


Figure 17: Thin section photos of Facies 3B ripple cross-stratified sandstone. Note the communuted organic debris along both the foreset and bottomsets of the ripples. Arrows atop of scale bars indicate way-up.

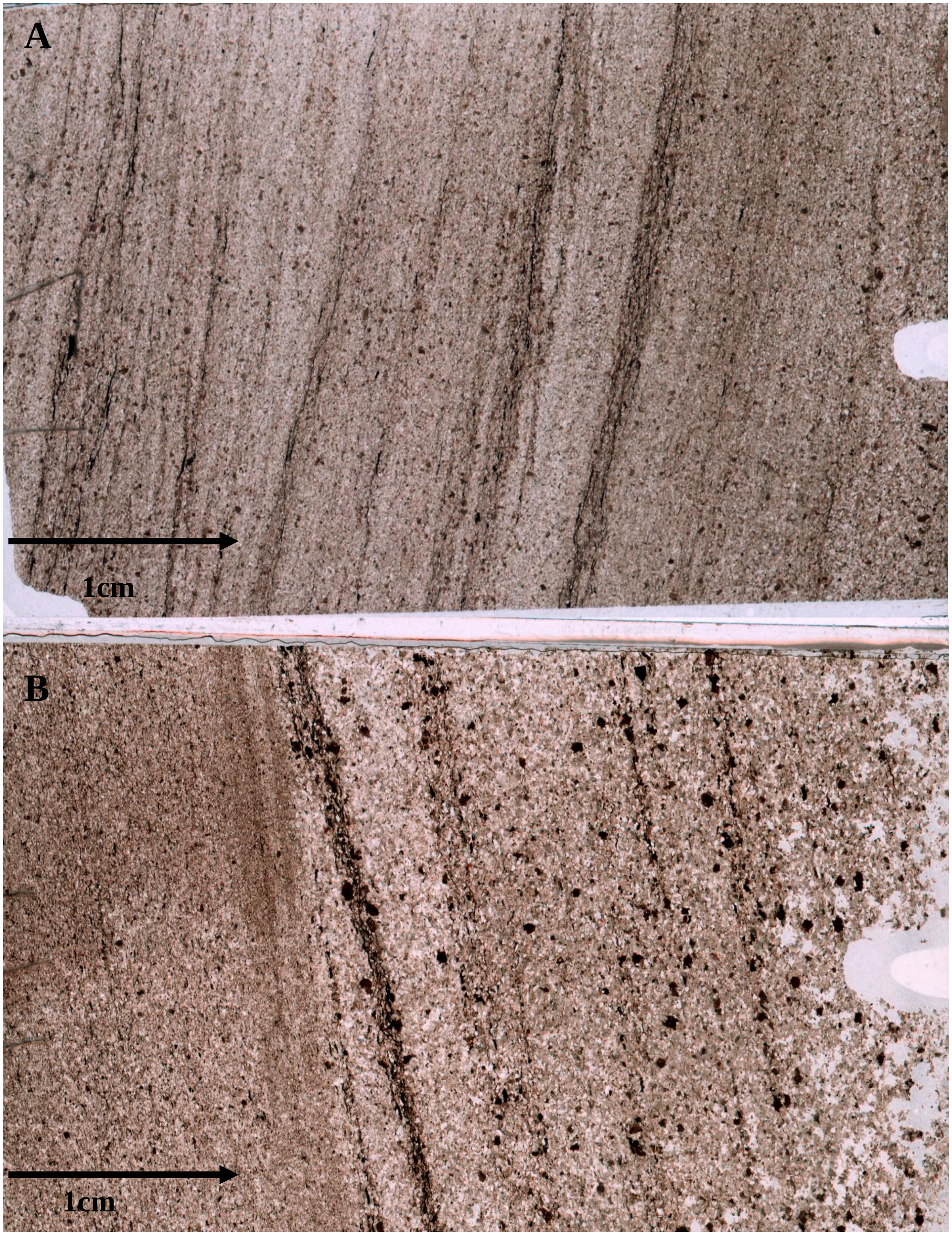


Figure 18: Thin section photos for Facies 3A, ripple cross-stratified sandstones. Note the low angle and of cross-stratification in both A and B.

2.5 Facies 4 (F4) – Carbonaceous siltstone and mudstone

2.5.1 Description

F4 is composed of very thinly-bedded (less than 2 cm) carbonaceous siltstone and mudstone. Mudstone is commonly black but in some cases has a dark brown hue; carbonaceous siltstone is generally black with a dark greyish hue. Carbonaceous mudstones are non-fissile, unlaminated and composed of well-sorted clay and silt sized particles. F4 mudstones are slightly harder than F2 mudstones. Carbonaceous siltstones are very thinly bedded (less than 2cm) and commonly parallel laminated.

Strata of F4 gradationally overlie, and in turn are gradationally overlain by coal (F5, see next). Calcite veins and calcite mineralization along fracture planes are common and concentrated near the base of F4 units.

2.5.2 Interpretation

Carbonaceous-rich strata of F4 are interpreted to be marsh deposits. Moreover, since they only occur immediately before the coal facies they also represent the transition from clastic to in-situ sediment accumulation. The influx of clastic sediment likely represents the transition between in-situ peat accumulating environments (F5) and clastic fluvial styles of sedimentation (F1, F2 and F3) created by an imbalance between basin subsidence and plant growth rate. In marsh deposits, the organic material becomes diluted by the influx of clastic sediments, which resulted in carbon-rich very fine-grained mudstones and siltstones.

2.6 Facies 5 (F5) – Coal

2.6.1 Description

Coal bands are black and composed mostly of vitrinite (35-60%) and inertinite (37-62%) (see Petrography Section). Coal brightness is used to quantify the amount of bright and dull banding within the coal seam and ranges from C6-C1 (1-100% brightly banded) but typically between C4-C2 (40-90% brightly banded). Individual bands typically range from 0.5-5 cm thick and coalesce to form two laterally continuous clean coal seams, an upper one that ranges from 1.0-3.0 m thick (Leichhardt seam) and a lower seam that is 3.0- 9.0 m thick (Vermont seam). In the Lenton area, these seams are overlain by a third seam (Burton Rider seam), which is typically between 1.0-2.0 m thick composed of dull coal (C6-C5, less than 10% bright). Base of F5 strata is abrupt and is overlain everywhere by F4. The lower coal seam contains a single, laterally continuous volcanic ash layer (F6).

Bright bands of coal, which are more common in the lower part of both coal seams, are more brittle and conchoidally fractured compared to the upper part of the seam. In addition, the uppermost part of the seam has significant secondary calcite mineralization along cleat planes. Overall, the coal seams contain little detrital sediment (i.e. low ash content).

2.6.2 Interpretation

The thick and laterally extensive nature of the F5 coals are considered to have accumulated in a long-lived, regionally extensive, low-lying peat system generated during a time of negligible clastic influx. The uniform seam thickness indicates a close balance between rates of subsidence and peat accumulation (Johnson, 1984). The observed dulling-up sequence is common in Permian coals of Australia (Beeston and Draper, 1991; Michaelsen and Henderson, 2000) and thought to represent the progressive drying out of the peat swamps that presumably caused more in-situ oxidation (Beeston and Draper, 1991).

F5 coals are predominantly bituminous in rank (between 87-94 % carbon) and is generally used as thermal and coking coal. Based on the thickness of the three coal seams, the peatland where the woody material accumulated is interpreted to have covered much of the Bowen Basin by the Late Permian, an area of at least 60000 km^2 (Fielding et al., 1992; Mallett et al, 1995; Michaelsen, 2002). The thickness of the seams and the minimal amount of clastic detritus (ash) indicate that the accumulation of the peat occurred in a stable environment where basin margin effects were minimal. With peat compaction factors of approximately 7:1 (or more) (Shearar and Moore, 1996), and the coal seams in the study area up to 12 m thick, suggests that at least 84 m of peat accumulated to form individual seams. To accumulate such a thickness of peat with negligible clastic sediment input requires the peatlands to have been raised above the surrounding terrain. Once raised surface water can no longer reach the center of the peatland in response to the flattening out of the peat causing the middle part of the peatland to become ombrotropic (entirely rain fed) and a shallow dome of peat develops (Stewart and Kantrud, 1971). In such a position the only clastic input would be wind-blown, which at least in the study area was apparently a negligible sediment contributor.

A modern peatland analogue for the Bowen Basin coal measures is interpreted to be modern cold-climate bogs in Canada (Martini and Glooschenko, 1985; Hawke et al., 1999). Here, the modern plant zonations in the tundra of northern Ontario to the hardwood swamps of southern Ontario are similar to those described from the Permian coal measures of the Bowen Basin (Martini and Glooschenko, 1985). Peat accumulation rates range from 0.1mm/year in the Arctic to 1mm/year in cool temperate regions suggesting that the Bowen Basin peats needed somewhere on the order of 84 ky to 0.84 My to accumulate. Moreover, the rate of basin subsidence remained similar to the rate of peat accumulation; too high and the basin would become inundated, and too low the basin would accumulate (clastic) mineral sediment rather than peat (Warwick, 2005). Nevertheless, although seemingly insightful to compare modern Hudson Bay peats with ancient Bowen Basin coals, major differences in tectonic activity and volcanism between the two environments makes the correlation equivocal (Martini and Glooschenko, 1985). Although these two environments are tectonically very different, eliminating the comparability of subsidence rates, sedimentation patterns and coal quality comparisons can still be drawn between modern and ancient large-scale cold climate plant zonations and growth rates. Dulling up sequences in coal, like those observed in the study area, are similarly observed in both modern day peat analogues where it is shown to be related to downward penetrating oxidation of the peat (Hawke et al., 1999).

Secondary calcite mineralization occurs in the uppermost part of F5, which is common in Late Permian coal measures in the Bowen Basin (Uysal et al., 2007). Based on Sm-Nd dating and rare-earth element (REE) concentrations, the calcite mineralization is thought to have occurred as a result of fluid-rock interactions associated with the timing of the final contractional phase of the Hunter-Bowen orogeny (235 ± 15 Ma) (Uysal et al., 2007). High epsilon Nd values (average of +1.2) indicate that the fluids involved in calcite precipitation interacted with isotopically primitive rocks (volcanogenic) and were likely sourced from a volcanic arc to the east of the basin (Baker et al., 1993; Fielding, 1997; Uysal, 2007).

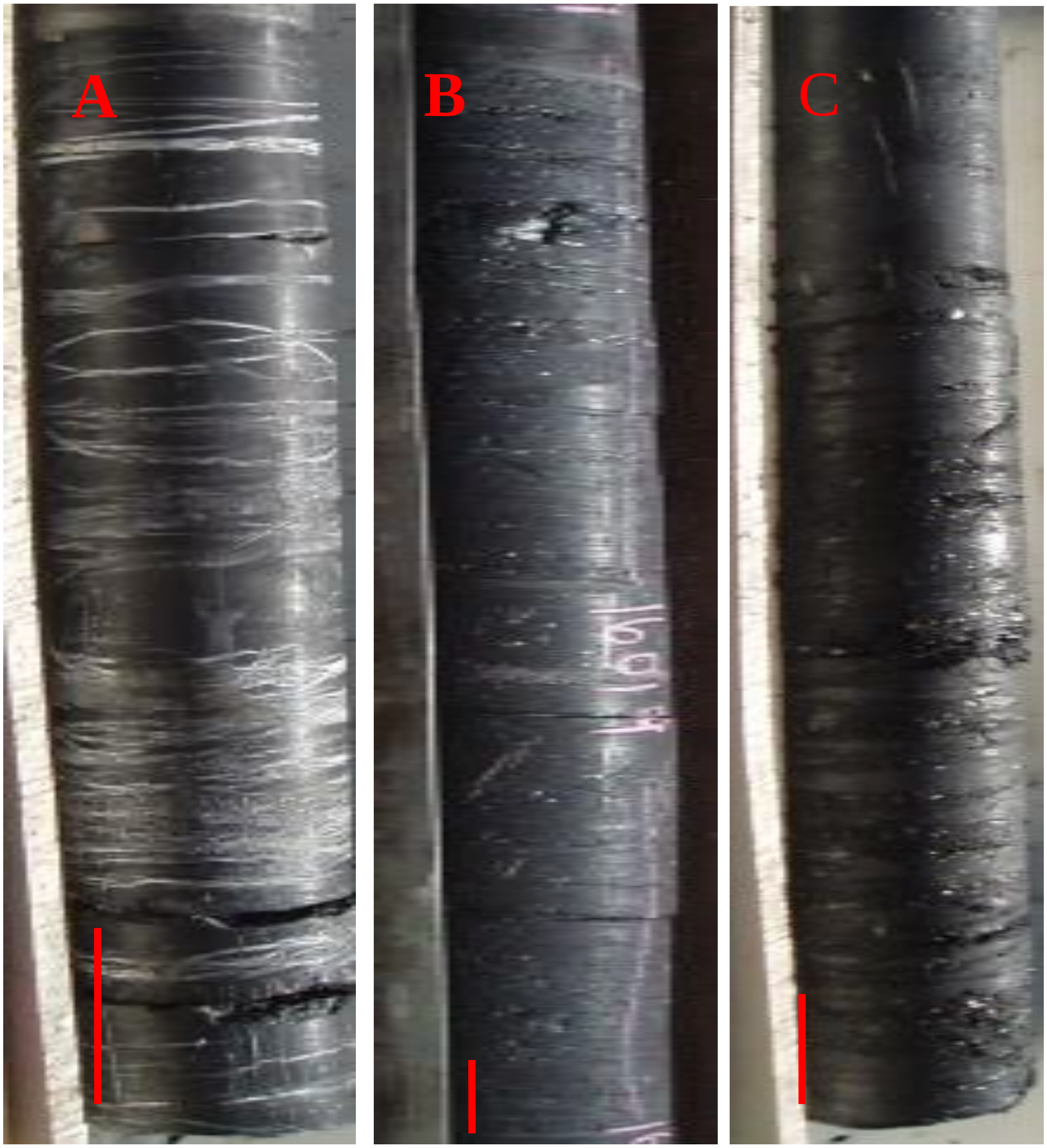


Figure 19: Different coal types from the Lenton deposit. All red bars are represent 5 cm. (A) Extensive calcite mineralization in the upper part of the Burton Rider seam, taken from LEN240PC at a depth of 179.5 m. (B) Moderately bright (C3-C4) banded coals from the Leichhardt seam taken from LEN241PC at a depth of 433 m. (C) Brightly-banded (C2) coal in the Vermont seam, taken from LEN240PC at a depth of 209.5 m. (A), (B) and (C) make up an idealized F5 section, with brightness increasing stratigraphically downward from A (Burton Rider) to B (Leichhardt) to C (Vermont)(see Figure 12, for stratigraphy).

2.7 Facies 6 (F6) – White clay

2.7.1 Description

Strata of F6 are composed of whitish-grey clay-sized particles and form massive bands that are generally less than 10 cm thick. These clay bands are very soft and can be qualified as clayey and malleable. Basal contacts are sharp and non-erosive. Based on gamma-log data for the study area, layers of F6 (identified by a large spike in the gamma log) are relatively uncommon and occur in less than 10% of the cores.

2.7.2 Interpretation

Deposition of F6 was coeval with F5 and occurred during the Middle-Late Permian (Koppe, 1978; Staines and Koppe, 1979; Mallet et al., 1995; Michaelsen, 2002). These clay bands are interpreted to be volcanic ash deposits, associated with active volcanism in the Late Permian (Koppe, 1978).

Volcanic ashes are easily identifiable on gamma ray profiles by the sudden increase in gamma value, due to the increase in radioactive elements (especially potassium, commonly present in feldspars and illite (clay mineral)). The occurrence of ash layers is extremely important in coal mining due to their negative effect on coal quality associated with increase in silica and phosphorus and the decrease (through dilution) in organic carbon content. F6 is derived from wind-blown ash emitted by volcanic activity and deposited in several laterally continuous beds throughout the Bowen Basin. The Yarrabee Tuff Bed is an expansive stratigraphic marker that is interpreted to mark the cessation of regional volcanism during the Late Permian (Matheson, 1990), and is the youngest ash layer in the study area. Although volcanic detritus forms extensive ash fall layers throughout the Bowen Basin (Mallett et al., 1995) they are rare in a 500 km^2 area that includes the study area (Mallett et al., 1995).

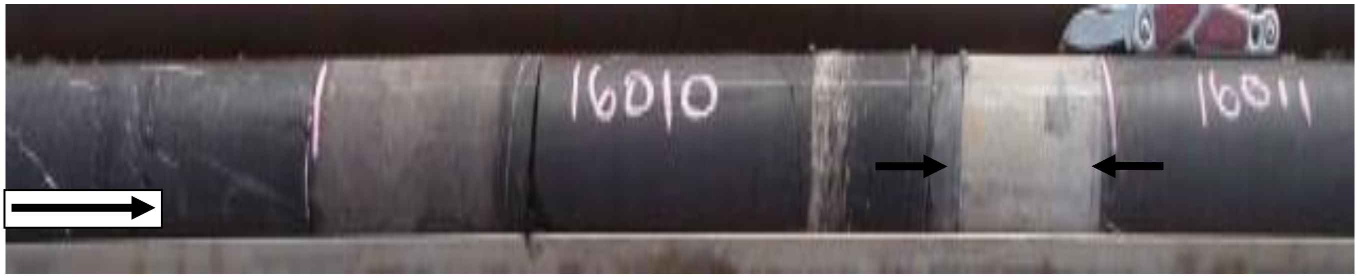


Figure 20: Volcanic ash (indicated by the arrows) from hole LEN241PC at a depth of 428.9 m. This volcanic ash seam is correlated with the Yarrabee Tuff bed, which is used as a regional stratigraphic marker throughout the Bowen Basin. The way-up arrow is 5 cm long.

Chapter 3: Geochemistry

Fourteen mudstone samples were collected from two cores drilled on the New Lenton Exploration site (see Table 3 for sample descriptions and depths). Samples were analyzed for major and trace elements using X-ray Fluorescence (XRF). Data were then plotted on various discrimination diagrams to help elucidate details about weathering patterns and oxidation state before and after sediment deposition. Four discrimination diagrams were used to help interpret the geochemical data, and include SiO_2/Al_2O_3 (sand/silt vs. clay), Ba/Sr (leaching ratio), Fe_2O_3 +MnO/Al_2O_3 (oxidation index) and Al_2O_3/ (Al_2O_3 + CaO* + Na_2O) X 100 (chemical index of alteration).

The chemical index of alteration (CIA) was calculated for the fourteen samples, CIA is interpreted to reflect the degree of weathering to which the sediments were subjected. In its complete form CIA ratio is Al_2O_3/(Al_2O_3 + CaO* + Na_2O + K_2O) X 100 (where CaO* is the calcium content in silicate-bearing minerals only) (Nesbitt and Young, 1982) and is based on the assumption that the degradation of feldspars and formation of clay minerals (specifically illite) is the dominant process during chemical weathering (Goldberg and Humayun, 2010).

Illite is common in rocks of the Rewan Group throughout the Bowen Basin and forms up to 20% of the clay mineral fraction (Bashari, 2000). Previous studies on the relationship between geothermal gradients and vitrinite reflectance suggest that organic maturation and widespread illite formation in the Bowen Basin coal measures is principally related to a short-lived hydrothermal event at ~210 Ma rather than the result of (maximum) burial diagenesis (Usayl et al., 2000a; 2000b; 2000c; 2000d). Nevertheless, an important control on illite formation is availability of potassium cations, which are usually sourced from the dissolution of K-bearing silicate minerals (feldspars and micas). Dissolution of these minerals is enhanced by pore fluids charged with organic acids generated from organic-rich sediments during hydrocarbon maturation (Eberl, 1993; Small, 1994). This generally enhances illitization (O'Shea and Frape, 1988; Li and Yongchuan, 1997) and may account for the higher amount of illite in organic rich mudstones in the Bowen Basin (Usayl, 2000c).

In order to correct for the unwanted effects of potassium metasomatism in the samples, a modified CIA-K ratio was used (Al_2O_3/ (Al_2O_3 + CaO* + Na_2O) X 100). In this case potassium (i.e. K_2O) is eliminated as a variable in order to correct for K^+ addition associated with potassium metasomatism (Maynard, 1992; Price and Velbel, 2003). For example, potassium metasomatism is commonly associated with the conversion of kaolin (residual weathering product) to illite by reaction with K^+-bearing pore waters (Fedo et al., 1995), which accordingly increases the amount of K in the samples.

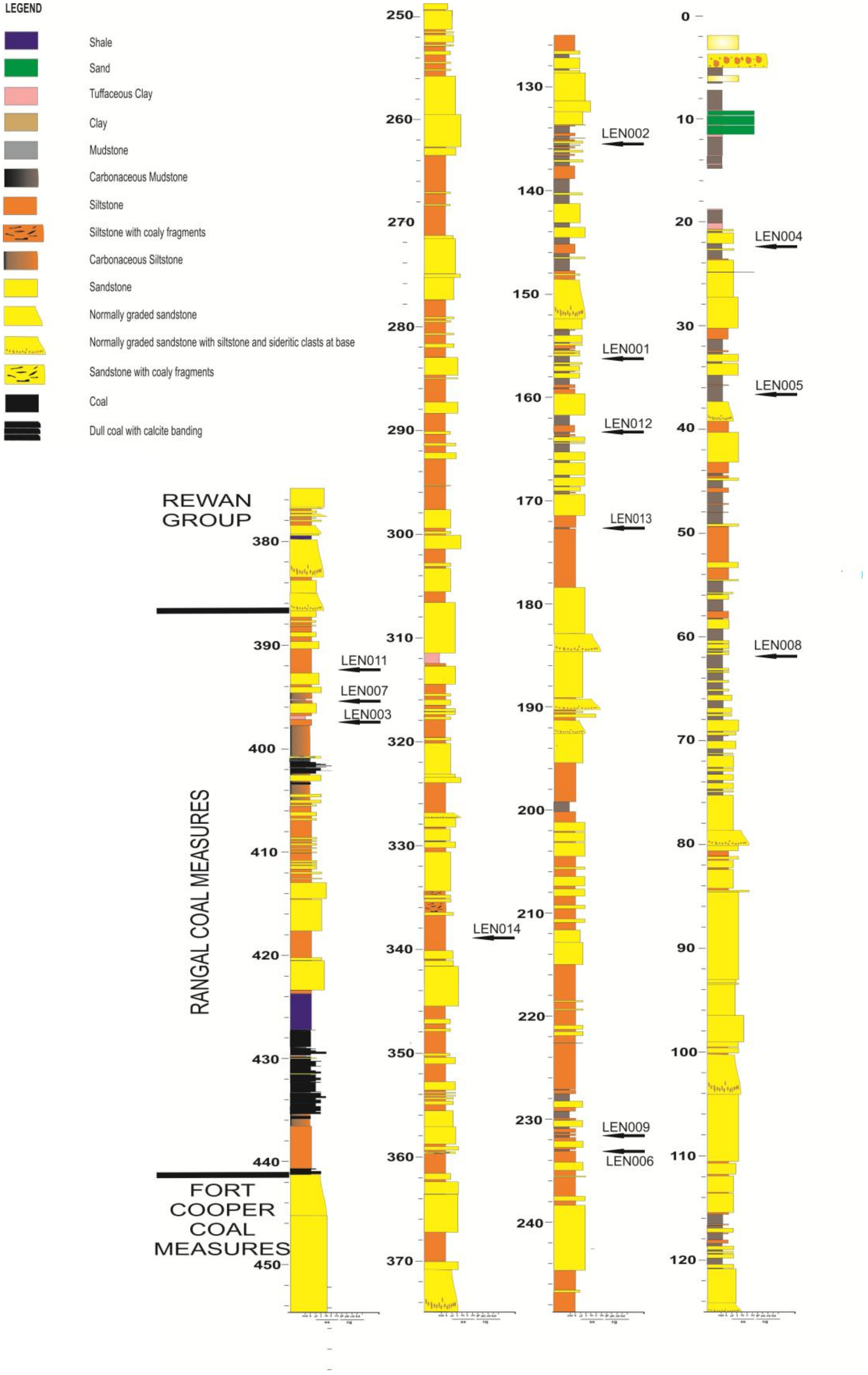
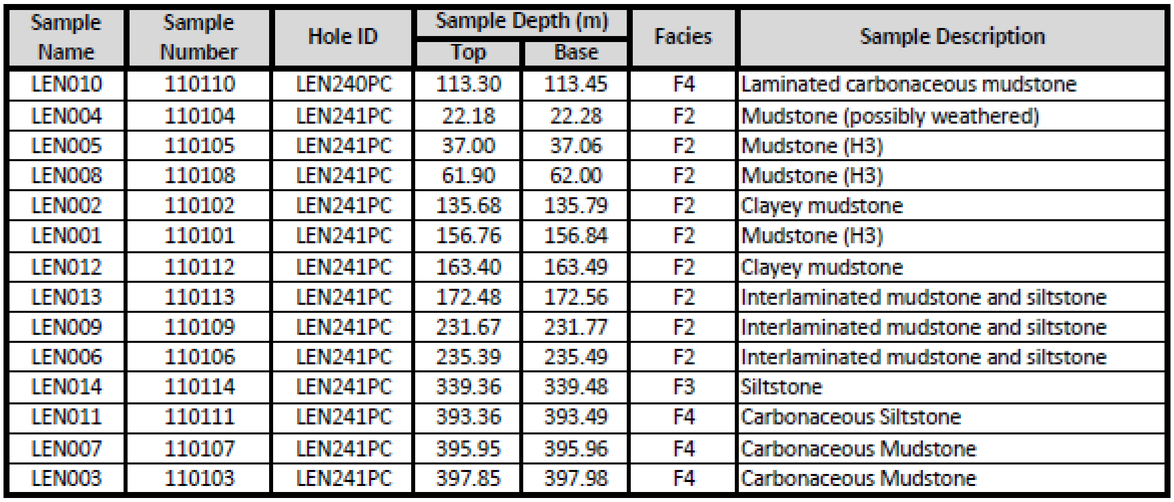


Figure 21: Stratigraphic log for LEN241PC with sample locations



Sample Name	Sample Number	Hole ID	Sample Depth (m)		Facies	Sample Description
			Top	Base		
LEN010	110110	LEN240PC	113.30	113.45	F4	Laminated carbonaceous mudstone
LEN004	110104	LEN241PC	22.18	22.28	F2	Mudstone (possibly weathered)
LEN005	110105	LEN241PC	37.00	37.06	F2	Mudstone (H3)
LEN008	110108	LEN241PC	61.90	62.00	F2	Mudstone (H3)
LEN002	110102	LEN241PC	135.68	135.79	F2	Clayey mudstone
LEN001	110101	LEN241PC	156.76	156.84	F2	Mudstone (H3)
LEN012	110112	LEN241PC	163.40	163.49	F2	Clayey mudstone
LEN013	110113	LEN241PC	172.48	172.56	F2	Interlaminated mudstone and siltstone
LEN009	110109	LEN241PC	231.67	231.77	F2	Interlaminated mudstone and siltstone
LEN006	110106	LEN241PC	235.39	235.49	F2	Interlaminated mudstone and siltstone
LEN014	110114	LEN241PC	339.36	339.48	F3	Siltstone
LEN011	110111	LEN241PC	393.36	393.49	F4	Carbonaceous Siltstone
LEN007	110107	LEN241PC	395.95	395.96	F4	Carbonaceous Mudstone
LEN003	110103	LEN241PC	397.85	397.98	F4	Carbonaceous Mudstone

Table 3: Summary of samples taken for geochemical analysis.

3.1 Analytical Techniques

Hand specimens were first crushed into a fine homogeneous powder to make a representative sample for geochemical analysis. The powder was then fused to a disk and analyzed for major and trace elements using XRF at the University of Ottawa. The XRF analytical protocol reports major elements in oxide weight percent and trace elements in parts per million (ppm).

3.2 Results and Discussion

Samples were analyzed for major and trace elements using XRF and are plotted individually in Figures 22, 23 and 24. Ratios of SiO_2/Al2O_3 (sand and silt to clay), Ba/Sr (leaching ratios) and (Fe_2O_3+ MnO)/ Al_2O_3 (oxidation ratios) were calculated for each sample from LEN241PC and plotted in Figure 25,26, 27 and 28 respectively.

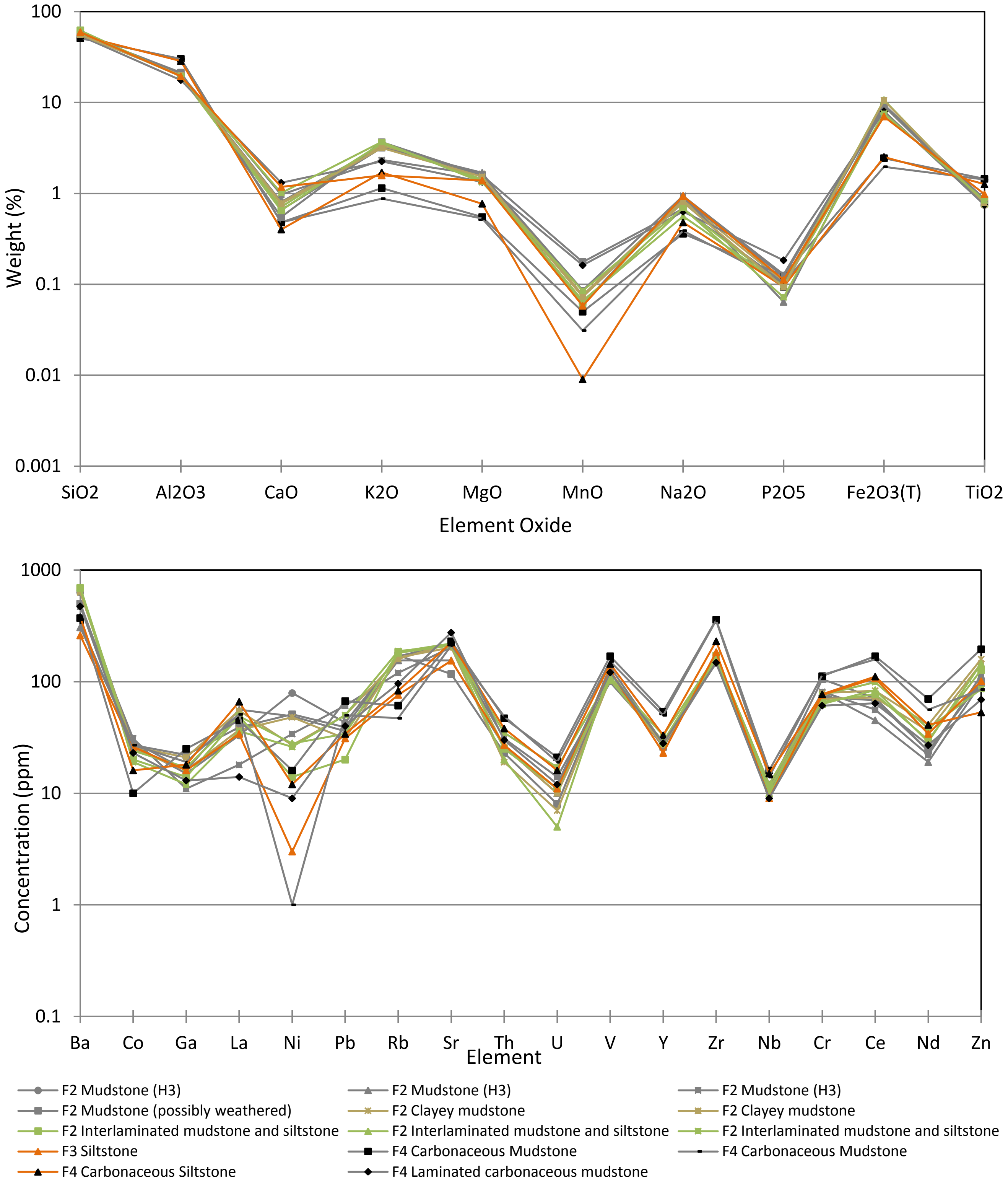


Figure 22: Elemental and oxide concentrations of samples from the Lenton deposit based on geochemical analysis using XRF.

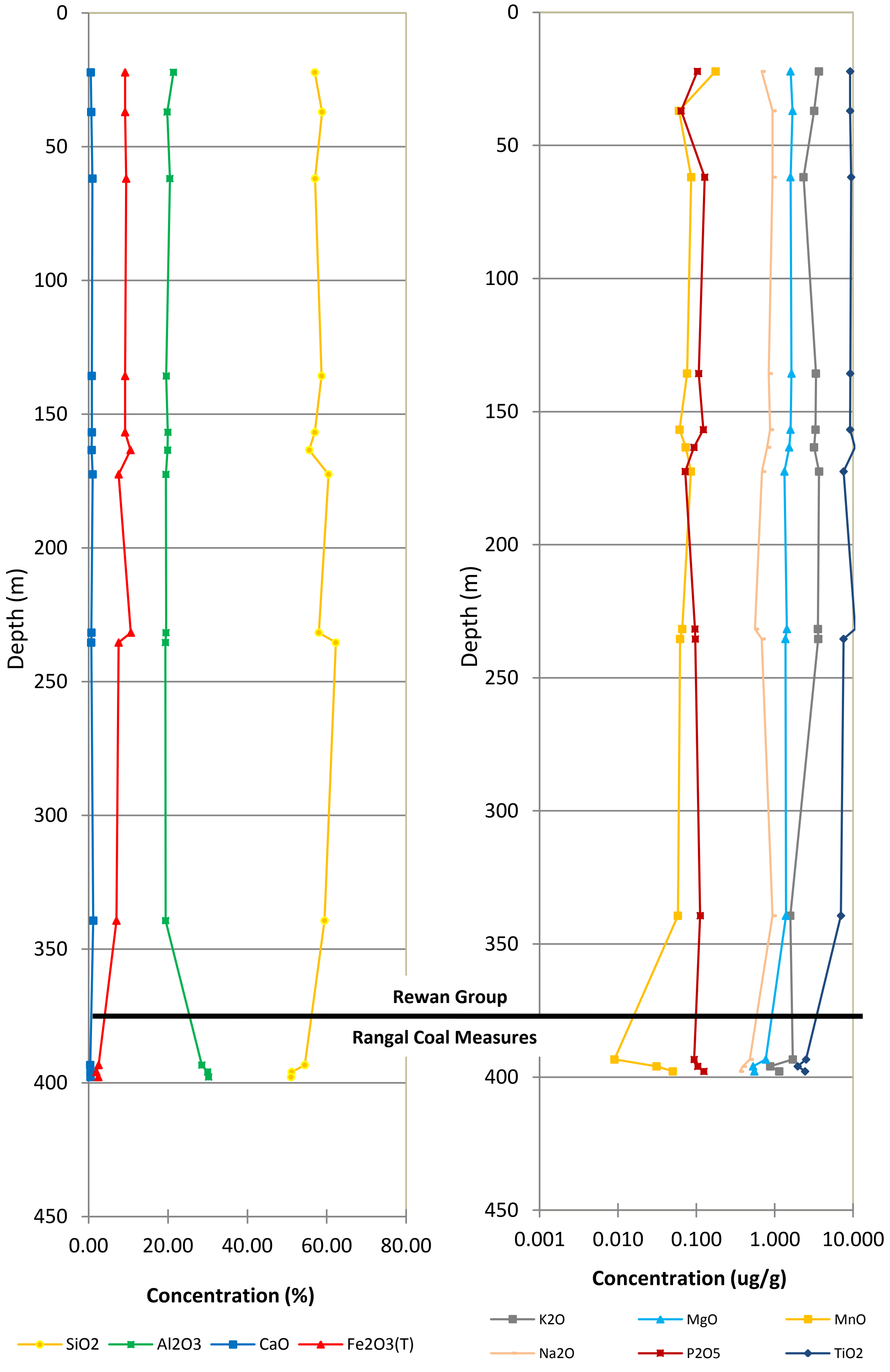


Figure 23: Major element concentrations with depth for all LEN241PC samples.

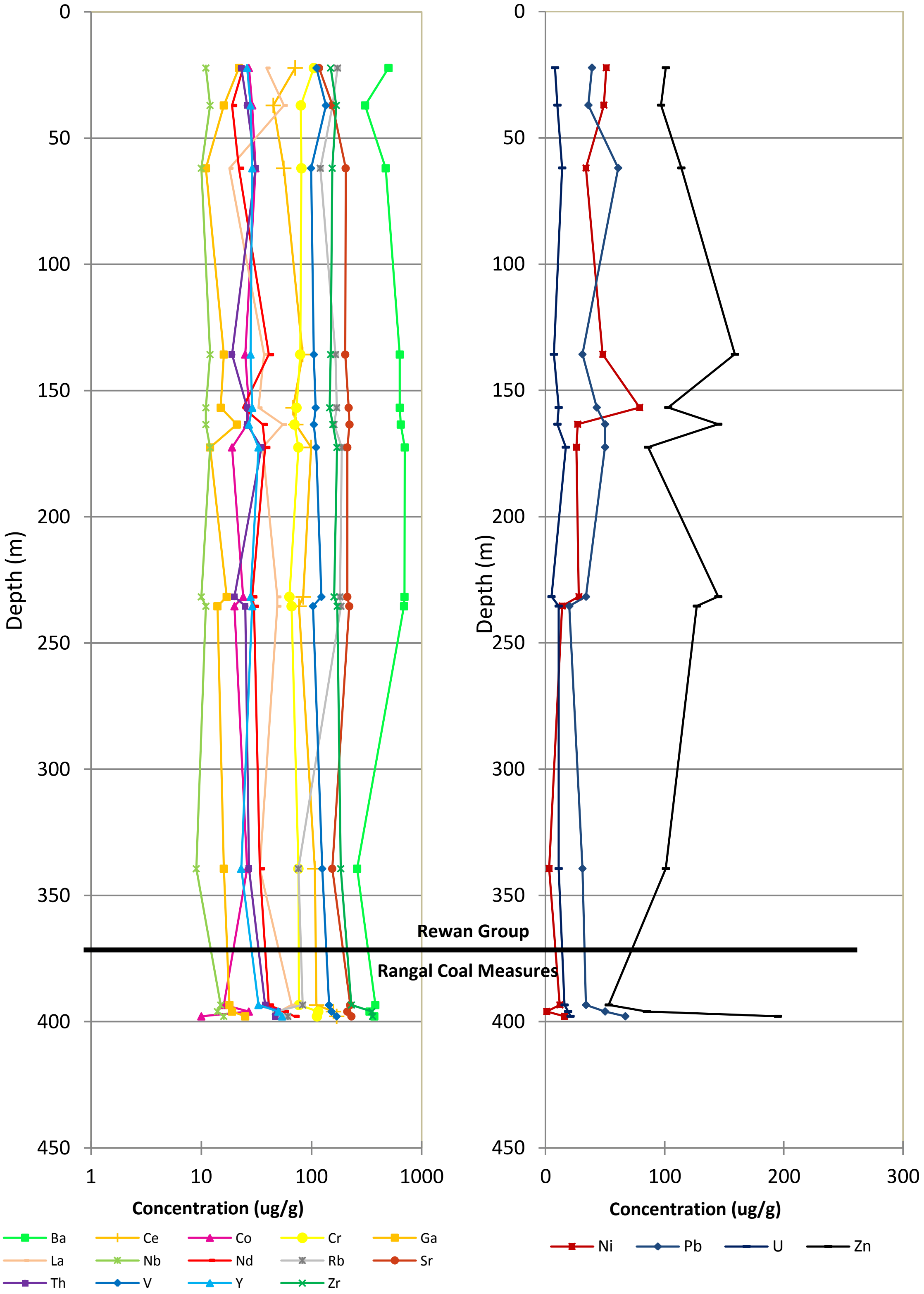


Figure 24: Variability of trace element concentrations with depth for LEN241PC samples.

Because of its abundance in upper crustal rocks, and also its chemical and mechanical stability at earth surface conditions, quartz is the most common sedimentary mineral, typically forming much of the sand and silt size fraction. Aluminum is commonly associated with feldspars, which are also common in upper crustal rocks, but are unstable at earth surface conditions and accordingly converted to clay minerals during chemical weathering. Owing to their atomic make-up, clay minerals form most of the clay-size fraction in surface sediment and sedimentary rocks. Based on the assumption that SiO_2 is a measure of quartz content and Al_2O_3 a proxy for clay content, the ratio SiO_2 vs. Al_2O_3 is indicative of the relative proportion of sand versus clay.

Stratigraphically downward the SiO_2/Al_2O_3 plot (Figure 25) shows a gradual increase followed by an abrupt decrease at about 375 m. This is expected as the samples below 375 m are from the Rangal Coal Measures, which are part of a peatmire/floodplain environment dominated by intense chemical weathering and fine-grained deposition. These strata are then abruptly overlain (~375 m) by sand-rich braided fluvial deposits of the Rewan Group. This unconformable contact coincides also with the Triassic-Permian boundary and a global-scale change in organic sedimentation. The progressive decrease in the SiO_2/Al_2O_3 ratio in the Rewan Group indicates that more mud and silt-sized particles are being preserved as the braided fluvial environment stabilizes.

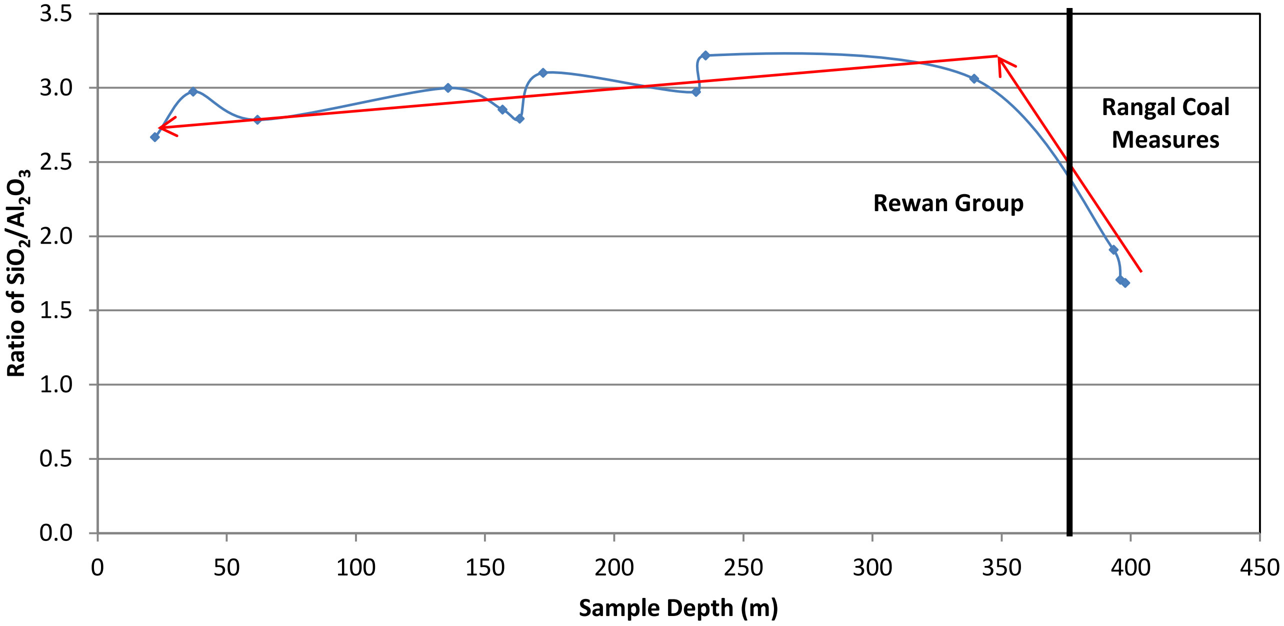


Figure 25: SiO_2/Al_2O_3 vs. Depth for LEN241PC. Note the dramatic decrease after about 350 m which coincides with the Permian-Triassic boundary event.

Sediments in the Bowen Basin have been interpreted to have been deposited by low-sinuosity fluvial systems that flowed from an easterly source into the study area (Kassan and Fielding, 1993). Sediment was derived primarily from arc-volcanic sources and felsic granitoids in the New England Fold Belt (Bashari, 2000). Since Ba and Sr occur in trace amounts in felsic magmas and arc-related rocks, and do not form any important minerals of their own, (Steuber, 1978) they are considered good indicators for assessing the intensity of chemical weathering (Land et al., 2000). Owing to substitution reactions, barium (Ba) and strontium (Sr) commonly accumulate preferentially in minerals with markedly different weathering susceptibilities Sr substituting for Ca in plagioclase and amphibole (Land et al., 2000) and Ba substituting for K in potassic feldspar (Mason and Moore, 1982). In general, Ca-bearing minerals are more easily weathered than K-bearing minerals because of differences in primary and secondary hydraulic conductivities, mass and solubility controls and kinetic effects (cf. White et al., 2000). This, therefore, suggests that higher Ba/Sr ratios are associated with more intense conditions of chemical weathering.

In Figure 26 the Ba/Sr ratio shows three distinct trends indicated by the arrows (1, 2 and 3). Trend 1 shows the lowest Ba/Sr ratio suggestive of limited weathering, likely associated with the waterlogged nature of the environment common in peatmires and floodplains, however the acidic conditions associated with peatmires suggest that feldspars would be more unstable, making them more susceptible to weathering. Depositional environments play a major role in determining the quantity and composition of the inorganic fraction in peats and coals. Transportation mechanisms (eg. wind, water, snow) and the hydrological regime (level of groundwater) of the peat influence the distribution of detrital mineral matter (Wust et al., 2002). The inorganic fraction of peat deposits consist of three kinds, biogenic, terrigenous (mineral matter from dust and floods) and orthochemical components (in-situ precipitation) (Wust et al., 2002). Dissolution and transformation of minerals may occur after burial of the peat deposits, and thus the inorganic matter of peatlands represent a repository for late diagentic processes, however, some of these minerals, specifically carbonates and mafic minerals, can be exported out of the swamp environment, likely removing Ca (and thus Sr) from the peats (Wust et al., 2002). The removal of Sr would increase the ratio, however both plagioclase and K-feldspar weathering products are unstable in acidic conditions (Chamley, 1989), which are often dominated by the generation of early diagentic kaolinite from terrigenous smectite and illite (Sàez and Cabrera, 2002), likely limiting the amount of both Ba and Sr in the peat environment resulting in a Ba/Sr ratio of around 1.5.

Trend 2 shows a slight decrease in the Ba/Sr ratio between 250 m and ~50 m, suggesting a slight (stratigraphic) upward decrease in the intensity of weathering. The sample lithologies associated with trend 2 are paleosols and mudstones. As discussed in Chapter 2, the occurrence of gleization features in these paleosols indicate intense chemical weathering and as expected paleosols have higher Ba/Sr ratios than the samples associated with floodplain and peatmire environments (mudstone and siltstone samples). Trend 2 is succeeded by an abrupt increase in Ba/Sr ratio followed by Trend 3, which is attributed to the effects of modern weathering on the first sample, since the base of modern chemical weathering in the study area is between 18-40 m and the sample was only 22 m below the surface.

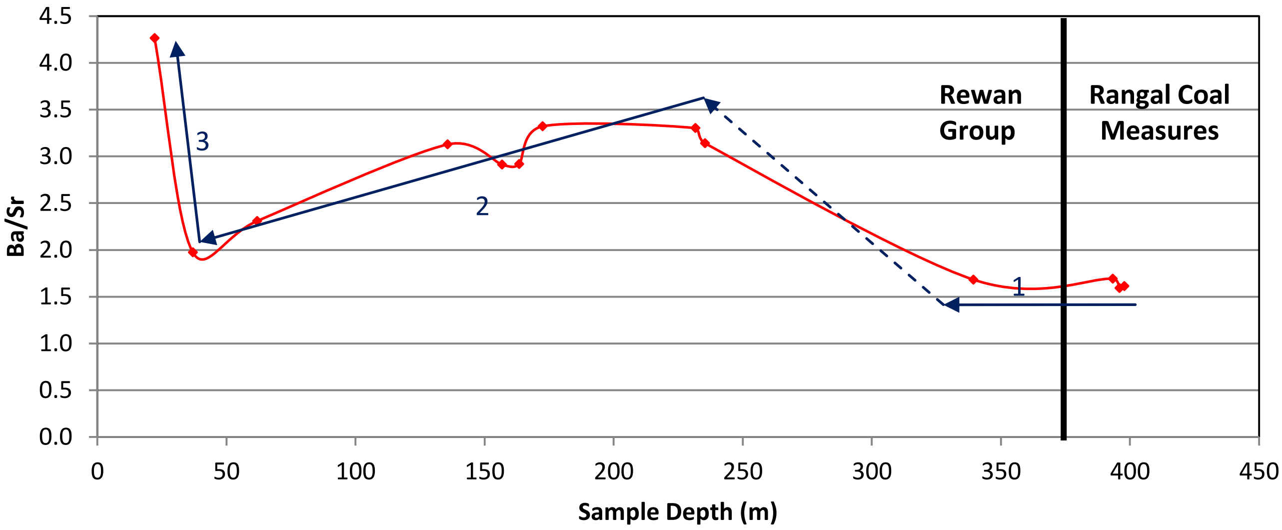


Figure 26: Ba/Sr ratio vs. depth for LEN241PC

Figure 27 shows the oxidation ratio (Fe_2O_3+MnO)/Al_2O_3, which is used to assess paleo-redox conditions (reducing vs. oxidizing). High values indicate oxidizing conditions since iron is in the +3 oxidation state and Fe_2O_3 is formed by the reaction of Fe^{3+} and O^{2-}. Conversely iron is preferentially in its reduced state (Fe^{2+}) under reducing conditions, resulting in lower oxidation ratios. Figure 27 shows trends in oxidation with depth, and suggests four distinct groups (1, 2, 3 and 4, respectively).

Group 1 shows the lowest (Fe_2O_3+MnO)/Al_2O_3 ratio, which correlates well with the change from the Rangal Coal Measures (below 375 m) to the Rewan Group (above 375 m). The Rangal Coal Measures are interpreted to be a peatmire/ floodplain environment. Here permanently waterlogged conditions causes oxygen to be depleted because of a combination of bacterial activity and chemical oxidation that exceeds diffusive recharge of atmospheric oxygen. Groups 2 and 4 show fairly similar (Fe_2O_3+MnO)/Al_2O_3 ratios. They represent the majority of the samples (8 of 13), and span most of the sample depth. As a consequence they likely represent the general overall oxidation state of the depositional environment associated with the Rewan Group. The Rewan Group has been interpreted to be a braided fluvial environment and therefore a setting where oxygen is generally omnipresent in the shallow subsurface. The third group, with slightly higher (Fe_2O_3+MnO)/Al_2O_3 values compared to groups 2 and 4, suggests more oxygen availability which might be explained by a lowering of the water table associated with a temporary change in seasonal waterlogged conditions, causing sediments to be exposed directly, either more often and for longer duration to the atmosphere.

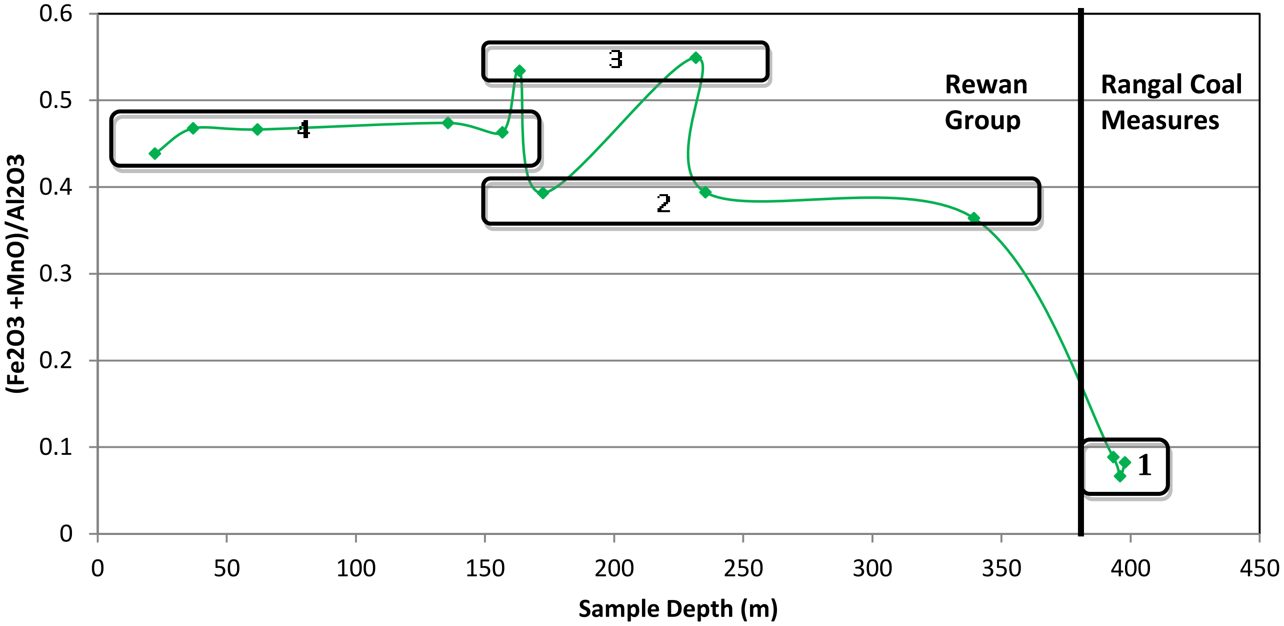


Figure 27: (Fe_2O_3+MnO)/Al_2O_3 vs. depth for LEN241PC

The sediment source for rocks in the Lenton area have been interpreted to be arc-orogen rocks formed during the renewal of compressional tectonics and arc volcanic activity during the Carboniferous (Ahmad et al., 1994) As evident in Figure 28, the CIA-K ratio (Al_2O_3/ (Al_2O_3 + CaO* + Na_2O) X 100) for all samples are greater than 90, indicating that the depositional area has been subjected to chemical weathering, as fresh feldspars and unweathered peraluminous igneous rocks have a CIA-K ratio below 70-75 (Andersson et al., 2004). High CIA-K values reflect the removal of chemically labile cations (eg. Ca^{2+}, Na^{+}, K^{+}) relative to more stable residual constituents (Al^{3+}, Ti^{4+}) during chemical weathering. High CIA-K ratios are expected since these mudstones were deposited in an oxidizing floodplain. Since these mudstones formed in an environment that was subject to seasonal waterlogging, the amount of weathering that these mudstones experienced was increased compared to unwaterlogged samples. The difference between chemical weathering in these two environments is associated with the hydrolysis of feldspars.

A plot of CIA-K against SiO_2 content shows a linear negative correlation. This indicates that grain size and CIA-K values are related, specifically higher SiO_2 indicates a higher proportion of sand sized particles, which would undergo less alteration than clay mineral dominated sediment subjected to the same burial conditions. This could also be attributed to the more clastic nature of the Rewan Group compared to the Rangals resulting in clastic (ie. SiO_2) contamination, which effectively dilutes the alkali signature.

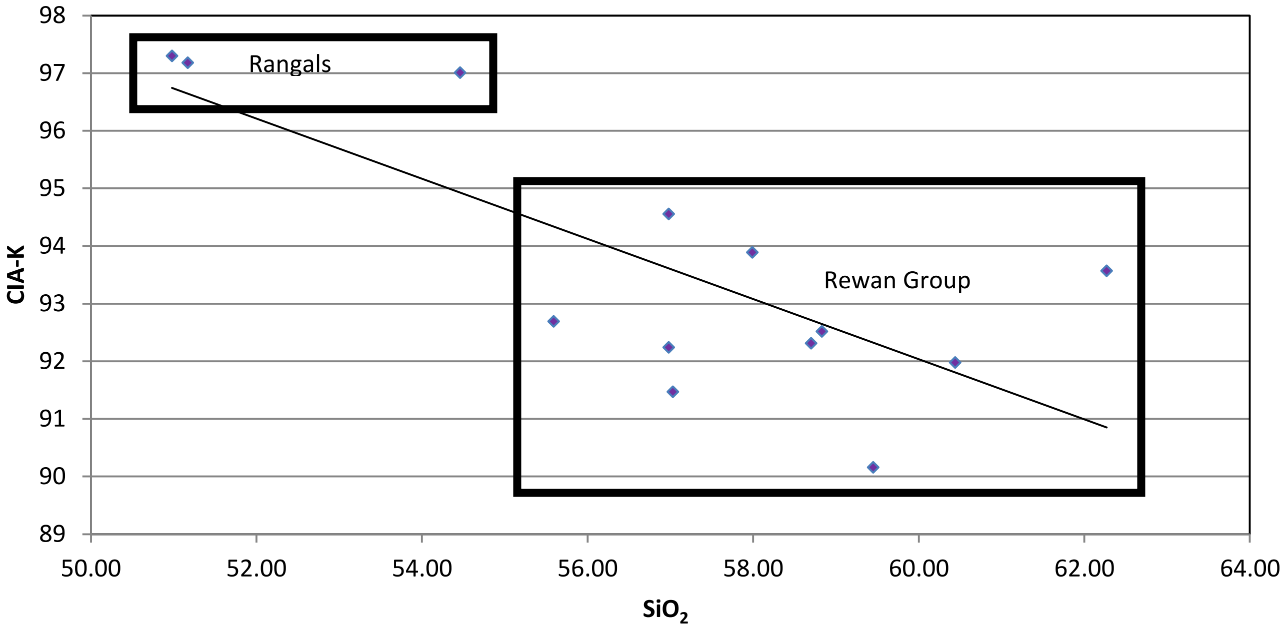


Figure 28: The chemical index of alteration (CIA-K) plotted against SiO_2 for all analyzed mudstone samples from Lenton core.

All three alteration indices (Figure 29) show a significant reduction in alteration below ~375 m depth. This abrupt and marked change occurs at or near the boundary between the Rewan Group and the Rangal Coal Measures (Blackwater Group) and represents a change from temporally to permanently waterlogged conditions associated with peatlands

(Blackwater Group). In the core the Permian-Triassic boundary occurs at 385 m depth and correlates well with marked changes in geochemistry and alteration indices below this depth. The Rewan Group has been interpreted to be a braided fluvial system whereas the Blackwater Group is associated with a peatmire/floodplain environment.

This change from permanently waterlogged conditions in the Blackwater Group to less permanent waterlogging in the Rewan Group indicates an increase in the susceptibility to alteration, likely associated with increased sediment input and exposure to oxygen. This boundary clearly marked a significant change in the geochemical signature of these rocks as can be seen in the previous figures. Changes associated with this boundary are an increase in sand/silt ratio, an increase in the leaching ratio and a significant increase in the oxidation ratios. All of these changes are interpreted to signify the change from a “calmer” depositional environment where sedimentation occurred at a much slower rate, with little influence from external sources to a more active fluvial environment in which atmospheric oxygen was available to influence the geochemistry of these mudstones.

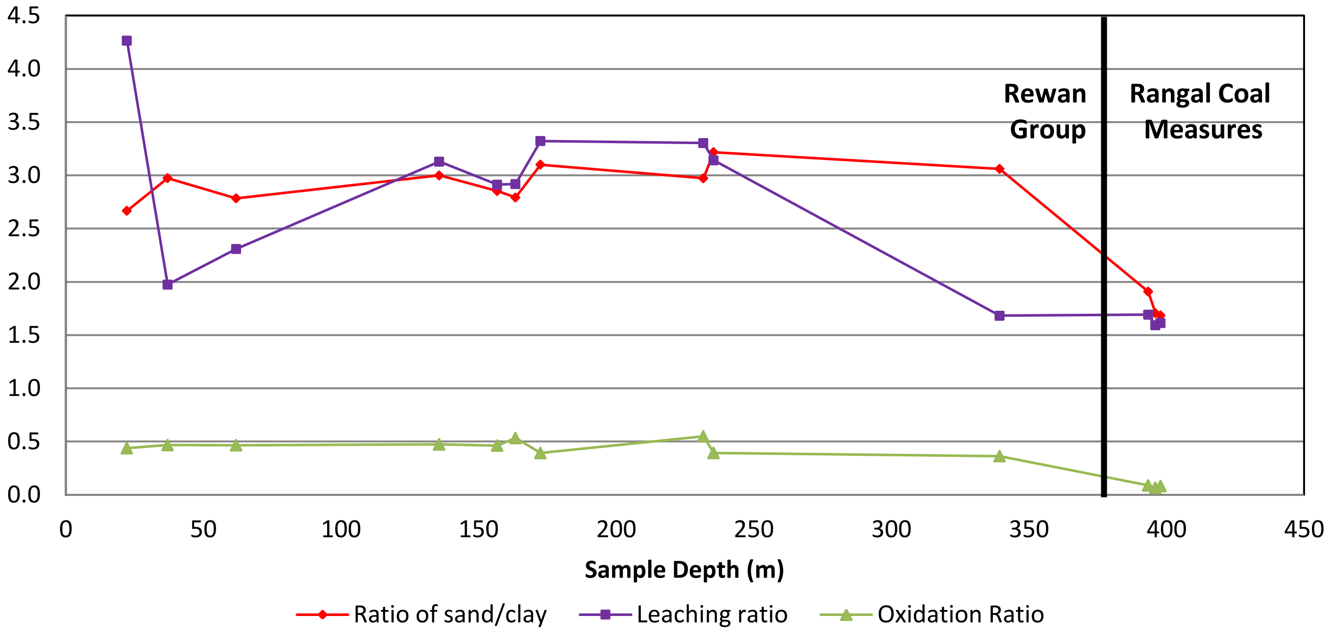


Figure 29: Summary of chemical indices of alteration for all mudstone samples in LEN241PC.

Chapter 4: Petrographic Analysis

4.1 Maceral Analysis

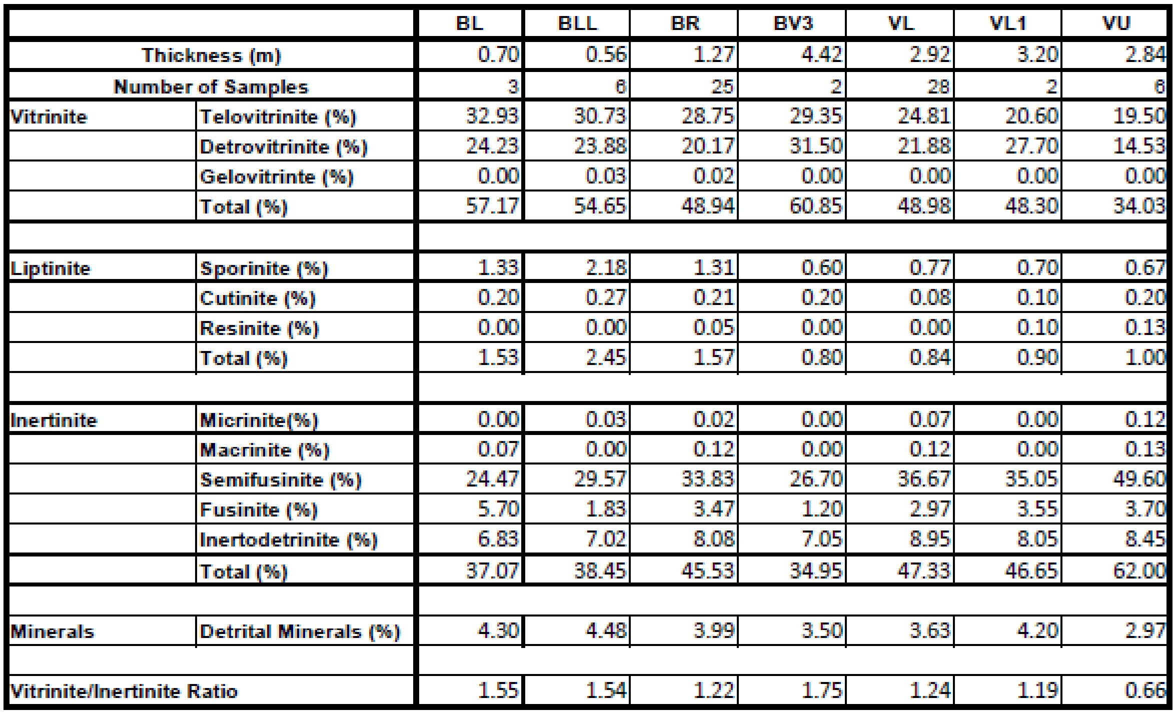
Coal is a heterogeneous material composed of a variety of different plant components. These components, termed macerals, are the organo-petrographic building blocks of coal, and whose chemical and physical characteristics determine the coal properties and its uses (Diessel, 1992). The depositional environments of precursor materials for coal and their relationship to coal petrography have been the subject of numerous studies, including Diessel (1982, 1986), Teichmuller, (1990), and Gruber and Sachenhofer, (2001). Maceral analysis uses optical properties, namely; colour, reflectance and fluorescence to identify and differentiate maceral types. In addition, the reflectance of macerals, specifically vitrinite, is used to determine the thermal maturity of the kerogens (organic matter). Vitrinite reflectance is sensitive to temperature, which correlates to hydrocarbon generation, generally occurring between 60 and 120^0 C.

Macerals are subdivided into three main groups based on their origin (liptinite) or differences in preservation (inertinite and vitrinite). In turn, each group is further subdivided into different maceral categories based on the origin of its components (see Table 4). Vitrinite is the most common maceral in bituminous coal and is the coalified remains of cell walls, woody tissues, leaves, stems, roots and branches (Ahmad, 2004). The chemistry of vitrinite changes with rank (function of increasing temperature) as it becomes progressively more crystalline and more tightly packed as organic molecule functional groups are lost. In plane light microscopy vitrinite has a pale grey/grey colour with little to no fluorescence (under ultraviolet light) and moderate reflectance (Ahmad, 2004). Liptinite is composed of the lipid-rich, waxy and resinous parts of plants that devolatilize during thermal maturation (termed coking) producing gases and oily tars and as a result gives them the highest potential for generating hydrocarbons (Ahmad, 2004). Liptinite is a darker grey under plane light with bright yellow to green fluorescence and the lowest reflectance amongst all macerals. In addition, owing to its lipid-rich makeup, and hence preferential degradation during the coalification process, liptinite is also the least well preserved coal maceral. The third coal maceral group, inertinite, is composed of plant material that has undergone extensive oxidization during the early stages of peat accumulation and burial. Inertinite has little to no fluorescence, high reflectance, and in plane light a colour that ranges from whitish-grey to white to yellowish-white (Ahmad, 2004).

Maceral Group	Maceral	Origin	Significance
Vitrinite	Telovitrinite	Humified stem, root, bark and leaf tissue that has survived intact and displays remnants of cellular structure	High vitrinite content, especially the structured telovitrinite indicates a permanently water-saturated peat and conditions of balanced or high accommodation.
	Detrovitrinite	Stem, root, bark and leaf tissue deposited as fine-grained attritus prior to humification	
	Gelovitrinite	Massive or sub-microscopic granular vitrinite gel larger than 0.02mm that is not clearly part of telo- or detro- vitrinite.	
Liptinite	Sporinite	Resins, fats, waxes and oils	Increased liptinite content indicates loss of biomass associated with poor preservation conditions and low accommodation relative to peat production.
	Cutinite	Cuticles of needles, shoots, stalks, leaves, roots and stems	
	Resinite	Resins, fats, waxes and oils	
Inertinite	Micrinite	Product of disproportionation reactions, or any other fine-grained oxidized plant material	High inertinite content, especially structured semifusinite, indicates a low or fluctuating mire water table and low accommodation relative to peat production. May also represent conditions of oxic groundwater
	Macrinite	Jellified plant material that has undergone some oxidation	
	Semifusinite	Partial oxidation of plant material that has survived intact and preserves remnant cellular structure	
	Fusinite	Combustion of plant material that remains intact and preserves remnant cellular structure	
	Inertodetrinite	Fragmented semifusinite and fusinite	
Inorganic Materials	Detrital Minerals	Allocthonous clastic sediments	High detrital mineral content from marine or fluvial input into the mire when accommodation exceeds peat accumulation.

Table 4: Origin and paleoenvironmental significance of macerals and maceral groups (Jerrett et al., 2011)

A total of 72 coal samples from 22 drill holes were analyzed for maceral identification by Australian Coal Industry Research Laboratories (ACIRL) located in Richlands, Queensland, Australia (Table 5). All samples were analyzed using the Australian Standard for Coal Petrography-Maceral Analysis (AS 2856.2).



		BL	BLL	BR	BV3	VL	VL1	VU
Thickness (m)		0.70	0.56	1.27	4.42	2.92	3.20	2.84
Number of Samples		3	6	25	2	28	2	6
Vitrinite	Telovitrinite (%)	32.93	30.73	28.75	29.35	24.81	20.60	19.50
	Detrovitrinite (%)	24.23	23.88	20.17	31.50	21.88	27.70	14.53
	Gelovitrinte (%)	0.00	0.03	0.02	0.00	0.00	0.00	0.00
	Total (%)	57.17	54.65	48.94	60.85	48.98	48.30	34.03
Liptinite	Sporinite (%)	1.33	2.18	1.31	0.60	0.77	0.70	0.67
	Cutinite (%)	0.20	0.27	0.21	0.20	0.08	0.10	0.20
	Resinite (%)	0.00	0.00	0.05	0.00	0.00	0.10	0.13
	Total (%)	1.53	2.45	1.57	0.80	0.84	0.90	1.00
Inertinite	Micrinite(%)	0.00	0.03	0.02	0.00	0.07	0.00	0.12
	Macrinite (%)	0.07	0.00	0.12	0.00	0.12	0.00	0.13
	Semifusinite (%)	24.47	29.57	33.83	26.70	36.67	35.05	49.60
	Fusinite (%)	5.70	1.83	3.47	1.20	2.97	3.55	3.70
	Inertodetrinite (%)	6.83	7.02	8.08	7.05	8.95	8.05	8.45
	Total (%)	37.07	38.45	45.53	34.95	47.33	46.65	62.00
Minerals	Detrital Minerals (%)	4.30	4.48	3.99	3.50	3.63	4.20	2.97
Vitrinite/Inertinite Ratio		1.55	1.54	1.22	1.75	1.24	1.19	0.66

Table 5: Maceral and mineral composition of coal seams in the Lenton exploration site. (BL- Burton Lower; BLL- Burton Lower-Lower; BR- Burton Rider; BV3- uneconomic material between the Vermont Upper and Lower seams; VL- Vermont Lower; Vermont Lower (repeated seam); VU- Vermont Upper).

Liptinite typically makes up only a small proportion of the maceral content in most coals, and therefore provides little insight into the processes of deposition or depositional environment. Nevertheless, common liptinite components include cutinite and resinite, which accumulate in forest swamps and sporinite, which is the residuum of reed marsh vegetation (Ahmed, 2004). The absolute abundance of the more common vitrinite and inertinite, on the other hand, provides important insight into the ancient depositional environment (Diessel, 2010). Moreover, since most of the constituent components in peat can be transformed into these two macerals during coalification, their relative abundances are used to interpret the local and regional conditions of coal formation and preservation. In most cases, inertinite and vitrinite contents vary due to differences in plant type, tectonics, climate, variable subsidence rates and diagenetic conditions controlled by local and regional factors (Diessel, 2010). In some instances, however, continental-scale (or larger) clustering of vitrinite/inertinite ratios can correspond to global conditions that overwhelmed local or regional influences (Diessel, 2010). For example, a global database of Permian coals (Figure 30) shows a secular decrease of inertinite content (indicating an increase in vitrinite) during the Middle Permian (shown by the red arrow). This is likely the result of profound changes in global sedimentation and preservation patterns related to major changes in climate (Retallack et al., 2006). Of note also, is that the changes coincided with the end-Guadalupian (Middle Permian) mass extinction, which was followed by landscape destabilization and a warm-wet post-apocalyptic greenhouse condition that resulted in significant changes in biodiversity (Retallack et al., 2006). Changes in climate, such as those during the end-Guadalupian, control the position of the permanent water table, which in turn controls peatmire accumulation (Jerrett et al., 2011). Peatmires survived through the end-Guadalupian extinction and thrived for about 9 my, indicated by the increase in inertinite content (shown by the blue arrow in Figure 30). The stratigraphic distribution of inertinite also shows a diversity in the macerals constituents before a second major mass extinction at the end of the Permian, which resulted in a global collapse of plant life and cessation of peat formation. The end-Permian was followed by a global coal gap in the Early Triassic associated with the extinction of 95%

of peat forming plants resulting from the Permian-Triassic boundary extinction (Michelson, 2002).

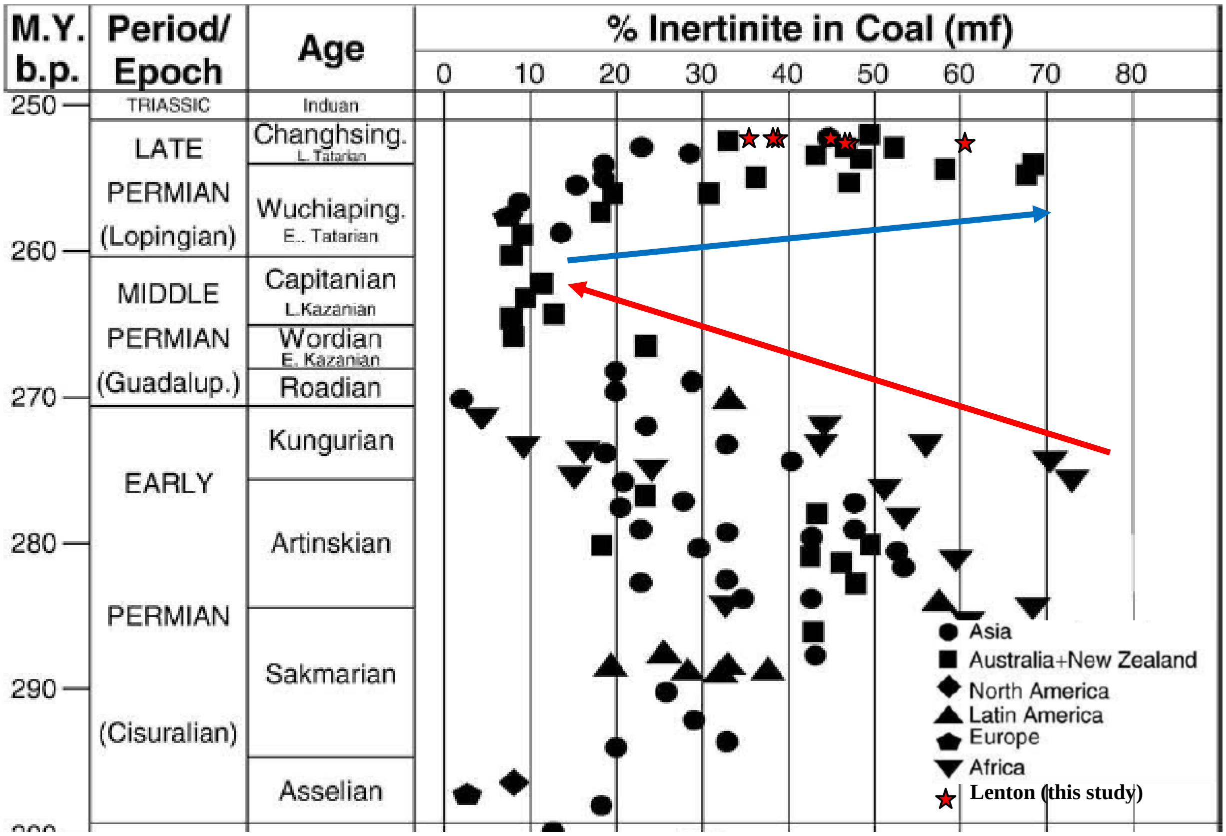


Figure 30: The stratigraphic distribution of inertinite in the Permian (modified from Diessel, 2010). The red arrow shows a large decrease in the inertinite % associated with the End-Guadalupian extinction and the blue arrow shows an increase in the inertinite % associated with the re-establishment of peatmires over a 9 my period, followed by the Permian-Triassic extinction resulting in a global coal gap lasting throughout the entire Early Permian.

Coals at Lenton have moderate to high (34-62%) inertinite content, which correlates well with other Late Permian coals around the world (Diessel, 2010). Interestingly, a link has been proposed between inertinite content in coal and atmospheric oxygen. During periods of lowered atmospheric oxygen levels the ignition temperature of organic matter is reduced (Wildman et al., 2004), which in turn increases the frequency of fires in the geological record (Shearer et al., 1995). However, Late Permian vegetation was protected by its high lignin content, which because if its higher activation energy is more likely to have smoldered rather than burned freely (Robinson, 1989). A more likely explanation of the transformation of lignin into inertinite is by simple chemical oxidation (Diessel, 1996).

The Permian-Triassic boundary marks a global extinction of 95% of peatmire systems, followed by a coal-forming hiatus of more than 10 my (Michaelson, 2002). This gap lasted until about the end of the Triassic and explains the paucity of Early Triassic and only rare occurrence of Middle Triassic coals (Retallack et al., 2006). In the study area this gap is represented by the absence of coal in continental strata of the Triassic Rewan Group.

4.1.1 Gelification Index and Tissue Preservation Index

Diessel (1986) suggested that depositional environment can be interpreted from coal maceral content. Specifically, two different indices: Tissue Preservation Index (TPI) and Gelification Index (GI), which when cross-plotted separate data into discrete paleoenvironments of peat formation (Figure 31).

The TPI is a ratio of decay-resistant versus non-resistant plant components (Sherar and Moore, 1996; Kalcon and Sachsenhofer, 1999). The TPI as originally proposed by Diessel (1992) is:

$$\text{TPI} = \frac{(\%\ \text{telovitrinite}) + (\%\ \text{teloinertinite})}{(\%\ \text{detrovitrinite}) + (\%\ \text{gelovitrinite}) + (\%\ \text{detroinertinite}) + (\%\ \text{geloinertinite})}$$

In decay-resistant plants (high TPI) , which preferentially accumulate in forest-like environments, primary cellular structure is typically well preserved and commonly associated with more lignin-supported wood cells (Ahmad, 2004). Low TPIs, on the other hand, indicate abundant herbaceous plants (ie. plants that lack lignin) or extensive degradation of woody components due to high rates of decomposition.

Although, this ratio has been used by several authors, it is often modified (eg. Kalkreuth et al., 1991; Kalcon and Sachsenhofer, 1999; Ahmad, 2004, this study) to account for different maceral assemblages present in site specific coals. In this study decay resistant macerals include telovitrinite, semifusinite and fusinite whereas non-resistant macerals comprise detrovitrinite, macrinite and inertodetrinite (see Table 4). A ratio of these was used to create a modified TPI for the Lenton area:

$$\text{Modified TPI} = \frac{(\%\ \text{telovitrinite}) + (\%\ \text{semifusinite}) + (\%\ \text{fusinite})}{(\%\ \text{detrovitrinite}) + (\%\ \text{macrinite}) + (\%\ \text{inertodetrinite})}$$

Gelification Index (GI) gives an indication of the degree of gelification (wetness), or conversely dryness, of the peat forming conditions. As originally proposed by Diessel (1992) the GI ratio is:

$$\text{GI} = \frac{(\%\ \text{vitrinite}) + (\%\ \text{geloinertinite})}{(\%\ \text{detroinertinite}) + (\%\ \text{teloinertinite})}$$

Low GIs are generally associated with dry basin margins and typically increase toward the basin center (i.e. area of maximum subsidence) (Ahmed, 2004). Lambertson et al. (1991) proposed an inverse relationship between the GI and oxidation.

Like TPI, GI is also typically modified (eg. Kalkreuth et al., (1991); Ahmad, 2004; this study) to account for differences in maceral composition with time and location. In this study the macerals indicating wet conditions (gelification) are vitrinite and macrinite whereas dry conditions are indicated by semifusinite, fusinite and inertodetrinite:

$$\text{GI} = \frac{(\%\ \text{vitrinite}) + (\%\ \text{macrinite})}{(\%\ \text{semifusinite}) + (\%\ \text{fusinite}) + (\%\ \text{inertodetrinite})}$$

Comparing TPI and GI gives an indication of the related proportion of preserved to degraded macerals, which then can be used to determine the degree of humification as well as the amount of wood that contributed to peat formation and wood preserved within the coal (Diessel, 1992). By comparing the amount of tissue preservation (TPI) to the overall wetness of the coal (GI), the initial peat forming paleoenvironment can be inferred using the zones devised by Diessel (1986) and later modified by Ahmad (2004).

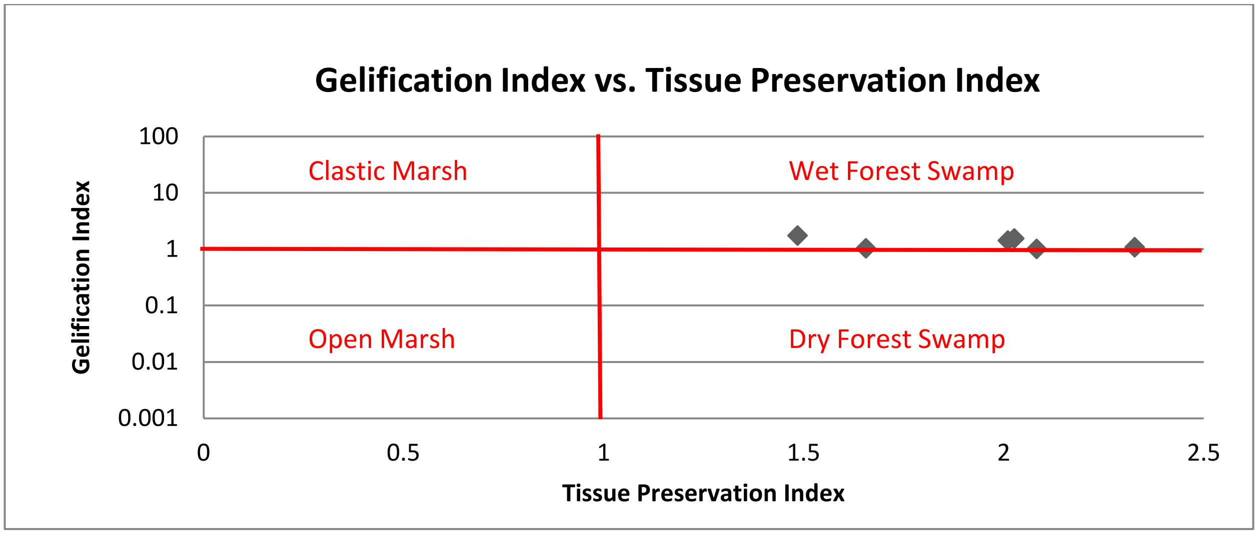


Figure 31: Cross plot of Gelification Index (GI) and Tissue Preservation Index (TPI) and interpreted paleoenvironments of peat formation (Ahmad, 2004). Lenton samples are indicated by black diamonds.

Samples from the Lenton study area plot in the wet forest swamp quadrant. The consistently high TPI values (> 1) indicate that plant material was relatively resistant to decomposition, which is typical of woody plants because they are less prone to oxidation than herbaceous components (eg. leaves) because of the support provided by lignin in the plant cell (Diessel, 1992). GI ratios are also of the order of 1or more, suggesting a consistently wet depositional environment.

These results are consistent with fossilized Glossopteris trees that have been hypothesized to have grown in wet forest-like environments (McLoughlin et al., 1997) and were the main source of organic attritus during the Late Permian in the Bowen Basin (Michealson, 2002). The presence of Glossopteris fossils has been widely documented in Permian strata throughout the Bowen Basin (see McLoughlin (1990) for a comprehensive review), and have been reported less than 30 km from the Lenton study area (Pigg and McLoughlin, 1997).

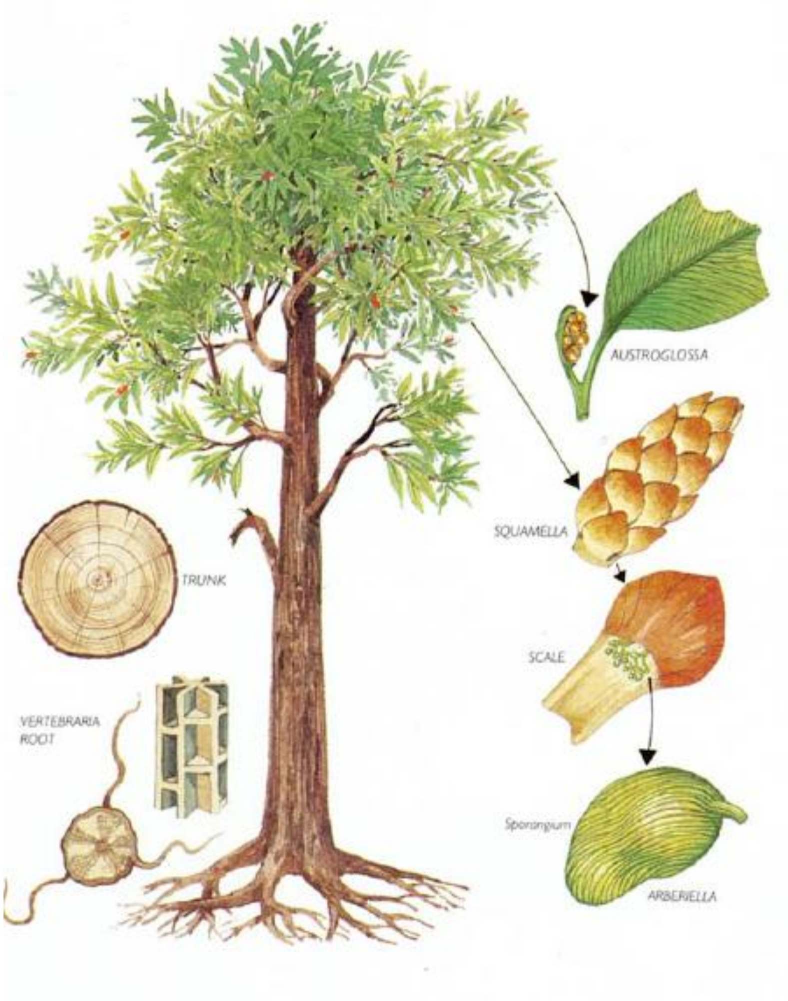


Figure 32: Reconstruction of the Glossopteris tree, which is made up mostly of lignin-rich plant materials such as bark, stems, and waxy leaves, which when devolatilized excrete oily tars and gases (increasing telovitrinite content and thus the tissue preservation index) (White, 1986).

Combining petrographic observations of maceral content with field observations shows that each coal seam in the Lenton area shows a consistent dulling-upward trend (see Chapter 2, Facies 5) together with a decrease in GI and increase in TPI (Figure 33). Moreover, the entire coal-bearing section of Lenton shows a long-term upward dulling.

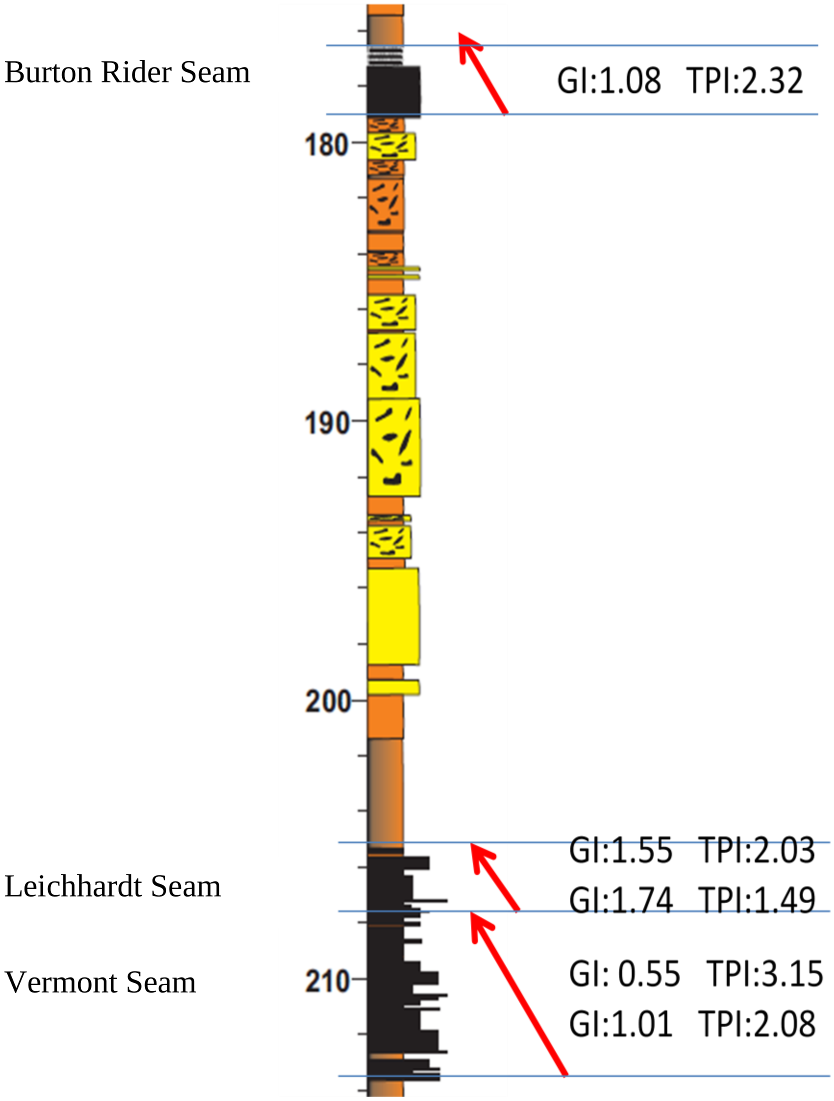


Figure 33: Stratigraphic section of the coal-bearing stratigraphy from the Lenton deposit, the GI and TPI values are shown for the top and bottom of each coal seam. Red arrows indicate the dulling-up trend observed in individual coal seams.

The long-term trend of progressive upward dulling indicates a general upward drying of environmental conditions. The fact that the trend is observed in both the individual coal seams and the full coal-bearing stratigraphic section indicates recurring short term decreases in groundwater levels superimposed on a systematic and protracted upward drying trend. Work by Wadsworth et al. (2002) suggests that long-term trends in coal-bearing environments are related to the relative rates of accommodation change and peat production (Figure 35). Coal formation is associated with environments in which rates of accommodation creation and peat production are approximately equal (known as the peat window).

A drying-up succession, which is indicated by a change from bright coal to dull coal, suggests that initially peat did not accumulate, due an imbalance between subsidence and plant production. In this case, the accommodation rate exceeds peat production rate and must become more balanced, either by raising the water table level so that peat can form or by reducing the rate of subsidence so that coal forming processes can exceed clastic sedimentation. The transition from clastic sedimentation to peat formation is typically indicated by the appearance of carbonaceous mudstone and siltstone or shaley coal.

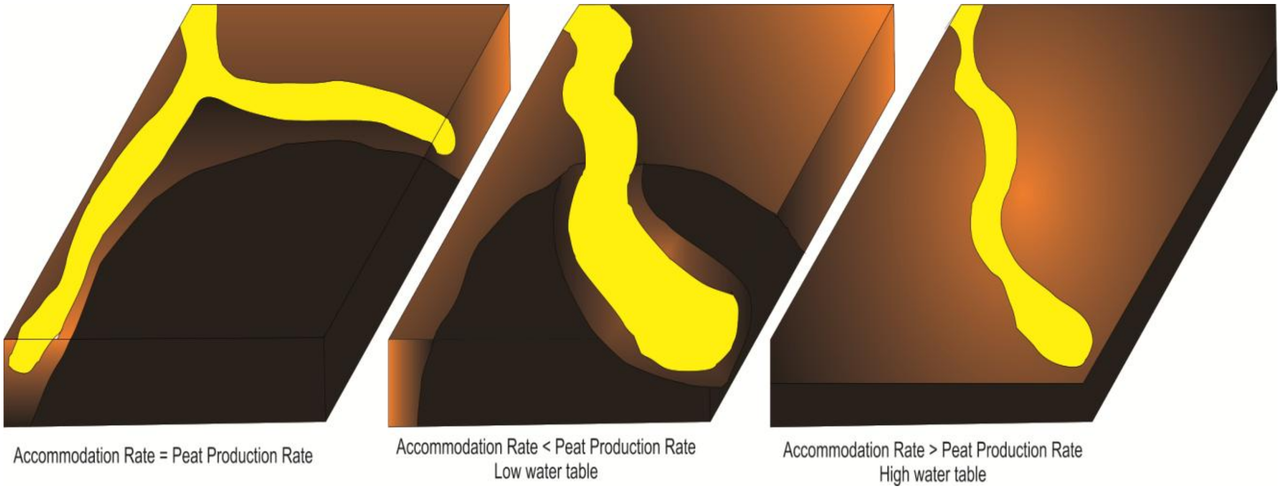


Figure 34: Possible depositional environments for different accommodation rate to peat production rate as described by Wadsworth (2002). When the accommodation ratio is approximately equal to the peat production ratio the conditions for peat formation and preservation are ideal, when the peat production rate is higher than the accommodation rate (low water table), the formation of degraded coal or erosion are common and lastly, when the accommodation rate is higher than the peat production rate (high water table) the result is flooding of the peatmire resulting in clastic sedimentation.

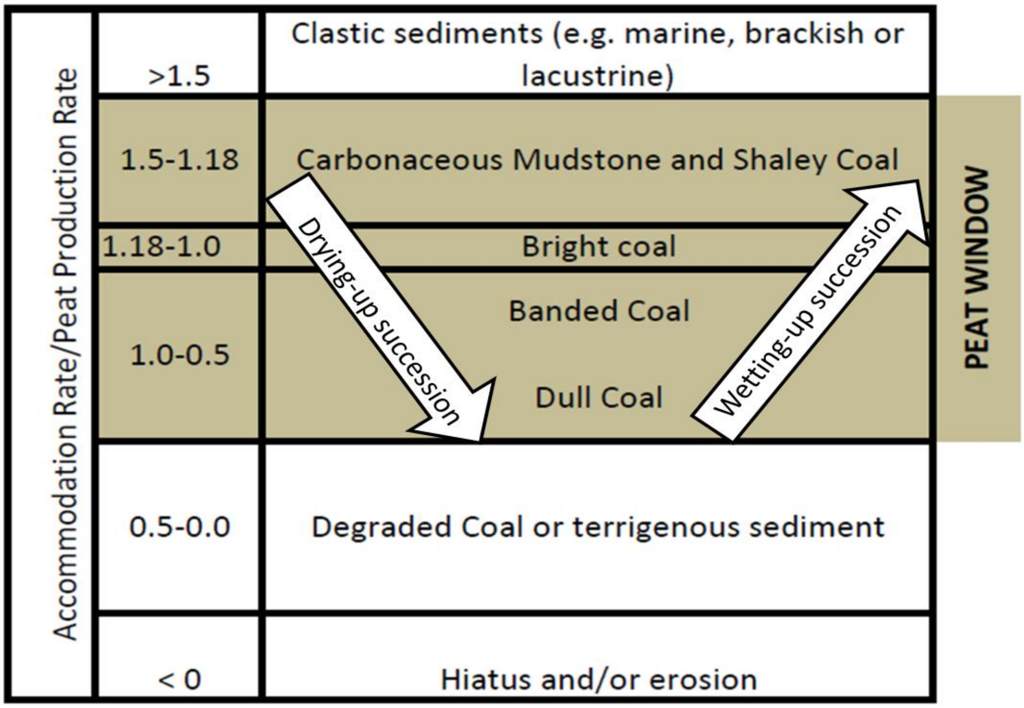


Figure 35: Idealized chart showing the relationship between accommodation rate/peat production rate and coal facies (Wadsworth et al, 2002; Jerrett et al., 2011). The coals at Lenton follow the drying up succession pathway very closely, as they transition from bright coals at the base to duller, more degraded coals at the top. This same trend is observed also in the three main coal seams (Burton, Leichhardt and Vermont).

The increase in TPI between the upper and lower parts of the Vermont and Leichhardt coal seams indicates that more of the primary plant features are being preserved in the upper parts of the seams. Since all of the peat-forming plants in the Late Permian Bowen Basin are the same species (McLoughlin, 1990) this increase is likely caused by the differences in conditions of preservation. The decrease in GI between the same the upper and lower parts indicates that the seams are getting progressively drier.

The GI and TPI are inversely proportional, indicating that wetter coals show less tissue preservation than the drier coals. This is likely associated with the overall inertinite content of the coals, as semifusinite and fusinite are used in both calculations, as the numerator for the TPI and as the denominator in the GI calculation, contributing largely to the inverse proportionality of these values. Inertinite is associated with plant material that has undergone extensive oxidation during the early stages of peat accumulation and burial, however semifusinite and fusinite still preserve their primary cellular structure and are as such are considered decay-resistant macerals. The fact the these two macerals make up a large proportion of the overall maceral composition (28-53%) indicates that in this case the high TPI values can be associated with drier environments in which the peats were exposed to oxygenating conditions that did not destroy the primary cellular structure of the coals.

Chapter 5: Discussion

5.1 Introduction

This chapter is sub-divided into two parts: depositional history and depositional model. The first part, depositional history, outlines the vertical stacking patterns of the six different facies and correlates them with upward changes in geochemistry to provide a detailed description of the depositional history of the Lenton deposit. The second part integrates well log, geophysical and geochemical data from coal deposits in the Bowen Basin to build a predictive depositional model for the Lenton deposit.

The Lenton deposit comprises two stratal units, the organic-rich Blackwater Group overlain by the sandstone-dominated Rewan Group. The Blackwater Group consists of three coal packages, which stratigraphically upwards are the Moranbah, Fort Cooper and Rangal coal measures. In the northern part of the Bowen Basin, which includes the Lenton deposit, the Moranbah and Fort Cooper (FCCM) coal measures, although thickly and areally well-developed, are too deeply buried to be considered economic. The Rangal Coal Measures, on the other hand, form a laterally continuous, shallowly buried unit that can be extracted using underground, but more importantly, inexpensive surface mining techniques.

The Rangal Coal Measures (RCM) is the uppermost unit of the Blackwater Group and its base is generally where drilling (and coring) in the Lenton study area stops. Stratigraphically upward the base of the RCM is marked by an abrupt change to strata lacking volcanoclastic detritus (Facies 6), which is abundant in rocks of the underlying Fort Cooper Coal Measures. The carbonaceous-rich RCM consists mostly of coal (F5), carbonaceous mudstone (F4) and graded sandstone and siltstone (F3) that in core make up approximately 30%, 15% and 55% of the RCM strata, respectively. Coal is thickest and of best quality in the basal 20% of the unit and comprises five plies that range from 0.5-6.0 m thick. These plies make up the combined Vermont and Leichhardt seams, which cumulatively in the Lenton study area range from 6-12 m thick. Near the top of the RCM is a ~ 2 m thick slightly poorer quality (higher ash content) coal seam (Burton Rider). F5 coal is interpreted to have accumulated in a long-lived, regionally extensive, low-lying peat system, which based on the maximum coal seam thickness of ~ 12 m and a peat compaction ratio of 7:1 (Shearar and Moore, 1996) suggests an initial 84 m-thick accumulation of peat. The Vermont and Leichhardt coal seams are separated by a thinly developed unit (up to 50 cm thick) of carbonaceous-rich mudstone and siltstone that represents a short-lived episode of higher clastic input and temporary cessation of low-ash peat accumulation.

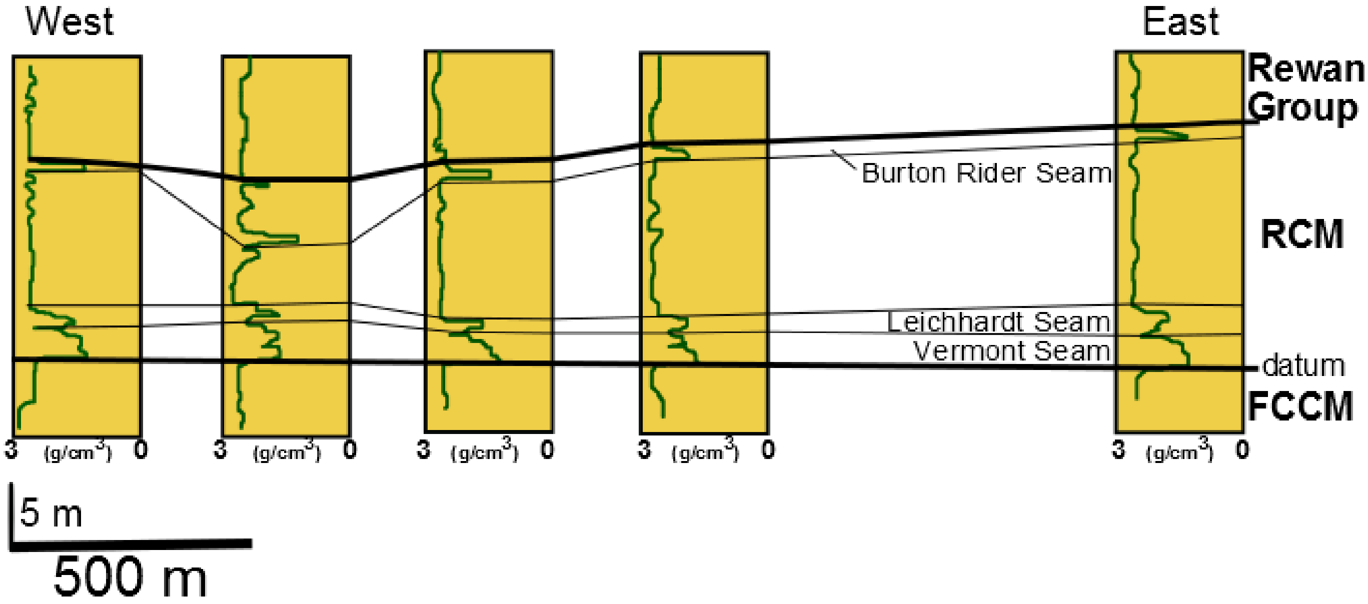


Figure 36: Stratigraphic correlation using downhole density logs of the Rangal Coal Measures (RCM) across the New Lenton study area. Note the general rightward deflection of the density logs

as the coal seams are approached correlating to the change from higher density sandstone and siltstone (~ 2.3 g/cm^3) to lower density coal (~1.6 g/cm^3).

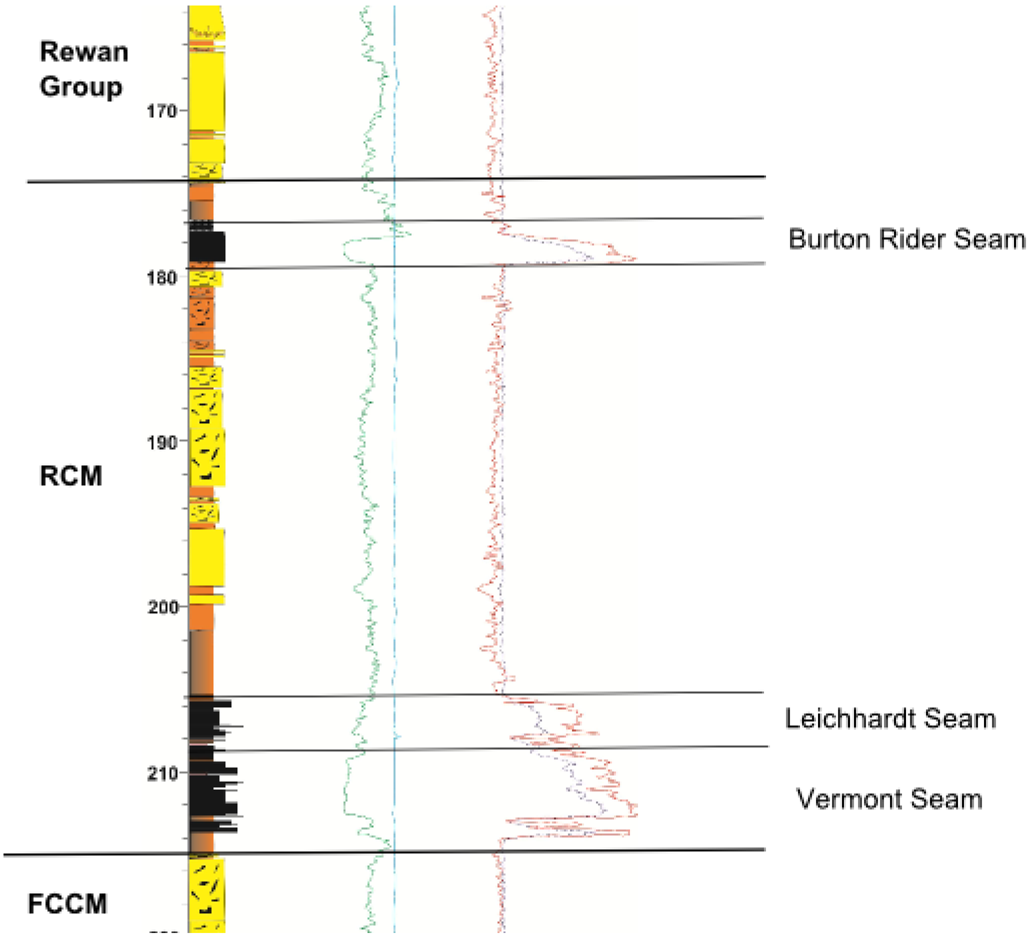


Figure 37: Type stratigraphic and geophysical logs for the Rangal Coal Measures in the New Lenton area. Geophysical log colours are green for gamma, light blue for calliper, red for long-spaced density and dark blue for short-spaced density. Refer to Figure 43 for lithology colour code.

Coal is formed by the accumulation, burial and maturation of peat within a reducing environment where the rate of peat accumulation and the height of the water table are balanced. The base of the Rangal Coal Measures marks the onset of optimal conditions for long-lived peatmire formation across the Bowen-Gunnedah-Sydney basins. Given the temperate to polar position of the Bowen Basin during the Permian (Frank et al., 2008) with the New Lenton deposit forming at an approximate latitude of 70 degrees south

(Veevers, 2005), modern-day peat analogues include the James Bay peatlands (northern Ontario), the Cumberland marshes (Saskatchewan) and the Ob River (Siberia). Canadian peatlands (both the James Bay peatlands and the Cumberland Marshes) have been widely used as climate analogues because they are located at approximately the same latitude as the Bowen Basin at the time of peat accumulation. Plant growth and preservation rates in these modern cold climate environments can be used as proxies for estimating plant growth and preservation rates for the Permian Bowen Basin as well as deducing the effects of climate on the formation of peat in these similarly large-scale, wood-dominated peatmire systems. Martini and Glooshenko (1985) showed that typical peat growth rates for *Sphagnum* in the high latitude James Bay peatlands (Northern Ontario) range from 0.1mm/year to 1mm/year. These rates are thought to be representative of those for cold-climate *Glossopteris* plants during the Permian (Martini and Glooshenko, 1985). Nevertheless, although a good analogue for peat development and climate, these Canadian cold-climate peats are forming in tectonically stable intracratonic basins, which are unlike the tectonically active foreland Permian Bowen Basin. Since tectonism exerts a major control on basin subsidence, which is key in the formation of peat (rates of subsidence and plant growth must be approximately equal for appreciable peat accumulation), having a climatically and tectonically similar modern analogue is important. Recently, the Ob River in Siberia has been proposed to be a more reliable analogue owing to its high latitude and tectonically active setting (Figure 38) (Lang et al., 2000). Nevertheless, although peat accumulating and tectonically active, subsidence rates are significantly lower than that estimated for the Permian Bowen Basin (Esterle, 2012, personal communication). In addition, studies comparing tectonic conditions in the

Permian Bowen Basin and the Ob River peatlands are limited. Notwithstanding differences in rates of subsidence, rates of peat accumulation in the Ob River are on the order of 1mm/year to 5 mm/year (Verhoeven et al., 2006), which is several times that in the James Bay and Cumberland regions, and more representative of the estimated 1mm/year rate of peat accumulation in the Permian Bowen Basin (Johnson, 2009).

Figure 38: Aerial photograph of the Ob River, Siberia. The extensive peatmire and marsh system (green), isolated channels and floodplain lakes are considered analogous to the interpreted depositional environments of Facies 3, 4 and 5 of the Permian Blackwater Group (Photo taken by: Alexey Sergeev http://www.asergeev.com/pictures/archives/compress/2011/935/26s.htm).

Based on modern analogue cold-climate peat accumulation rates that range from about 0.1 mm/year to 5 mm/year or more (Martini and Glooschenko, 1985; Verhoeven et al.,

2006) suggest that Bowen Basin peats, specifically the combined 12 m thick Vermont and Leichhardt coal seams, required as little as 17 ky to as much as 0.84 my to accumulate. Moreover, systematic changes in the tissue preservation index (TPI) (the preservation of primary cellular structure) and gelification index (GI) (degree of wetness) in both the individual coal seams and throughout the entire Blackwater Group indicate short-term drying upward episodes superimposed on a long-term drying upward trend (Figure 39). Recurring short-term episodes are probably related to lowered local groundwater levels, most likely driven by climate changes. These, then are superimposed on the longer-term drying-upward trend interpreted to be driven by tectonic influences on basin subsidence associated with the Hunter-Bowen Orogeny; the final phase of compressive deformation during the Late Permian-Early Triassic (Fegusson, 1991). These changes are also reflected in coal quality, a term used to describe characteristics of coal, including clastic content (ash), moisture, sulfur content, carbon content and energy potential. In the Vermont and Leichhardt seams, coal quality decreases stratigraphically upward suggesting the increased effects of chemical oxidation and as a consequence, deterioration of the accumulating organic matter. This most probably reflects reduced rates of burial (i.e. subsidence) and accordingly prolonged exposure to near surface oxidation processes.

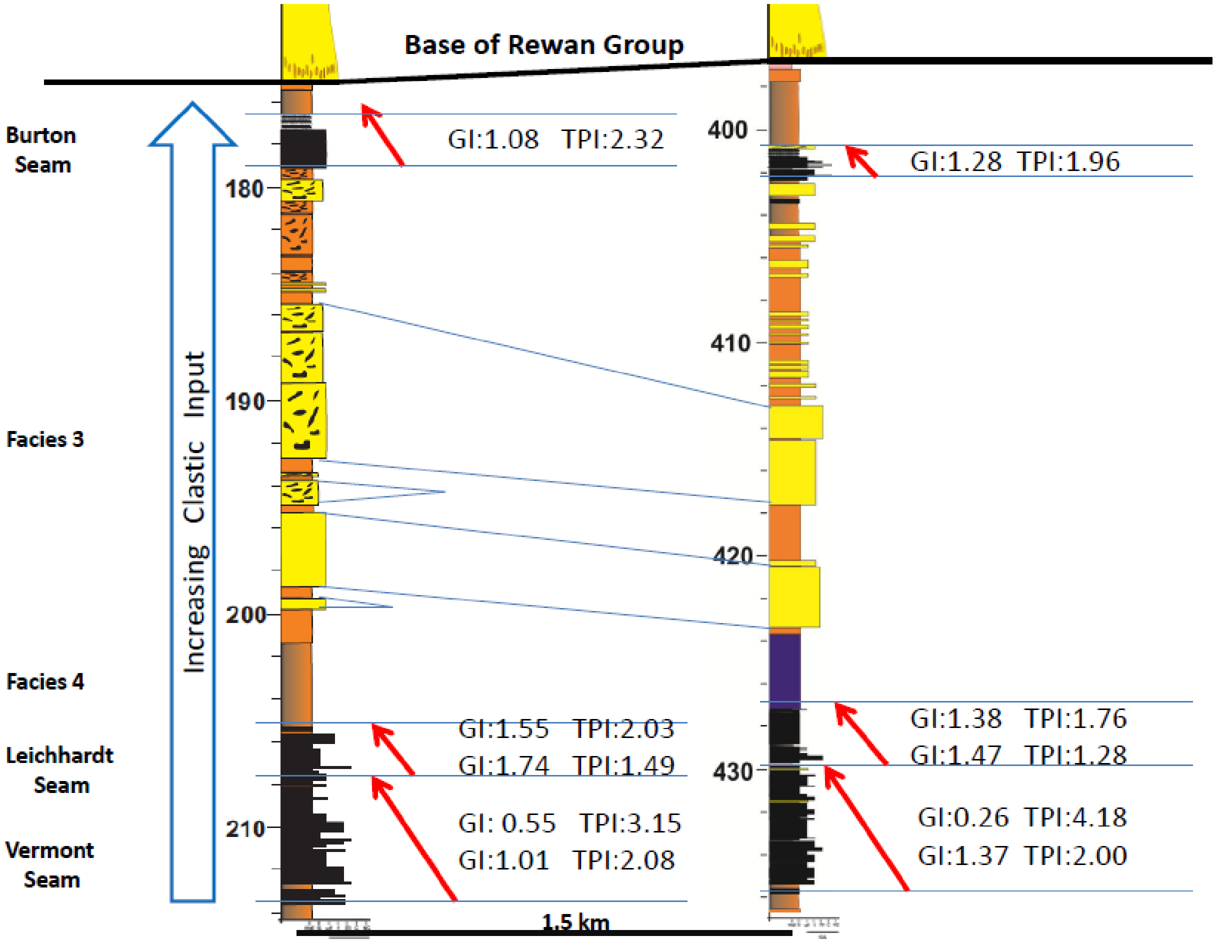


Figure 39: Stratigraphic changes through the Blackwater Group indicate drying upward on both short and long time scales. This is illustrated by decreases in GI (Gelification Index), increases in TPI (Tissue Preservation Index) and the red arrow indicating dulling upward trends within each of the 3 coal seams and the Blackwater Group as a whole. Vertical scale in meters. See Figure 43 for description of strata colour code.

The peat forming environment in which the Vermont and Leichhardt seams formed changed as in-situ deposition of carbonaceous-rich detritus (F5) became gradually replaced by marshes and the deposition of clastic carbonaceous mudstone and siltstone (F4). This likely resulted from the collapse of the domed peat-forming environment (peatmire) caused by either an increase in subsidence where plant growth could no longer keep up with subsidence and the peatmire drowned, or changes in climate where reduced availability of water lowered rates of plant growth. Based on geochemical data suggesting a long-term period of lowered subsidence rates associated with the Hunter-Bowen Orogeny (see discussion above) the gradual transition from peat-forming to marsh environments was probably caused by a change to more arid conditions. This, then, was eventually succeeded by the deposition of clastic sediments (F3 siltstones and sandstones) and the establishment of a fluvial system across the basin. Channel deposits are particularly common in the bottom 75% of the RCM succession, however the upper 25% are dominated by floodplain deposition of siderite-rich siltstone suggesting the establishment of quiescent, waterlogged conditions. Fluvial channels consist of laterally restricted few meter-thick, fining upward successions of fine- to medium-grain, dune cross-stratified sandstone overlain gradationally by fine-grained, ripple cross-stratified sandstone. Overlying the floodplain-dominated environment, conditions for the accumulation and preservation of peat were once again established and resulted in the deposition of the ash-rich Burton Rider seam. Like the Vermont and Leichhardt superseam, the Burton Rider seam exhibits a similar upward drying trend (F5 to F4 to F3), however, this time the cessation of peat formation was permanent.

The unconformity that separates generally fine-grained strata of the Rangal Coal Measures (Blackwater Group) from sandstones of the Rewan Group was caused by uplift and erosion associated with a major compressive event during the Hunter Bowen Orogeny (Korsch et al., 2009a, 2009b, also see discussion below). Medium-to coarse-grained sandstone (F1) and graded sandstone to siltstone (F3) are more common in the lower part of the Rewan Group and are interpreted to represent deposition in a braided fluvial system. This is based on the lateral continuity (i.e. sheet-like nature) of the sandstone deposit, thinness (up to only a few meters) of channel fill deposits, paucity of mudstone layers and the omnipresence of traction transport sedimentary structures, namely dune and lesser ripple cross-stratification. Braided fluvial deposits at the base of the Rewan Group are of the order of 100 m thick and are gradationally overlain by a thick succession of paleosols of F2 (interbedded siltstone and mudstone). These paleosols were deposited in a floodplain environment, most likely following a major and permanent diversion (i.e. avulsion) of the channel system away from the Lenton study area. Conditions in the now extensive floodplain, which included the Lenton study area, accumulated an at least 50 m thick succession of gleyed paleosols, these strata form the modern ground surface. Lithological features in the gleysols including colour mottling and drab root haloes suggest reducing and oxidizing conditions, which likely suggests seasonal waterlogging. This is substantiated by geochemical changes, specifically rhythmic variations in oxidation ratio ((Fe_2O_3 + MnO)/Al_2O_3) (see Figure 27). These differences have been linked to changes in the water table which caused temporary changes in the exposure of the sediments to oxygen directly and evidenced by the variegated colour of the gleysols.

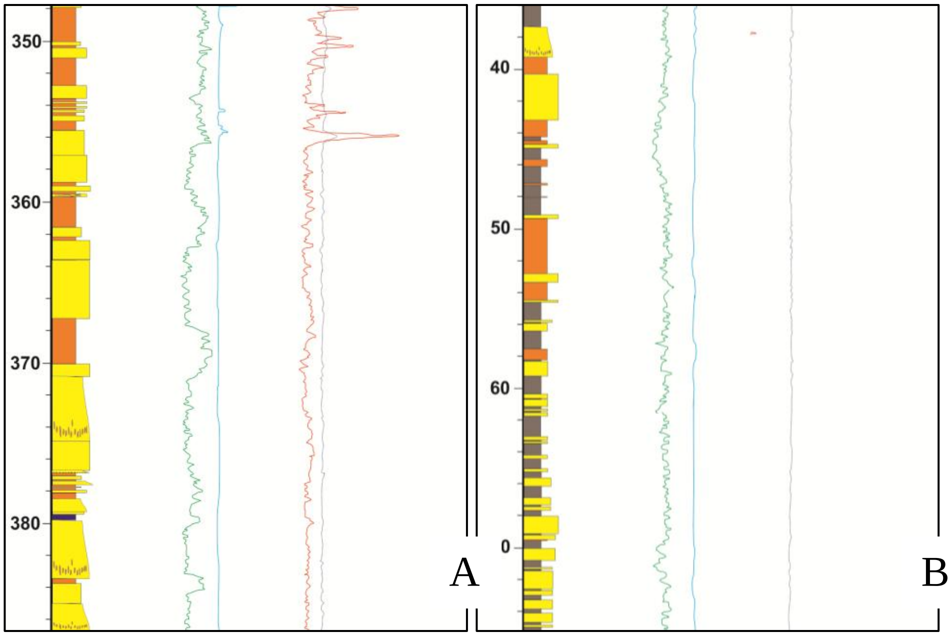


Figure 40: Stratigraphic and geophysical logs for Rewan Group strata in the New Lenton area. Figure 40A shows the typical stratigraphy for the lower part of the Rewan group that is dominated by sandstone of F1 and F3. Figure 40B shows the upper part of the Rewan Group stratigraphy dominated by siltstone and mudstone that are interpreted to be paleosols formed in an extensive, seasonally flooded floodplain. Geophysical log colours are green for gamma, light blue for calliper, red for long-spaced density and dark blue for short spaced density. Refer to Figure 43 for lithology colour code. Note: density logs are not available for Figure 40B because the hole was cased to 170 m with steel.

Based on a QFL (Quartz-Feldspar- Lithic fragment) diagram (Dott, 1964), all of the samples analyzed in this study are classified as lithic arenites. However samples cluster into two separate populations indicating an important mineralogical change between sandstones of the Triassic Rewan Group and those of the Permian Rangal Coal Measures, specifically more abundant lithic fragments and lower quartz in the Rewan Group. This mineralogical change was likely caused by uplift and consequent accelerated erosion of eastern sediments sources during the latter part of the Hunter-Bowen Orogeny and the final filling of the Permian-Triassic Bowen Basin.

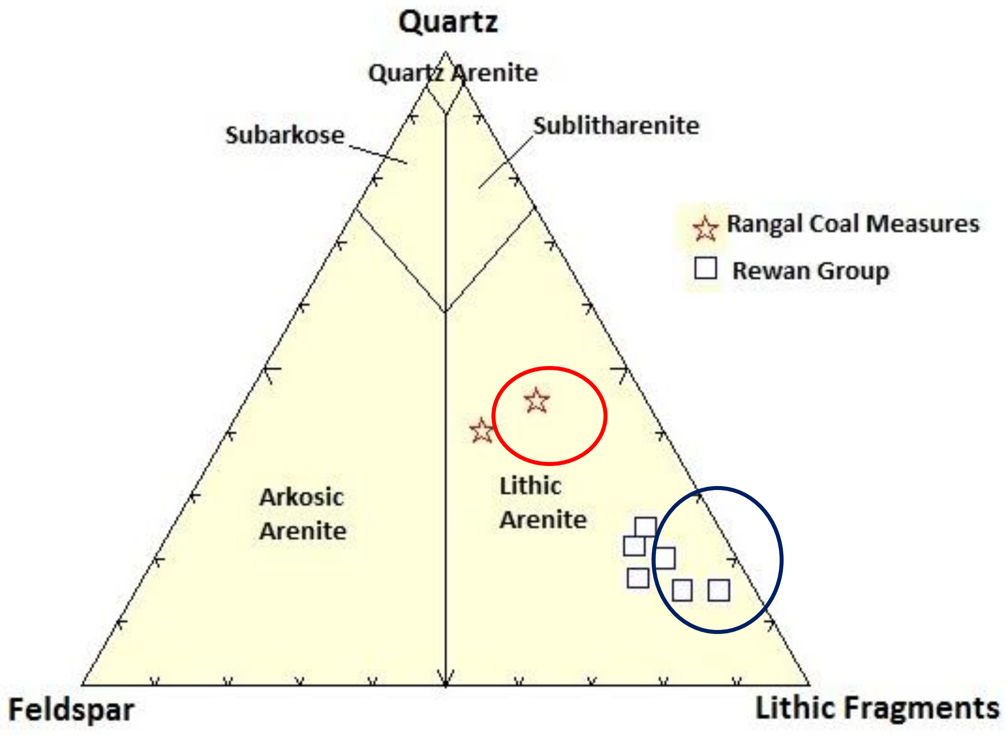


Figure 41: Quartz- Feldspar- Lithic Fragment diagram for nine sandstone samples from the New Lenton study area (ternary plot based on Dott, 1964).

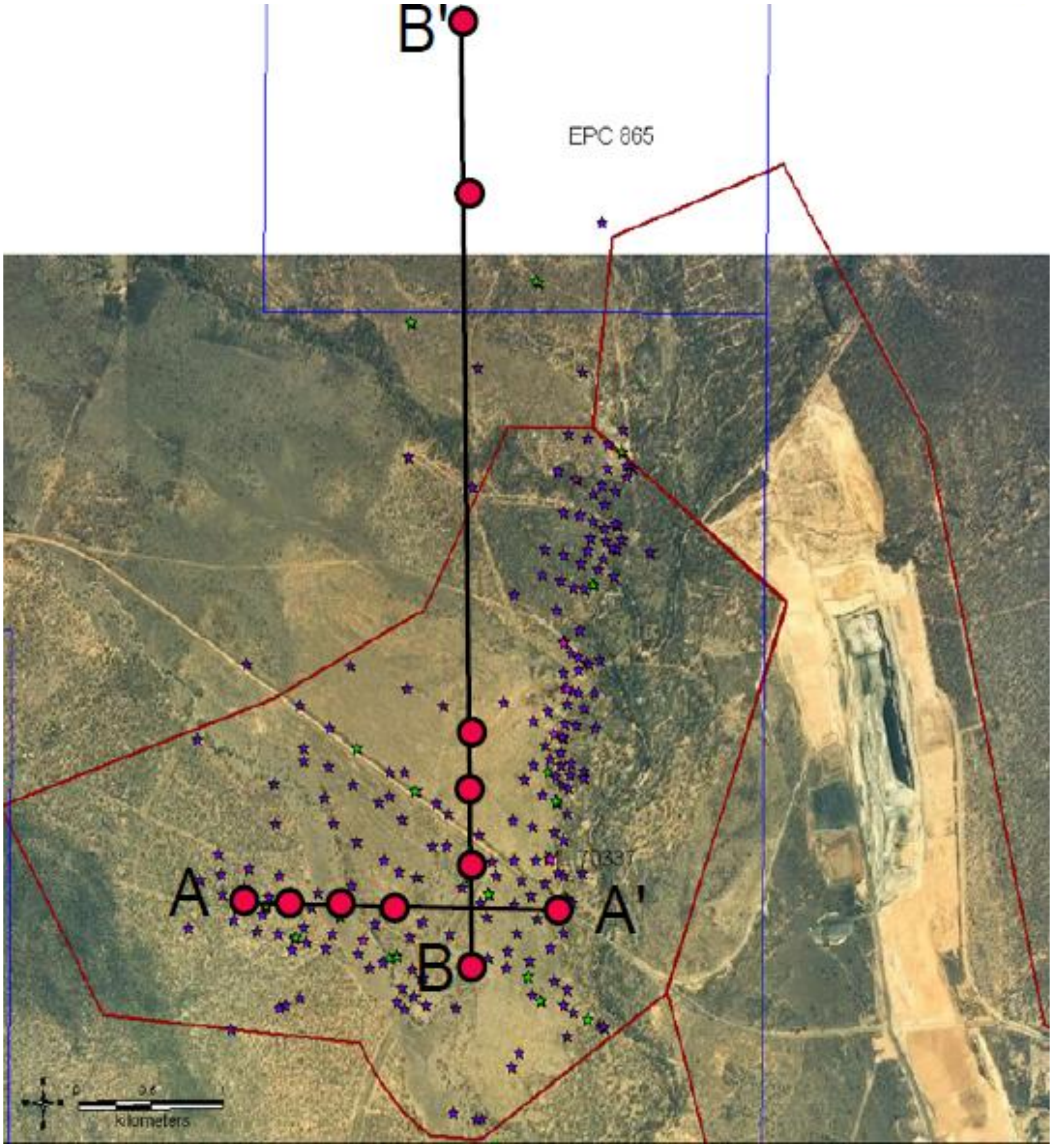


Figure 42: Lenton study area showing the location of A-A' and B-B' in Figures 36 and 43 respectively. Stars indicate the location of drill holes and colours indicate the type of drilling (purple- reverse circulation, pink- large diameter core, and green- 4-inch core). Circled locations are included in the cross sections.

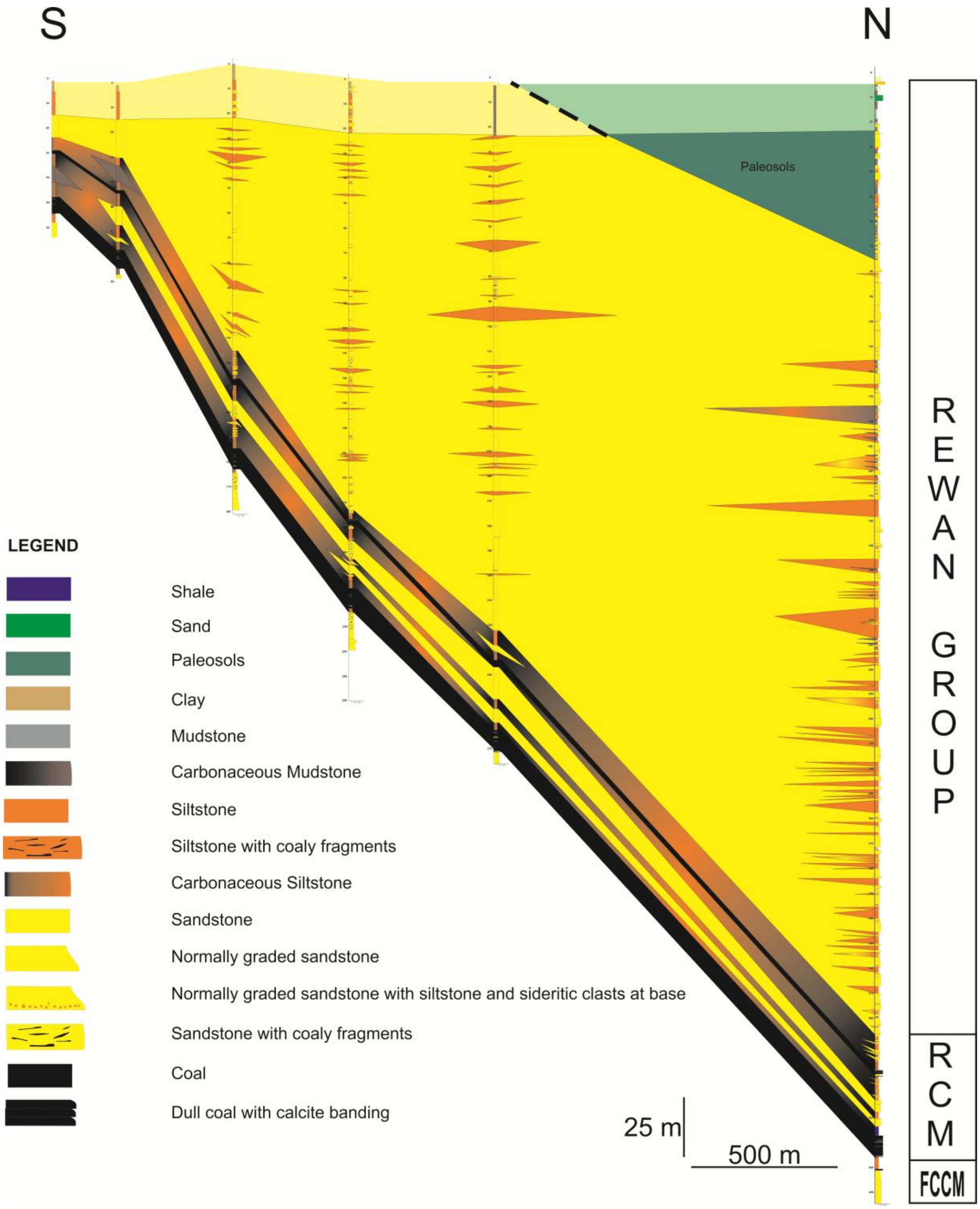


Figure 43: Stratigraphic correlation across the Lenton study area. The uppermost Blackwater Group (Rangal Coal Measures, RCM) is composed predominantly of facies 3 (siltstone and sandstone), 4 (carbonaceous siltstone and mudstone) and 5 (coal). The Rangal Coal Measures are overlain unconformably by the Rewan Group, which consists of two distinct packages, the first composed of facies 1 (graded sandstone) and 3 (sandstone and siltstone), representative of deposition in a braided fluvial system overlain by facies 2, (mudstone and siltstone), representing floodplain deposition after a major avulsion of the channel system. The lighter areas at the top of the section show the depth of modern weathering in the New Lenton area. Note that the New Lenton area is affected by significant faulting as outlined in Chapter 1.

Based on the work of Fielding et al. (1997) the tectonic model for the Bowen Basin comprises three tectonic stages during the Early Permian to the Late Triassic, and which are interpreted to have significantly influenced the style and areal distribution of sedimentation. Stage one is characterized by rapid subsidence during the Early to Middle Permian that resulted in deposition of marine siliciclastics throughout the Bowen Basin. This, then, was followed by reduced thermal subsidence (Stage 2) and the superposition of coarse-grained, continental clastic rocks marking the infill of the marine Bowen Basin. Rates of basin subsidence, however, were little different than rates of organic sediment accumulation and allowed the formation of long-lived peatmire systems (F5) that eventually led to the accumulation of the Blackwater Group coal measures in the Bowen Basin. Stage three begins in the Late Permian and marks the beginning of the change from passive-thermal subsidence to foreland thrust-load-induced burial. During this stage, the New England Orogen and the adjacent Bowen-Gunnedah-Sydney basin system were affected by subduction-driven retro-thrusting to the east as a result of the ~35 my Hunter-Bowen Orogeny (Korsch et al., 2009b). Initially this reverse in subsidence patterns, which most probably started slowly caused the long-term upward drying trend and the termination of conditions conducive to peat formation. This, then was punctuated by a discrete contractional event that caused widespread uplift and erosion, which is manifested by the unconformity separating strata of the RCM and the Rewan Group. Erosion of the rising continental magmatic arc became the primary source of sediment for the basin system during the Early Triassic resulting in deposition of the volcanoclastic-rich Rewan Group. Sediment accumulation in the Bowen Basin terminated around 235-230 Ma as a result of thin-skinned thrust deformation of the basin during the late stages of the Hunter-Bowen event, followed by erosion of the basin fill (Fielding et al., 1997, Korsch et al., 2009a).

Chapter 6: Conclusions

6.1 Summary

This study documents the stratal attributes and origin of fluvial, peatmire and floodplain strata of the Permian Blackwater and Triassic Rewan groups. Based on core descriptions, petrographic and geochemical analyses, six lithological facies were identified: medium- to coarse-grained sandstone (F1), interbedded siltstone and mudstone (F2), graded sandstone and siltstone (F3), carbonaceous siltstone and mudstone (F4), coal (F5) and white clay (F6). Facies 3 was further sub-divided into two subfacies based on differences in cross-stratification.

The Permian Blackwater Group is made up of F3, F4 and F5, which have been interpreted to represent different depositional environments within a fully continental system, specifically floodplain lakes (F3A), low-energy fluvial channels (F3B), marsh deposits (F4) and peatmires (F5). Maceral analysis of coals in this group demonstrate a drying-upward trend based on differences in the tissue preservation index (TPI) and the gelification index (GI) between coal seams related to changes in plant preservation. This drying upward trend, which is manifested additionally in the sedimentological and geochemical attributes of the succession, is interpreted to be the result of slowing basin subsidence in concert with recurring climatic changes. These short-term climatic changes are superimposed on the long-term tectonic changes indicating two different and distinct controls on peat accumulation and preservation in the Bowen Basin.

Coal-bearing strata of the Permian Blackwater Group are then unconformably overlain by the coal-barren Triassic Rewan Group made up of braided-fluvial channels (F1), paleosols (F2), floodplain lakes (F3A) and low-energy fluvial channels (F3B). F1, F3A and F3B accumulated in a sand-rich braided fluvial setting that became succeeded abruptly upward by gleysols (F2), likely caused by a permanent diversion of major channel systems, which abruptly terminated fluvial deposition in the Lenton area. The changes in sedimentation patterns, climatic controls, sediment provenance and tectonic conditions throughout the Permian and Triassic described above all played a vital role in the formation and preservation of coal deposits within the Bowen Basin, specifically the Rangal Coal Measures.

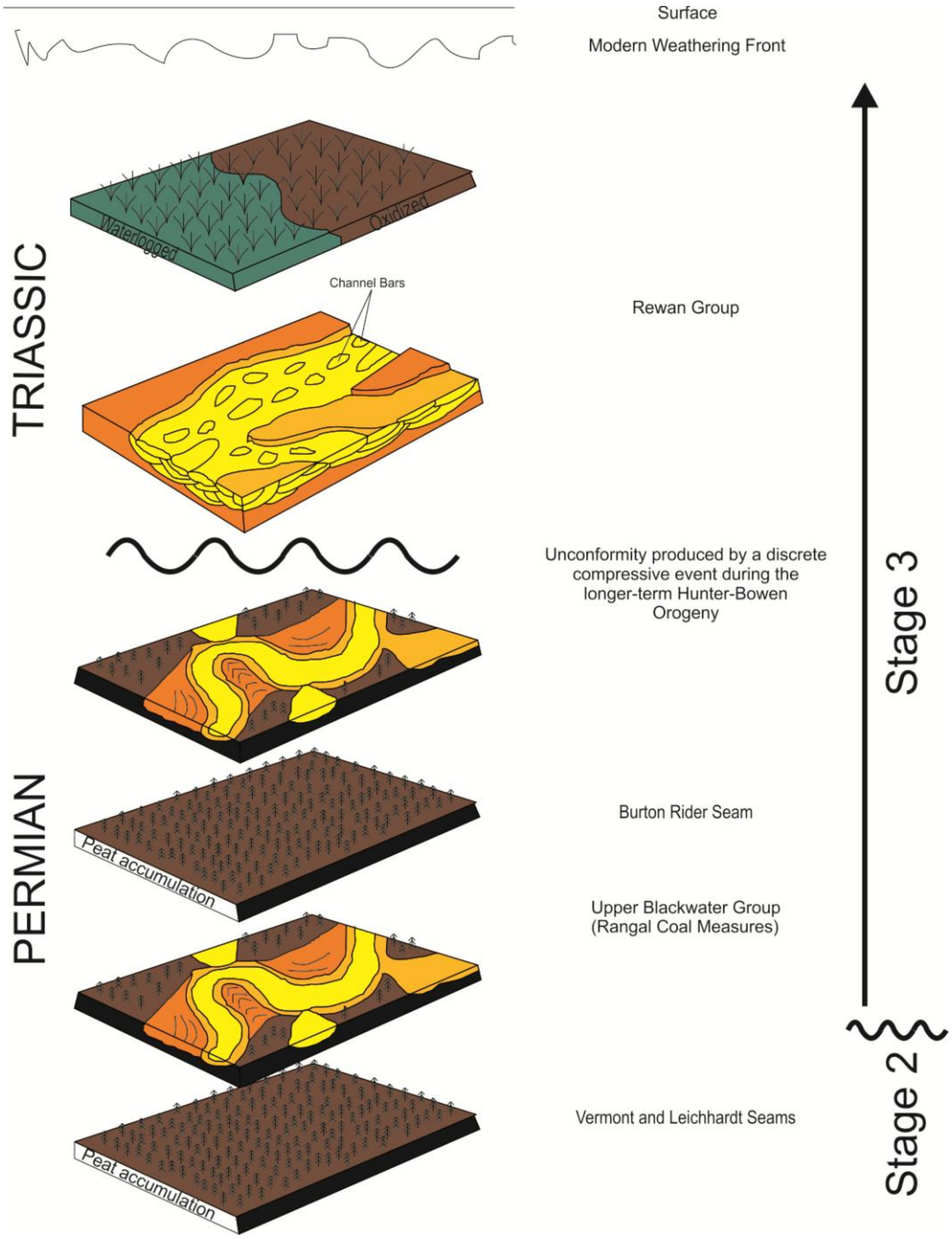


Figure 44: Peat accumulates in long-lived, well developed peatmires where rates of subsidence and accumulation of organic detritus are balanced. Conditions like these resulted in the development of the Vermont and Leichhardt seams, which were gradationally overlain by marsh-type deposits (F4), which in turn are overlain by fluvial-type deposits (F3A and F3B). The second, shorter-lived peat accumulating episode formed the Burton Rider seam. The Blackwater Group is then unconformably overlain by the sandstone-rich braided fluvial strata of the Rewan Group composed predominantly of F1 and F3, which in turn is overlain abruptly by a thick succession of gleyed paleosols (F2), likely caused by a major and permanent diversion of the channel system away from the study area.

6.2 Implications for future coal exploration

Coal was first discovered in the Bowen Basin in 1878 and the first coal mine was opened in 1920 near Collinsville. Since then the number of operational mines has continued to increase, with 48 mines currently in operation and 50 mining permits under consideration (Queensland Department of Energy and Mines, 2012). The New Lenton deposit is scheduled to become an operational mine within the next decade and the economic viability of the project is aided by the fact that the coal seams can be extended from an open-cut to an underground resource through longwall mining techniques. Observations and interpretations of dulling up sequences, tissue preservation and modern analogues made in this study will help in the prediction of coal quality and lateral continuity in the New Lenton deposit, and become particularly useful as depth to the coal seams increases to the north and expensive subsurface mining techniques become required.

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APPENDIX 1: LITHOLOGICAL LOGS

The following appendix contains lithological logs produced from two fully cored holes (LEN240PC and LEN241PC) from the Lenton deposit, on which this project is based. All holes were logged in the field using codes described in the lithology dictionary (next page) and input digitally into a geodatabase for use in a geological model of the deposit.

New Hope

Lenton Header & Lithology Dictionary

Header Codes

PROJECT	
LEN	Lenton

STATE	
QD	Queensland

COUNTY	
-	*Leave Blank*

PARISH	
-	*Leave Blank*

PORTION	
-	*Leave Blank*

GEOLOGICAL PROVINCE	
BB	Bowen Basin

LEASE	
0337	ML70337 - Lenton
E766	EPC766 - Lenton
E865	EPC865 - Lenton North

SOURCE	
-	*Leave Blank*

MAP ZONE	
A8455K	AGD84 - Zone 55K
G9455K	GDA94 - Zone 55K

AMG EASTING

Put Predicted/GPS coordinate in field until Surveying is complete, then update the field with correct coordinate

AMG NORTHING

Put Predicted/GPS coordinate in field until Surveying is complete, then update the field with correct coordinate

ELEVATION

Leave this field blank until surveying is

ROTATION	
-	*Leave this field blank*

DRILLING COMPANY	
L2	L2 Drilling
NH	New Hope
SK	S&K Drilling

GEOPHYSICS COMPANY	
NH	New Hope

HOLE STATUS	
D	GPS & DTM
G	GPS
O	GPS & SPOTS
P	Predicted
R	Resurveyed
S	Surveyed

DATE STARTED

Date in which drilling started

DATE COMPLETE

Date in which drilling was completed

TOTAL DEPTH

Total depth of the hole

HOLE SIZE

A value measured according to the outside diameter of the drill bit, measured in millimetres

CORE SIZE	
HM	HMLC
HQ	HQ (65mm)
LC	6-INCH (150mm)
PQ	PQ (85mm)
XC	4-INCH (100mm)

DRILL TYPE	
A	Air Core
C	Reverse Circulation
H	HQ Hole
L	6" Core Hole
M	HMLC Hole
P	PQ Hole
R	Rotary (Chip) Hole
X	4-inch Core Hole

DRILL RIG	
L2	L2 Drilling Rig
N2	New Hope Rig 2
N3	New Hope Rig 3
N4	New Hope Rig 4
SK	S&K Drill Rig

GEOPHYSICAL DEPTH

Depth which geophysics probe reached

GEOPHYSICAL PROBES/LOGS	
C	Caliper
D	Dual Density Source
G	Gamma
O	Sonic
U	Microdensity Source
V	Verticality
Z	Acoustic Scanner

Lithology Codes

SEAM NAME	
BHWE	Base of Weathering
BHWL	Base of Standing Water Level
BL	Burton Lower Seam
BLT	Burton-Leichhardt Seam
BLU	Burton-Leichhardt Upper Seam
BR	Burton Rider Seam
BV2	Burton Vermont 2 Seam
BV3	Burton Vermont 3 Seam
GRH1	Girrah Seam
REW	Rewan Formation
THAD	THAD
VL	Vermont Lower Seam
VL1	Vermont Lower 1 Seam
VL2	Vermont Lower 2 Seam
VU	Vermont Upper Seam
YARR	Yarrabee Tuff

BASE DEPTH

The base depth of unit which is being logged

SAMPLE NUMBER

According to the sample number in the sample tag booklet which corresponds to the sample bag

BIT TYPE	
B	Blade Bit
C	Tungsten Carbide Coring Bit
D	Diamond coring Bit
E	Hammer Bit
M	Claw (Mill Claw) Bit
P	PCD (Polycrystalline Diamond) Bit
R	Roller Bit

LITHOLOGY TYPE	
AL	ALLUVIUM
BA	**BASALT**
BR	BRECCIA
C1	**COAL, >90% bright**
C2	**COAL, 60-90% bright**
C3	**COAL, 40-60% bright**
C4	**COAL, 10-40% bright**
C5	**COAL, <10% bright**
C6	**COAL, dull <1% bright**
C7	**COAL, dull, conchoidal**
C8	**COAL, fibrous**
C9	**COAL, weathered**
CD	COAL, cindered
CF	COAL, fusainous
CG	CONGLOMERATE
CH	CHERT
CL	**CLAY**
CN	STONY COAL
CO	COAL
CS	**CLAYSTONE**
CU	COAL, undifferentiated
CZ	COALY SHALE
FI	FILL
FW	FOSSIL WOOD
GV	GRAVEL
HA	COAL, heat altered
IG	IGNEOUS ROCK
IS	IRONSTONE
KC	COAL, coked
KL	CORE LOSS
MD	**MUD**
MM	METAMORPHIC ROCK
MS	**MUDSTONE**
NK	NOT CORED
NL	NOT LOGGED
NR	NO RECOVERY
OW	OLD WORKINGS
PY	PYRITE
QT	QUARTZITE
SA	**SAND**
SD	SIDERITE
SH	SHALE
SI	**SILT**
SL	**SILTSTONE**
SO	SOIL
SS	**SANDSTONE**
TF	TUFF
VR	VOLCANIC ROCK
XC	**CARBONACEOUS CLAYSTONE**
XH	**CARBONACEOUS SHALE**
XM	**CARBONACEOUS MUDSTONE**
XS	**CARBONACEOUS SANDSTONE**
XT	**CARBONACEOUS SILTSTONE**

SHADE	
B	medium
D	dark
L	light
M	mottled
S	speckled
V	variegated

HUE	
B	brownish
C	creamy
E	greenish
F	buff
G	greyish
K	blackish
L	bluish
N	fawny
O	orangey
P	pinkish
R	reddish
U	purplish
W	whitish
Y	yellowish

COLOUR	
B	brown
C	cream
E	green
F	buff
G	grey
K	black
L	blue
N	fawn
O	orange
P	pink
R	red
U	purple
W	white
Y	yellow
Z	off-white

GRAIN SIZE	
AG	agglomerate
AP	aphanitic
BO	bouldery
CO	cobbly
CS	coarse grained
CV	coarse to very coarse grained
FM	fine to medium grained
FN	fine grained
FV	very fine to fine grained
GR	granular
LA	lapilli
MC	medium to coarse grained
MD	medium grained
PB	pebbly
PO	porphyritic
VC	very coarse grained

GRAIN SIZE ...cont	
VF	very fine grained

LITHOLOGICAL QUALIFIERS	
AB	abundant
AL	altered
BA	basaltic
BB	60-90% bright
BD	40-60% bright
BE	bentonite
BN	bands
BP	penny bands
BR	>90% bright
BU	near base of unit
CA	calcareous
CC	conchoidal
CD	cindered
CE	cement
CG	conglomeratic
CI	concretion
CL	clayey
CM	common
CO	coaly
CR	chloritic
CS	carbonaceous
CT	clasts
CX	coal
CY	claystone
DB	10-40% bright
DD	<1% bright
DM	1-10% bright
ET	and
FD	feldspathic
FE	ferruginous
FL	feldspathic-lithic
FR	fragments
FW	fossil wood
GN	grains
GV	gravelly
HA	heat affected
HR	hard
IG	igneous rock
IP	in part
IS	iron staining
KA	kaolinitic
LF	litho-feldspathic
LI	limonitic
LL	lithic labile
LM	laminae
LN	lenses
LT	lithic
LZ	limestone
MD	muddy
MI	micaceous
MM	metamorphic rock
MN	minor
MU	near middle of unit
MZ	mudstone
ND	nodules
OC	occasional
OX	oxidised
PA	partings
PB	pebbles
PC	partly carbonaceous
PR	plutonic rock
PY	pyritic
QF	quartz-feldspathic
QL	quartz-lithic
QT	quartzite
QU	quartz
QZ	quartzose
RA	rare
SC	stringers of coal
SD	sideritic
SH	shaly
SI	siliceous
SK	streaks
SL	silty
SN	stony
SP	sporadic
SS	sandy
ST	staining
SX	siltstone
SY	sooty
SZ	sandstone
TF	tuffaceous
TN	tonsteinous
TO	throughout
TU	near top of unit
UF	uniform
VE	vesicular
VN	veins
VR	volcanic rock
WI	with
WP	wisps

MECHANICAL STRENGTH	
DD	disintegrates on drilling
EX	expanding clay
FR	friable
FS	fissile
IN	indurated
LO	loose
PP	partly puggy
PU	puggy
S1	solid core
S2	broken core
S3	very broken core
S4	fragmented core
UF	uniform
UN	unconsolidated
WC	weakly cemented

ROCK STRENGTH	
H1	very weak rock
H2	weak rock
H3	moderately weak rock
H4	moderately strong rock
H5	strong rock
H6	very strong rock
LO	loose
UN	unconsolidated
WC	weakly cemented
X1	very soft
X2	soft
X3	firm

ROCK STRENGTH ...cont	
X4	stiff
X5	very stiff

ROUNDING	
A	angular
D	subrounded
R	rounded
S	subangular
V	very angular
W	well rounded

SORTING	
M	moderately sorted
P	poorly sorted
W	well sorted

GRAIN DESCRIPTION	
AC	acicular
BL	bladed
EQ	equant
PR	prolate
TB	tabular

MATRIX DESCRIPTION	
CA	calcareous matrix
CM	clayey matrix
SI	siliceous matrix
SL	silty matrix

POROSITY	
H	high porosity
M	medium porosity
L	low porosity

PERMEABILITY	
H	highly permeable
M	moderately permeable
S	slightly permeable
I	impermeable

WEATHERING	
FR	fresh
WE	weathered
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
EW	extremely weathered

BED SPACING	
F	finely laminated (<3mm)
L	laminated (<10mm)
U	very thinly bedded (10-30mm)
T	thinly bedded (30-100mm)
M	medium bedded (100-300mm)
C	thickly bedded (300-1000mm)
V	very thickly bedded (>1000mm)

BED SEPARATION	
A	abrupt lower contact
D	distinct base
E	erosional base
F	interfingered with lower unit
G	gradational lower contact
I	irregular lower contact
K	slickensided base
O	sharp base
P	low angle inclined bedding
R	fractured at base
S	sheared at base
T	faulted at base
U	diffuse bedding
Y	sharp wavy base

BEDDING DIP

Dip angle between 0-90 degrees

SEDIMENTARY STRUCTURES	
AM	amygdaloidail
BT	with bioturbation
BW	with burrowing
CC	cone in cone
CV	with convolute bedding
DB	with disturbed bedding
DY	with sedimentary dyke
FB	flow banded
FL	with flaser bedding
GB	with graded bedding
IB	interbedded
IC	imbricate clasts
IR	with irregular bedding
LB	with lenticular beds
LD	with load casts
LM	laminae
MA	with massive bedding
MF	micro-faulting
MP	with mud pellets
PB	with planar bedding
RB	with ripple bedding
RO	with rootlets
RU	rip up clasts
SL	with slumping
VE	vesicular
WB	with wavy bedding
WH	with horizontal bedding
XB	with cross beddeding

SEDIMENTARY STRUCTURE DIP

Dip angle between 0-90 degrees

TECTONIC STRUCTURE TYPE	
C	with cleats
D	with dykes
E	with even fractures
F	with faults
H	subhorizontal joints
J	with joints
K	with kink bands
M	multi-directional joints
O	oblique joints
R	with fractures
S	with shearing
V	with veins
X	subvertical joints

TECTONIC STRUCTURE SPACING	
C	closely spaced (0-100mm)
M	medium spaced (101-1000mm)
W	well spaced (>1000mm)

TECTONIC STRUCTURE DESC.	
A	calcite filled
B	with brecciation
C	curved
D	conchoidal
H	horizontal
I	irregular
J	joints parallel to bedding

TECTONIC STRUCTURE DESC. ...cont	
K	with slickensides
L	lenticular
P	planar
Q	quartz filled
R	reverse
S	striated
T	stepped
U	uneven
X	coal cleat

TECTONIC STRUCTURE DIP

Dip angle between 0-90 degrees

FOSSIL/MINERAL ABUNDANCE	
A	abundant
C	common
M	minor
R	rare
S	sparse

FOSSIL/MINERAL TYPE	
BM	black mica
BT	bioturbation
BW	burrows
CA	calcite
CF	coaly fragments
CH	chlorite
CL	clay
CM	coaly laminae
CO	coal
CP	coaly partings
CW	coaly wisps
FE	iron
FL	carbonaceous flecks
GY	gypsum
IL	ilmenite
IO	iron oxide
KA	kaolinite
LI	limonite
LM	laminae
MG	magnetite
MI	mica
MN	manganese
PF	plant fragments
PR	plant remains
PY	pyrite
QZ	quartz
RO	rootlets
RT	root traces
SD	siderite
VV	vivanite
WF	woody fragments
XB	carbonaceous bands
XF	carbonaceous fragments
XG	carbonaceous grains
XL	carbonaceous laminae
XR	carbonaceous remains
XW	carbonaceous wisps

FOSSIL/MINERAL ASSOCIATION	
BN	bands
BP	on bedding planes
BS	on bedding surfaces
BU	near base of unit
CC	cone in cone structure
CE	cement
CI	concretions
CL	in cleats
CT	clasts
CV	in cavities
DS	disseminated throughout
FD	infilling fault discontinuities
FP	on fracture planes
FR	fragments
GN	grains
IF	infilling fractures
IP	in part
IV	infilling vesicles
LM	laminae
LN	lenses
MA	matrix
MU	near middle of unit
ND	nodules
OJ	on joint surfaces
PO	in pods
RF	replacing fossils
RZ	replacement zone
SR	stringers
ST	staining
TU	near top of unit
VN	in veins
WP	in wisps

SEDIMENTARY RELATIONSHIP	
BM	towards base and middle of unit
BN	bands
BU	towards base of unit
CT	clasts
CU	coarsening up to
CU	coarsening up
FR	fragments
FU	fining up
GD	grading into
IB	interbedded with
IR	irregularly interbedded with
LM	laminated
LN	with lenses of
MU	towards middle of unit
TB	towards top and base of unit
TO	throughout
TU	towards top of unit

If you require another code, please consult the person in charge of the dictionary within New Hope Coal

LENTON
Lithology Log

Hole LEN240PC

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
1.000	1.000	LEN		03/09/2009	MEB								NR																														
1.340	2.340	LEN		03/09/2009	MEB								CL	D	O	B					S1	X3							WE														
0.160	2.500	LEN		03/09/2009	MEB								SS	B	G	B	MD	CL			S2	H1							WE														
0.200	2.700	LEN		03/09/2009	MEB								CL	D	R	O					PP	X3							WE														
0.270	2.970	LEN		03/09/2009	MEB								CL	B		G		GV			S2	X3							WE														
0.330	3.300	LEN		03/09/2009	MEB								CL	B	O	G		SS			S3	X2							WE														
Run 1: 0 - 3.3 m D:3.3m R:2.3m L:1.0m																																											
0.280	3.580	LEN		04/09/2009	MEB								SS	D	O	B	MD	CL	BN		S2	X2							WE														
0.090	3.670	LEN		04/09/2009	MEB								CL	B		G		SS			S2	X3							WE														
0.070	3.740	LEN		04/09/2009	MEB								SS	D	O	B	MD	CL			S2	X2							WE														
0.050	3.790	LEN		04/09/2009	MEB								CL	B		G		SS			S2	X2							WE														
0.500	4.290	LEN		04/09/2009	MEB								SS	B	O	B		CL	BN		S2	X2							WE														
0.290	4.580	LEN		04/09/2009	MEB								CL	B		G					S3	X3							WE														
0.250	4.830	LEN		04/09/2009	MEB								CL	B		G		SS	GV		S3	X3							WE														
0.700	5.530	LEN		04/09/2009	MEB								CL	B	R	G		SN	SS	IP	S3	X3							WE														
0.110	5.640	LEN		04/09/2009	MEB								SL	B	Y	B					S1	H1							WE														
0.140	5.780	LEN		04/09/2009	MEB								CL	B		G					S1	X3							WE														
0.300	6.080	LEN		04/09/2009	MEB								SS	B	Y	B	FN				S2	H1							WE														
0.050	6.130	LEN		04/09/2009	MEB								SS	B		G					S2	H1							WE														
0.170	6.300	LEN		04/09/2009	MEB								SS	B	Y	G	FN				S3	H1							WE														
Run2: 3.3-6.3m D:3.0m R:3.0m																																											
0.070	6.370	LEN		04/09/2009	MEB								CL	B	O	B		PB			S1	X3							WE														
0.160	6.530	LEN		04/09/2009	MEB								CL	B		G		SS			S1	X3							WE														
0.870	7.400	LEN		04/09/2009	MEB								SL	B	O	R		CL	IP		S1	X3							WE														
0.370	7.770	LEN		04/09/2009	MEB								SL	B	R	B					S1	H1							WE														
0.400	8.170	LEN		04/09/2009	MEB								SL	B	O	G					S1	X3							WE														
0.070	8.240	LEN		04/09/2009	MEB								SL	B	O	B		CL	IP		S1	X3							WE														

LENTON
Lithology Log

Hole LEN240PC

Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
													Rock Descriptor								**Geotech**		**Sedimentology**							**Bedding**			**Structure**						**Fossil/Mineral**				
0.330	8.570	LEN		04/09/2009	MEB								CL	B	O	B					S1	X3							WE														
0.180	8.750	LEN		04/09/2009	MEB								SL	B		B					S1	H1							WE														
0.550	9.300	LEN		04/09/2009	MEB								SS	D	R	B	FN	FE			S3	H2							WE														
									Run 3: 6.3 – 9.3m D:3.0m R:3.0m																																		
0.620	9.920	LEN		04/09/2009	MEB								SL	B	R	B	FN	FE			S1	H1							WE														
0.020	9.940	LEN		04/09/2009	MEB								CL	B		G					S1	X3							WE														
0.660	10.600	LEN		04/09/2009	MEB								SL	B	R	G		FE			S1	H2							WE														
0.490	11.090	LEN		04/09/2009	MEB								SS	B		G	FN	FE			S1	H2							WE														
0.060	11.150	LEN		04/09/2009	MEB								SS	B		G	FM	FE			S1	H2							WE														
0.140	11.290	LEN		04/09/2009	MEB								SS	B		G	FN	FE			S1	H2							WE														
0.320	11.610	LEN		04/09/2009	MEB								SS	B		G	FN	CL			S1	H1							WE														
0.060	11.670	LEN		04/09/2009	MEB								CL	B	R	B					S1	H1							WE														
0.130	11.800	LEN		04/09/2009	MEB								SS	B	R	G	FM	FE			S1	H1							WE														
0.240	12.040	LEN		04/09/2009	MEB								SS	D	R	G	MD	FE			S2	H2							WE														
0.060	12.100	LEN		04/09/2009	MEB								SL	B		G		FE			S1	H2							WE														
0.090	12.190	LEN		04/09/2009	MEB								SS	B		G	FM	FE			S2	H2							WE														
0.070	12.260	LEN		04/09/2009	MEB								CL	B	R	B		FE			S1	X3							WE														
0.110	12.370	LEN		04/09/2009	MEB								SL	B		G		FE			S1	H2							WE														
0.110	12.480	LEN		04/09/2009	MEB								SS	B		G	MD	SL	BN		S1	H2							WE														
0.150	12.630	LEN		04/09/2009	MEB								SL	B		G		SS	BN		S1	H2							WE														
0.070	12.700	LEN		04/09/2009	MEB								CL	B	R	B		SS			S1	H1							WE														
0.170	12.870	LEN		04/09/2009	MEB								SS	B		G	FM				S1	H2							WE														
0.040	12.910	LEN		04/09/2009	MEB								SL	B		G					S1	H2							WE														
0.100	13.010	LEN		04/09/2009	MEB								SS	B		G	FM				S1	H2							WE														
0.180	13.190	LEN		04/09/2009	MEB								SL	B		G					S1	H2							WE														
0.150	13.340	LEN		04/09/2009	MEB								SS	B		G					S1	H2							WE														
0.260	13.600	LEN		04/09/2009	MEB								SL	B		G					S1	H2							WE														

LENTON
Lithology Log

Hole LEN240PC

												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.110	13.710	LEN		04/09/2009	MEB								SS	B		G	MD				S1	H2							WE														
0.120	13.830	LEN		04/09/2009	MEB								SL	B		G					S1	H2							WE														
0.100	13.930	LEN		04/09/2009	MEB								SS	B		G	MD	FE			S1	H2							WE														
0.090	14.020	LEN		04/09/2009	MEB								SL	B		G		CL	IP		S1	H1							WE														
0.070	14.090	LEN		04/09/2009	MEB								SS	B		G	FM	FE			S1	H2							WE														
0.280	14.370	LEN		04/09/2009	MEB								SL	B		G		FE			S2	H2							WE														
0.430	14.800	LEN		04/09/2009	MEB								SL	B	R	G		FE			S3	H2							WE														
0.410	15.210	LEN		04/09/2009	MEB								SS	B	R	B	FM	FE			S2	H1							WE														
0.000	15.210	LEN		04/09/2009	MEB		BHWE																																				
0.260	15.470	LEN		04/09/2009	MEB								SS	B		G	FN				S1	H2							FR														
0.290	15.760	LEN		04/09/2009	MEB								SL	B		G					S2	H2							FR														
0.040	15.800	LEN		04/09/2009	MEB								CL	B	O	B					S1	H1							FR														
0.670	16.470	LEN		04/09/2009	MEB								SS	B		G	FN				S1	H2							FR														
1.140	17.610	LEN		04/09/2009	MEB								SL	B		G					S2	H2							FR														
0.130	17.740	LEN		04/09/2009	MEB								SS	B		G	FM				S1	H2							FR														
0.060	17.800	LEN		04/09/2009	MEB								SS	B	R	B	MD	FE			S3	H1							FR														
0.060	17.860	LEN		04/09/2009	MEB								SS	B	R	B	MD	FE			S3	H1							FR														
0.440	18.300	LEN		04/09/2009	MEB								SS	B		G	CS				S1	H3							FR														
0.370	18.670	LEN		04/09/2009	MEB	GT1							SS	B		G	CS				S1	H3							FR														
0.420	19.090	LEN		04/09/2009	MEB								SS	B		G	CS				S1	H3							FR														
0.180	19.270	LEN		04/09/2009	MEB								SL	B		G		CL			S1	H2							FR														
0.630	19.900	LEN		04/09/2009	MEB								SL	B		G					S1	H1							FR														
0.450	20.350	LEN		04/09/2009	MEB								SL	B		G		CL			S1	H2							FR														
0.170	20.520	LEN		04/09/2009	MEB								SL	B		G					S2	H2							FR														
0.280	20.800	LEN		04/09/2009	MEB								SS	B		G	FN				S2	H3							FR														
0.060	20.860	LEN		04/09/2009	MEB								SS	B		G	FM				S1	H3							FR														
0.100	20.960	LEN		04/09/2009	MEB								SL	B		G					S1	H3							FR														

LENTON
Lithology Log

Hole LEN240PC

												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.080	21.040	LEN		04/09/2009	MEB								SS	B		G	FM				S1	H3							FR														
0.130	21.170	LEN		04/09/2009	MEB								SL	B		G					S1	H3							FR														
0.120	21.290	LEN		04/09/2009	MEB								SS	B		G	FM				S1	H3							FR														
0.030	21.320	LEN		04/09/2009	MEB								SL	B		G					S1	H3							FR														
1.160	22.480	LEN		04/09/2009	MEB								SS	B		G	FM				S1	H3							FR														
0.210	22.690	LEN		04/09/2009	MEB								SL	B		G		CL	IP		S2	H3							FR														
0.270	22.960	LEN		04/09/2009	MEB								SL	B		G		SS	BN		S1	H3							FR														
0.180	23.140	LEN		04/09/2009	MEB								SS	B		G	MD				S1	H3							FR														
0.660	23.800	LEN		04/09/2009	MEB								SS	B		G	FM				S2	H3							FR														
1.540	25.340	LEN		04/09/2009	MEB								SS	B		G	MD				S1	H3							FR														
0.070	25.410	LEN		04/09/2009	MEB								SS	B		G	FM				S1	H3							FR														
0.100	25.510	LEN		04/09/2009	MEB								SS	B		G	MD				S1	H3							FR														
0.050	25.560	LEN		04/09/2009	MEB								SL	D		G					S2	H3							FR														
0.140	25.700	LEN		04/09/2009	MEB								SS	B		G	MD				S2	H3							FR														
0.650	26.350	LEN		04/09/2009	MEB								SS	B		G	MD				S1	H3							FR														
0.950	27.300	LEN		04/09/2009	MEB								SL	B		G		SS	IP		S3	H3							FR														
0.720	28.020	LEN		04/09/2009	MEB								SS	B		G	FN				S1	H3							FR														
0.370	28.390	LEN		04/09/2009	MEB	GT2							SS	B		G	FN				S1	H3							FR														
0.140	28.530	LEN		04/09/2009	MEB								SS	B		G	FN				S1	H3							FR														
0.040	28.570	LEN		04/09/2009	MEB								SL	B		G					S2	H3							FR														
0.310	28.880	LEN		04/09/2009	MEB								SS	B		G	FN				S1	H3							FR														
0.160	29.040	LEN		04/09/2009	MEB								SL	B		G					S1	H3							FR														
1.260	30.300	LEN		04/09/2009	MEB								SS	B		G	FN				S2	H2							FR														
0.570	30.870	LEN		04/09/2009	MEB								SL	B		G					S2	H3							FR														
2.330	33.200	LEN		04/09/2009	MEB								SS	B		G	FN	SL	BN		S2	H3							FR														
0.100	33.300	LEN		04/09/2009	MEB								KL																FR														
0.560	33.860	LEN		04/09/2009	MEB								SS	B		G	FN				S1	H3							FR														

												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.810	34.670	LEN		04/09/2009	MEB								SL	B		G					S2	H3							FR														
1.380	36.050	LEN		04/09/2009	MEB								SS	B		G	FN				S2	H3							FR														
0.250	36.300	LEN		04/09/2009	MEB								SS	B		G	FN				S2	H3							FR														
0.410	36.710	LEN		04/09/2009	MEB								SL	B		G		SS	BN		S1	H3							FR														
0.100	36.810	LEN		04/09/2009	MEB								SS	B		G	MD				S1	H3							FR														
0.370	37.180	LEN		04/09/2009	MEB								SL	B		G		SS	BN		S1	H3							FR														
0.030	37.210	LEN		04/09/2009	MEB								SS	B		G	MD				S1	H3							FR														
1.890	39.100	LEN		04/09/2009	MEB								SS	B		G	FN	SL	BN		S2	H3							FR														
0.820	39.920	LEN		04/09/2009	MEB								SL	B		G					S2	H3							FR														
0.920	40.840	LEN		04/09/2009	MEB								SS	B		G	FN				S1	H3							FR														
0.070	40.910	LEN		04/09/2009	MEB								SS	B		G	MD	SL	BN		S1	H3							FR														
0.160	41.070	LEN		04/09/2009	MEB								SS	B		G	FN				S1	H3							FR														
0.270	41.340	LEN		04/09/2009	MEB								SS	B		G	FM	SL	BN		S2	H3							FR														
0.160	41.500	LEN		04/09/2009	MEB								SL	B		G		SS	BN		S2	H3							FR														
0.070	41.570	LEN		04/09/2009	MEB								SS	B		G	FM				S2	H3							FR														
0.220	41.790	LEN		04/09/2009	MEB								SL	B		G		SS	BN	CM	S2	H3							FR														
0.110	41.900	LEN		04/09/2009	MEB								SS	B		G	FM				S2	H3							FR														
0.200	42.100	LEN		04/09/2009	MEB								SL	B		G		SS	BN		S2	H3							FR														
0.190	42.290	LEN		04/09/2009	MEB								SS	B		G	MD	SL	BZ		S1	H3							FR														
0.310	42.600	LEN		04/09/2009	MEB								SS	B		G	FN				S1	H3							FR														
0.340	42.940	LEN		04/09/2009	MEB	GT3							SS	B		G	FN				S1	H3							FR														
1.690	44.630	LEN		04/09/2009	MEB								SS	B		G	FN	SL	BN		S2	H3							FR														
0.240	44.870	LEN		04/09/2009	MEB								SS	B		G	FM				S1	H3							FR														
0.160	45.030	LEN		04/09/2009	MEB								SS	B		G	MD				S2	H3							FR														
0.030	45.060	LEN		04/09/2009	MEB								SS	B		G	FN				S1	H3							FR														
0.040	45.100	LEN		04/09/2009	MEB								SS	B		G	MD				S1	H3							FR														
0.320	45.420	LEN		04/09/2009	MEB								SS	B		G	MC				S1	H4							FR														

												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.730	46.150	LEN		04/09/2009	MEB								SS	B		G	FN				S1	H3							FR														
0.950	47.100	LEN		04/09/2009	MEB								SL	B		G		SS	BN		S2	H3							FR														
1.000	48.100	LEN		04/09/2009	MEB								SS	B		G	FM				S1	H3							FR														
0.450	48.550	LEN		04/09/2009	MEB								SS	B		G	FN				S1	H3							FR														
0.900	49.450	LEN		04/09/2009	MEB								SS	B		G	MD				S2	H3							FR														
0.230	49.680	LEN		04/09/2009	MEB								SS	B		G	MC	SL	BZ		S1	H3							FR														
1.320	51.000	LEN		04/09/2009	MEB								SS	B		G	MD				S2	H3							FR														
0.100	51.100	LEN		04/09/2009	MEB								SS	B		G	CS				S1	H4							FR														
1.350	52.450	LEN		04/09/2009	MEB								SS	B		G	CS				S1	H4							FR														
0.060	52.510	LEN		04/09/2009	MEB								SL	B	K	G		MN	SS	BN	S1	H3							FR														
0.750	53.260	LEN		04/09/2009	MEB								SS	B		G	CS				S1	H4							FR														
0.340	53.600	LEN		04/09/2009	MEB	GT4							SS	B		G	CS				S1	H4							FR														
0.400	54.000	LEN		04/09/2009	MEB								CS	B		G	FN				S3	H3							FR														
1.700	55.700	LEN		04/09/2009	MEB								SS	B		G	FN				S3	H3							FR														
0.220	55.920	LEN		04/09/2009	MEB								SS	B		G	FM				S1	H3							FR														
0.580	56.500	LEN		04/09/2009	MEB								SS	B		G	CS				S1	H3							FR														
0.500	57.000	LEN		04/09/2009	MEB								SS	B		G	MC				S2	H3							FR														
2.000	59.000	LEN		04/09/2009	MEB								SS	B		G	FM				S1	H3							FR														
0.040	59.040	LEN		04/09/2009	MEB								SL	B		G		WI	SX	BN	S1	H3							FR														
1.060	60.100	LEN		04/09/2009	MEB								SS	B		G	FM				S1	H3							FR														
0.250	60.350	LEN		04/09/2009	MEB								SS	B		G	FM	SL	BN		S1	H3							FR														
0.090	60.440	LEN		04/09/2009	LMC								SS	D	R	B	FM				S3	H3							FR														
0.660	61.100	LEN		04/09/2009	LMC								SS	B		G	FM				S1	H3							FR														
0.550	61.650	LEN		04/09/2009	LMC								SS	B		G	MD				S1	H3							FR														
0.140	61.790	LEN		04/09/2009	LMC								SS	B		G	MD	SL	BZ		S1	H3							FR														
0.150	61.940	LEN		04/09/2009	LMC								SS	B		G	FM				S1	H3							FR														
0.710	62.650	LEN		04/09/2009	LMC								SS	B		G	FN	SL			S1	H3							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.220	62.870	LEN		04/09/2009	LMC	GT5							SS	B		G	FN				S1	H3							FR														
0.280	63.150	LEN		04/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
3.000	66.150	LEN		04/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.410	66.560	LEN		04/09/2009	LMC								SS	B		G	FN	WI	SX	BN	S1	H3							FR														
0.280	66.840	LEN		04/09/2009	LMC								SL	B		G		WI	SZ	WP	S1	H3							FR														
0.230	67.070	LEN		04/09/2009	LMC								SS	B		G	FN	WI	SX		S1	H3							FR														
0.240	67.310	LEN		04/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.470	67.780	LEN		04/09/2009	LMC								SS	B		G	FN	WI	SX	WP	S1	H3							FR														
0.150	67.930	LEN		04/09/2009	LMC								SL	B		G					S1	H3							FR														
0.570	68.500	LEN		04/09/2009	LMC								SS	B		G	FN	WI	SX	WP	S1	H3							FR														
0.650	69.150	LEN		04/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.770	69.920	LEN		04/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.200	70.120	LEN		04/09/2009	LMC								SS	B		G	FN	WI	SX	WP	S1	H3							FR														
1.480	71.600	LEN		04/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.050	71.650	LEN		04/09/2009	LMC								KL																FR														
0.300	71.950	LEN		04/09/2009	LMC								SS	B		G	FN	OC	SX	WP	S1	H3							FR														
3.100	75.050	LEN		04/09/2009	LMC								SS	B		G	FN	SL			S4	H3							FR														
0.780	75.830	LEN		04/09/2009	LMC								SS	B		G	FN	WI	SX	WP	S1	H3							FR														
0.030	75.860	LEN		04/09/2009	LMC								SS	B		G	FM				S1	H3							FR														
0.040	75.900	LEN		04/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.350	76.250	LEN		04/09/2009	LMC								SS	B		G	FM				S1	H3							FR														
1.750	78.000	LEN		04/09/2009	LMC								SS	B		G	FN	WI	SX	WP	S3	H3							FR														
0.180	78.180	LEN		04/09/2009	LMC								SS	B		G	FM				S1	H3							FR														
0.320	78.500	LEN		04/09/2009	LMC								SS	B		G	FN	WI	SX	WP	S1	H3							FR														
0.460	78.960	LEN		04/09/2009	LMC								SS	B		G	FM				S1	H3							FR														
0.110	79.070	LEN		04/09/2009	LMC								SS	B		G	FN	WI	SX	WP	S1	H3							FR														
0.160	79.230	LEN		04/09/2009	LMC								SS	B		G	FM				S1	H3							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossil/Minerals Association	Sedimentary Relationship	Coal Type
0.070	79.300	LEN		04/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.070	79.370	LEN		04/09/2009	LMC								SS	B		G	FN	WI	SX	WP	S1	H3							FR														
0.780	80.150	LEN		04/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.090	80.240	LEN		04/09/2009	LMC								SS	B		G	FM				S1	H3							FR														
0.220	80.460	LEN		04/09/2009	LMC								SS	B		G	MD				S1	H3							FR														
0.100	80.560	LEN		04/09/2009	LMC								SS	B		G	FM	WI	SX	BN	S1	H3							FR														
0.090	80.650	LEN		04/09/2009	LMC								SL	D		G		WI	SZ	BN	S1	H3							FR														
0.180	80.830	LEN		04/09/2009	LMC								SS	B		G	FM	WI	SX	BN	S1	H3							FR														
0.220	81.050	LEN		04/09/2009	LMC								SS	B		G	MD				S1	H3							FR														
0.490	81.540	LEN		04/09/2009	LMC								SS	B		G	FM	RA	SX	WP	S3	H3							FR														
0.210	81.750	LEN		04/09/2009	LMC								SS	B		G	MD				S1	H3							FR														
0.350	82.100	LEN		04/09/2009	LMC	GT6							SS	B		G	MD				S1	H3							FR														
1.900	84.000	LEN		04/09/2009	LMC								SS	B		G	MD				S1	H3							FR														
0.050	84.050	LEN		04/09/2009	LMC								SS	B		G	MD	WI	SX	WP	S1	H3							FR														
0.110	84.160	LEN		04/09/2009	LMC								SS	B		G	MD	WI	SX	WP	S1	H3							FR														
0.310	84.470	LEN		04/09/2009	LMC								SS	B		G	MC				S1	H3							FR														
0.320	84.790	LEN		04/09/2009	LMC								SS	B		G	MD				S1	H3							FR														
0.300	85.090	LEN		04/09/2009	LMC								SL	B		G		WI	SZ	BN	S1	H3							FR														
1.910	87.000	LEN		04/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.200	87.200	LEN		04/09/2009	LMC								SS	B		G	FN	CO	FR	TO	S1	H3							FR														
0.180	87.380	LEN		04/09/2009	LMC								SL	B		G		WI	SX	WP	S1	H3							FR														
0.090	87.470	LEN		04/09/2009	LMC								SS	B		G	FM	WI	CO	FR	S1	H3							FR														
0.140	87.610	LEN		04/09/2009	LMC								SL	B		G					S1	H3							FR														
0.250	87.860	LEN		04/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.150	88.010	LEN		04/09/2009	LMC								SS	B		G	MD	WI	SX	BN	S1	H3							FR														
0.460	88.470	LEN		04/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
1.100	89.570	LEN		04/09/2009	LMC								SS	B		G	FM	MN	CO	FR	S1	H3							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.010	89.580	LEN		04/09/2009	LMC								CA	A		W					S1	H3							FR														
0.420	90.000	LEN		04/09/2009	LMC								SS	B		G					S1	H3							FR														
0.230	90.230	LEN		04/09/2009	LMC								SL	B		G					S1	H3							FR														
0.010	90.240	LEN		04/09/2009	LMC								SS	A		G	CS				S1	H3							FR														
0.210	90.450	LEN		04/09/2009	LMC								SL	B		G					S1	H3							FR														
1.470	91.920	LEN		04/09/2009	LMC								SS	A		G	CS				S1	H3							FR										A	CA	FP		
0.040	91.960	LEN		04/09/2009	LMC								SS	B		G	FM				S1	H3							FR														
1.040	93.000	LEN		04/09/2009	LMC								SS	A		G	CS				S1	H3							FR														
0.250	93.250	LEN		04/09/2009	LMC								SS	B		G	MD				S1	H3							FR														
0.330	93.580	LEN		04/09/2009	LMC								SS	B		G	FM				S1	H3							FR														
0.110	93.690	LEN		04/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
1.040	94.730	LEN		04/09/2009	LMC								SS	B		G	FM	OC	SX	WP	S1	H3							FR														
1.270	96.000	LEN		04/09/2009	LMC								SS	B		G	MD				S1	H3							FR														
0.150	96.150	LEN		04/09/2009	LMC								SS	B		G	FM				S1	H3							FR														
0.300	96.450	LEN		04/09/2009	LMC								SS	B		G	MD	WI	CO	WP	S1	H3							FR														
0.100	96.550	LEN		04/09/2009	LMC								SS	B		G	FM				S1	H3							FR														
0.060	96.610	LEN		04/09/2009	LMC								SL	B		G		CL			S1	H3							FR														
0.300	96.910	LEN		04/09/2009	LMC								SL	B		G					S1	H3							FR														
1.040	97.950	LEN		04/09/2009	LMC								SS	B		G	FM				S1	H3							FR														
0.060	98.010	LEN		04/09/2009	LMC								SS	B		G	FM	SL			S1	H3							FR														
0.280	98.290	LEN		04/09/2009	LMC	GT7							SS	B		G	FM	SL			S1	H3							FR														
0.210	98.500	LEN		04/09/2009	LMC								SS	B		G	FN	WI	SX	BN	S1	H3							FR														
0.130	98.630	LEN		04/09/2009	LMC								SS	B		G	FM				S1	H3							FR														
0.090	98.720	LEN		04/09/2009	LMC								SS	B		G	FM	WI	SX	BN	S2	H3							FR														
0.280	99.000	LEN		04/09/2009	LMC								SS	B		G	FM	SL	BN	BU	S1	H3							FR														
0.040	99.040	LEN		04/09/2009	LMC								SS	B		G	FM	SL	BN	TO	S1	H3							FR														
0.050	99.090	LEN		04/09/2009	LMC								SS	B		G	FM				S1	H3							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.080	99.170	LEN		04/09/2009	LMC								SL	B		G					S1	H3							FR														
0.440	99.610	LEN		04/09/2009	LMC								SS	B		G	MD				S1	H3							FR														
0.100	99.710	LEN		04/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.130	99.840	LEN		04/09/2009	LMC								SS	B		G	FN	CA	FR	TO	S1	H3							FR														
0.070	99.910	LEN		04/09/2009	LMC								SL	B		G					S1	H3							FR														
1.620	101.530	LEN		04/09/2009	LMC								SL	B		G		CA	BN	TO	S1	H3							FR														
0.280	101.810	LEN		04/09/2009	LMC								SS	B		G	FM	CA	BN	TO	S1	H3							FR														
0.190	102.000	LEN		04/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.140	102.140	LEN		09/09/2009	LMC								SS	B		G	FM	SX	WP	TO	S1	H3							FR														
0.300	102.440	LEN		09/09/2009	LMC								SS	D		G	FN				S1	H3							FR														
0.330	102.770	LEN		09/09/2009	LMC								SS	B		G	MD				S1	H3							FR										M	CA	FP		
0.870	103.640	LEN		09/09/2009	LMC								SS	B		G	FM				S1	H3							FR														
0.040	103.680	LEN		09/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
1.060	104.740	LEN		09/09/2009	LMC								SS	B		G	MD				S1	H3							FR														
0.050	104.790	LEN		09/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.090	104.880	LEN		09/09/2009	LMC								SL	B		G					S1	H3							FR														
									EOR 38 D3.00 R2.88																																		
0.800	105.680	LEN		09/09/2009	LMC								SL	B		G					S1	H3							FR														
0.070	105.750	LEN		09/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.650	106.400	LEN		09/09/2009	LMC								SL	B		G		CO	WP	TO	S1	H3							FR														
0.450	106.850	LEN		09/09/2009	LMC								SS	B		G		SZ	BN	TO	S1	H3							FR										M	CO	WP		
0.120	106.970	LEN		09/09/2009	LMC								SS	B		G	FN	SX	BN	TO	S1	H3							FR														
0.870	107.840	LEN		09/09/2009	LMC								SS	B		G	MD	SX	BN	MU	S1	H3							FR														
0.160	108.000	LEN		09/09/2009	LMC								SL	B		G					S1	H3							FR														
									EOR 39 D3.00 R3.12																																		
0.120	108.120	LEN		09/09/2009	LMC								SL	B		G		WI	SZ	BN	S1	H3							FR														
0.620	108.740	LEN		09/09/2009	LMC								SS	B		G	CS	SD	BU		S1	H4							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.060	108.800	LEN		09/09/2009	LMC								SS	B	G	B	MD	WI	SD	BN	S1	H5							FR														
									EOR 40 D0.80 R0.80																																		
0.120	108.920	LEN		17/09/2009	LMC								KL																FR														
0.280	109.200	LEN		17/09/2009	LMC								SS	B		G	MD	WI	SX	CA	S1	H3							FR														
0.120	109.320	LEN		17/09/2009	LMC								SL	B		G		WI	CO	WP	S1	H3							FR														
1.460	110.780	LEN		17/09/2009	LMC								SS	B		G	MD				S1	H3							FR														
0.170	110.950	LEN		17/09/2009	LMC	GT8							SS	B		G	MD					H3							FR														
0.050	111.000	LEN		17/09/2009	LMC								SS	B		G	MD				S1	H3							FR														
									EOR 41 D2.20 R 2.08																																		
0.210	111.210	LEN		17/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
1.670	112.880	LEN		17/09/2009	LMC								SS	B		G	MD	CO	WP	TO	S1	H3							FR														
0.560	113.440	LEN		17/09/2009	LMC								SS	B		G	FM	CO	LM	TO	S1	H3							FR														
0.560	114.000	LEN		17/09/2009	LMC								SS	B		G	MD	CO	FR	TO	S1	H4							FR										M	CA	FR		
									EOR 42 D3.00 R3.08																																		
0.210	114.210	LEN		17/09/2009	LMC								SS	B		G	MD	CO	FR	TO	S1	H4							FR														
0.250	114.460	LEN		17/09/2009	LMC								SS	B		G	FN	CO	WP	TO	S1	H3							FR														
0.870	115.330	LEN		17/09/2009	LMC								SS	B		G	MD				S1	H3							FR														
0.140	115.470	LEN		17/09/2009	LMC								SL	D		G		CO	FR	TO	S1	H3							FR														
0.170	115.640	LEN		17/09/2009	LMC								SL	B		G		CS	FR		S1	H3							FR														
0.340	115.980	LEN		17/09/2009	LMC								SS	B		G	FN	SX	LM	TO	S1	H3							FR														
0.160	116.140	LEN		17/09/2009	LMC								SS	B		G	MD				S1	H3							FR														
0.400	116.540	LEN		17/09/2009	LMC								SL	B		G		SZ	LM	TO	S1	H3							FR														
0.310	116.850	LEN		17/09/2009	LMC								SL	D		G		CO	FR	TO	S1	H3							FR														
0.150	117.000	LEN		17/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
									EOR 43 D3.00 R2.92																																		
0.280	117.280	LEN		17/09/2009	LMC								SL	D		G					S1	H3							FR														
0.110	117.390	LEN		17/09/2009	LMC								SS	D		G	FN				S1	H3							FR														

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													Rock Descriptor								Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossil/Minerals Abundance	Fossil/Minerals Type	Fossil/Minerals Association	Sedimentary Relationship	Coal Type
0.110	117.500	LEN		17/09/2009	LMC								SL	D		G					S1	H3							FR														
0.200	117.700	LEN		17/09/2009	LMC								SS	D		G	FN	WI	SX	BN	S1	H3							FR														
0.460	118.160	LEN		17/09/2009	LMC								SL	D		G					S1	H3							FR														
0.760	118.920	LEN		17/09/2009	LMC								SS	D		G	FN	WI	SX	BN	S1	H3							FR														
0.700	119.620	LEN		17/09/2009	LMC								SS	D		G	FM	WI	SX	BN	S1	H3							FR														
0.380	120.000	LEN		17/09/2009	LMC								SL	D		G					S1	H3							FR														
									EOR 44 D3.00 R3.05																																		
0.260	120.260	LEN		17/09/2009	LMC								SL	D		G		SD				H4							FR														
0.240	120.500	LEN		17/09/2009	LMC								SS	B		G					S1	H4							FR														
0.560	121.060	LEN		17/09/2009	LMC								SL	B		G		WI	SZ	BN	S1	H4							FR														
0.150	121.210	LEN		17/09/2009	LMC								SS	B		G	MD	WI	SX	BN	S1	H4							FR														
0.190	121.400	LEN		17/09/2009	LMC								SL	B		G		WI	CA		S1	H4							FR														
0.720	122.120	LEN		17/09/2009	LMC								SS	B		G	FN	WI	SX	BN	S1	H4							FR										C	CA	FP		
0.200	122.320	LEN		17/09/2009	LMC	GT9							SS	B		G	MD				S1	H4							FR														
0.160	122.480	LEN		17/09/2009	LMC	GT9							SL	B		G					S1	H3							FR														
0.520	123.000	LEN		17/09/2009	LMC								SL	B		G					S1	H3							FR														
									EOR 45 D3.00 R2.95																																		
0.150	123.150	LEN		17/09/2009	LMC								SL	B		G		WI	SZ	BN	S1	H3							FR														
0.030	123.180	LEN		17/09/2009	LMC								SS	B		G	CS					H4							FR														
0.070	123.250	LEN		17/09/2009	LMC								SL	B		G		WI	SZ	BN	S1	H3							FR														
0.160	123.410	LEN		17/09/2009	LMC								SL	B		G					S1	H3							FR														
0.780	124.190	LEN		17/09/2009	LMC								SS	B		G	FM	WI	CO	WP	S1	H3							FR										C	CA	VN		
1.540	125.730	LEN		17/09/2009	LMC								SS	B		G	FN	WI	CO	FR	S1	H3							FR														
0.270	126.000	LEN		17/09/2009	LMC								SL	B		G					S1	H3							FR														
									EOR 46 D3.00 R3.00																																		
0.710	126.710	LEN		17/09/2009	LMC								SS	B		G	FN	CS	WP	TO	S1	H3							FR														
0.790	127.500	LEN		17/09/2009	LMC								SS	B		G	VF	WI	SX		S1	H3							FR														

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													Rock Descriptor								Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossil/Minerals Abundance	Fossil/Minerals Type	Fossil/Minerals Association	Sedimentary Relationship	Coal Type
0.980	128.480	LEN		17/09/2009	LMC								SS	B		G	FN	WI	SX	LM	S1	H3							FR														
									EOR 47 D3.00 R2.48																																		
1.520	130.000	LEN		17/09/2009	LMC								SS	B		G	FN	WI	SX		S1	H3							FR														
0.340	130.340	LEN		17/09/2009	LMC								SS	B	B	G	FM	SD			S1	H5							FR														
0.110	130.450	LEN		17/09/2009	LMC								SS	B		G	FN				S1	H4							FR														
0.140	130.590	LEN		17/09/2009	LMC								SS	B	B	G	FM	SD			S1	H5							FR														
0.190	130.780	LEN		17/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.220	131.000	LEN		17/09/2009	LMC								SS	B		G	FM				S1	H3							FR														
0.290	131.290	LEN		17/09/2009	LMC								SS	B		G	FM	CS	WP	TO	S1	H3							FR														
0.210	131.500	LEN		17/09/2009	LMC								SS	B		G	FN				S1	H4							FR														
									EOR 48 D2.50 R3.15																																		
0.500	132.000	LEN		17/09/2009	LMC								SS	B		G	FN				S1	H4							FR														
									EOR 49 D0.50 R 0.37																																		
0.390	132.390	LEN		17/09/2009	LMC								SL	D		G					S1	H3							FR														
0.110	132.500	LEN		17/09/2009	LMC								SS	B		G	FN	WI	SX	BN	S1	H3							FR														
0.380	132.880	LEN		17/09/2009	LMC								SS	B		G	CS				S1	H4							FR														
0.130	133.010	LEN		17/09/2009	LMC								SS	B		G	MD	CA			S1	H4							FR														
0.210	133.220	LEN		17/09/2009	LMC	GT10							SS	B		G	MD	CA			S1	H4							FR														
0.120	133.340	LEN		17/09/2009	LMC	GT10							SS	B		G	MD				S1	H3							FR														
1.030	134.370	LEN		17/09/2009	LMC								SS	B		G	MD				S1	H4							FR														
0.630	135.000	LEN		17/09/2009	LMC								SS	B		G	MD	WI	SX	LM	S1	H4							FR														
									EOR 50 D3.00 R3.00																																		
1.290	136.290	LEN		17/09/2009	LMC								SS	B		G	CS				S1	H4							FR														
0.120	136.410	LEN		17/09/2009	LMC								CL	D		G					S1	H2							FR														
1.030	137.440	LEN		17/09/2009	LMC								SS	B		G	FN	WI	CO	WP	S1	H3							FR														
0.560	138.000	LEN		17/09/2009	LMC								SS	B		G	MD				S1	H4							FR														
									EOR 51 D3.00 R3.05																																		

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.390	138.390	LEN		17/09/2009	LMC								SS	B		G	CS				S1	H4							FR														
0.200	138.590	LEN		17/09/2009	LMC								SS	B		G	CS	CO	LM	TO	S1	H4							FR														
1.610	140.200	LEN		17/09/2009	LMC								SS	B		G	CS				S1	H4							FR														
0.280	140.480	LEN		17/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
									EOR 52 D3.00 R2.57																																		
1.320	141.800	LEN		17/09/2009	LMC								SS	B		G	FN	WI	SX		S1	H3							FR														
									EOR 53 D0.80 R1.20																																		
0.390	142.190	LEN		17/09/2009	LMC								SS	B		G	FN	WI	SX		S1	H3							FR														
0.500	142.690	LEN		17/09/2009	LMC								SS	B		G	FM				S1	H3							FR														
0.170	142.860	LEN		17/09/2009	LMC								SS	B		G	MD				S1	H3							FR														
0.140	143.000	LEN		17/09/2009	LMC								SS	B		G	FM	WI	SX		S1	H3							FR														
0.390	143.390	LEN		17/09/2009	LMC								SS	B		G	MD	CS	LM	TO	S1	H3							FR														
0.190	143.580	LEN		17/09/2009	LMC								SL	B		G					S1	H3							FR														
0.220	143.800	LEN		17/09/2009	LMC								SS	B		G	MD				S1	H3							FR														
0.080	143.880	LEN		17/09/2009	LMC								SL	B		G		SZ	BN	TO	S1	H3							FR														
0.120	144.000	LEN		17/09/2009	LMC								SS	B		G	MD	CO	FR	TO	S1	H3							FR														
									EOR 54 D2.20 R2.27																																		
0.210	144.210	LEN		17/09/2009	LMC								SS	B		G	MD	SX	BN	BU	S1	H3							FR														
0.280	144.490	LEN		17/09/2009	LMC								SS	B		G	FN				S1	H4							FR														
0.170	144.660	LEN		17/09/2009	LMC								SS	B		G	MD				S1	H4							FR														
0.270	144.930	LEN		17/09/2009	LMC	GT11							SS	B		G	MD				S1	H4							FR														
0.890	145.820	LEN		17/09/2009	LMC								SS	B		G	MD				S1	H4							FR														
0.500	146.320	LEN		17/09/2009	LMC								SS	B		G	MD	CO	WP	TO	S1	H4							FR														
0.680	147.000	LEN		17/09/2009	LMC								SS	B		G	MD				S1	H4							FR														
									EOR 55 D3.00 R3.00																																		
1.750	148.750	LEN		17/09/2009	LMC								SS	A		G	MD				S1	H4							FR										R	CO	LM		
0.350	149.100	LEN		17/09/2009	LMC								SS	B		G	FN				S1	H4							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.150	149.250	LEN		17/09/2009	LMC								SS	B		G	FN	WI	CO	LM	S1	H4							FR														
0.750	150.000	LEN		17/09/2009	LMC								SS	B		G	MD	CO	LM	TU	S1	H4							FR														
									EOR 56 D3.00 R2.97																																		
0.090	150.090	LEN		17/09/2009	LMC								SS	B		G	MD	CO	LM	TO	S1	H4							FR														
0.050	150.140	LEN		17/09/2009	LMC								SS	B		G	FN				S1	H4							FR														
0.110	150.250	LEN		17/09/2009	LMC								SL	B		G		CO	FR	TO	S1	H3							FR														
									EOR 57 D0.25 R0.25																																		
0.280	150.530	LEN		29/09/2009	LMC								SL	B		G		CO	FR	TO	S1	H3							FR														
0.480	151.010	LEN		29/09/2009	LMC								SL	B		G					S1	H3							FR														
0.240	151.250	LEN		29/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.280	151.530	LEN		29/09/2009	LMC								SS	B		G	MD	WI	SX	BN	S1	H3							FR														
0.710	152.240	LEN		29/09/2009	LMC								SL	B		G		WI	SZ	BN	S1	H3							FR														
0.190	152.430	LEN		29/09/2009	LMC								SS	B		G	FM	WI	CS	LM	S1	H4							FR														
0.070	152.500	LEN		29/09/2009	LMC								SS	B		G	MD	CS	WP	TO	S1	H3							FR														
0.150	152.650	LEN		29/09/2009	LMC								SL	B		G		CS	WI	SZ	S1	H3							FR														
									EOR 58 DR3.00 R2.65																																		
0.420	153.070	LEN		29/09/2009	LMC								XT	D	B	K					S2	H3							FR														
0.090	153.160	LEN		29/09/2009	LMC								SL	B	G	G		CS	WI	SZ	S1	H3							FR														
0.050	153.210	LEN		29/09/2009	LMC								XT	D	K	G					S1	H3							FR														
0.070	153.280	LEN		29/09/2009	LMC								SS	A		G	CS	SD	TU		S1	H4							FR														
0.930	154.210	LEN		29/09/2009	LMC								SS	A		G	CS				S1	H4							FR														
0.370	154.580	LEN		29/09/2009	LMC								SS	B	K	G	FN	WI	CS	LM	S1	H3							FR														
1.070	155.650	LEN		29/09/2009	LMC								SS	A	K	G	CS				S1	H4							FR														
0.250	155.900	LEN		29/09/2009	LMC	GT12							SS	A		G	CS				S1	H4							FR														
									EOR 59 D2.90 R3.15																																		
0.270	156.170	LEN		29/09/2009	LMC								SS	A		G	MD				S1	H4							FR														
0.100	156.270	LEN		29/09/2009	LMC								SS	A		G	MD	CO	LM	TO	S1	H4							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossil/Minerals Abundance	Fossil/Minerals Type	Fossil/Minerals Association	Sedimentary Relationship	Coal Type
0.310	156.580	LEN		29/09/2009	LMC								SS	A		G	CS				S1	H4							FR														
0.370	156.950	LEN		29/09/2009	LMC								SS	A		G	CS				S1	H5							FR										C	SD	ND		
0.310	157.260	LEN		29/09/2009	LMC								SS	A		G	MD				S1	H4							FR														
0.540	157.800	LEN		29/09/2009	LMC								SS	A		G	CS				S1	H4							FR														
0.150	157.950	LEN		29/09/2009	LMC								SS	A		G	CS	SD			S1	H5							FR														
0.950	158.900	LEN		29/09/2009	LMC								SS	A		G	CS				S1	H4							FR														
									EOR 60 D3.00 R3.08																																		
0.890	159.790	LEN		29/09/2009	LMC								SS	A		G	CS				S1	H4							FR														
0.260	160.050	LEN		29/09/2009	LMC								SL	B		G		WI	SZ	BN	S1	H3							FR														
0.090	160.140	LEN		29/09/2009	LMC								SS	A		G	MD	SD	ND	TO	S1	H5							FR														
1.860	162.000	LEN		29/09/2009	LMC								SS	A		G	MD				S1	H4							FR														
									EOR 61 D3.10 R3.05																																		
1.120	163.120	LEN		30/09/2009	LMC								SS	A		G	MD				S1	H4							FR														
0.050	163.170	LEN		30/09/2009	LMC								SS	A		G	FM	SX	BN	TO	S1	H5							FR														
0.200	163.370	LEN		30/09/2009	LMC								SS	A		G	FN	SD			S1	H5							FR														
0.370	163.740	LEN		30/09/2009	LMC								SS	A		G	MD				S1	H4							FR														
0.120	163.860	LEN		30/09/2009	LMC								SL	B		G		SZ	BN	TO	S1	H3							FR														
0.360	164.220	LEN		30/09/2009	LMC								SS	A		G	MD	MN	CO	LM	S1	H4							FR														
0.330	164.550	LEN		30/09/2009	LMC								SS	A		G	CS	CO	BN	MU	S1	H4							FR														
0.450	165.000	LEN		30/09/2009	LMC								SS	A		G	CS	SX	ND	TO	S1	H5							FR														
									EOR 62 D3.00 R3.00																																		
0.340	165.340	LEN		30/09/2009	LMC								SS	A		G	CS	CA	BN	BU	S1	H4							FR														
0.200	165.540	LEN		30/09/2009	LMC								SS	A		G	MD	SD	ND	TO	S1	H5							FR					0					C	CO	FR		
0.240	165.780	LEN		30/09/2009	LMC	GT13							SS	A		G	MD				S1	H4							FR										C	CO	FR		
0.090	165.870	LEN		30/09/2009	LMC								SS	A		G	MD	SD			S1	H5							FR										C	CO	FR		
0.070	165.940	LEN		30/09/2009	LMC								SL	B		G					S1	H4							FR														
0.230	166.170	LEN		30/09/2009	LMC								SS	A		G	MD				S1	H4							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
									EOR 63 D3.00 R1.17																																		
1.360	167.530	LEN		30/09/2009	LMC								SL	B		G		CO	FR	TO	S1	H3							FR														
0.580	168.110	LEN		30/09/2009	LMC								SS	B		G	FN	WI	SX	TO	S1	H3							FR														
1.220	169.330	LEN		30/09/2009	LMC								SS	B		G	FN	WI	SX	BN	S1	H3							FR														
									EOR64 D1.33 R3.10																																		
0.080	169.410	LEN		30/09/2009	LMC								SL	B		G		WI	SZ	BN	S1	H3							FR														
0.550	169.960	LEN		30/09/2009	LMC								SS	A		G	MD	SX	LM	TO	S1	H3							FR										S	CO	LM		
0.220	170.180	LEN		30/09/2009	LMC								SS	A		G	MD	CS	LM	TO	S1	H3							FR														
0.070	170.250	LEN		30/09/2009	LMC								SS	A		G	MD				S1	H4							FR														
0.750	171.000	LEN		30/09/2009	LMC								SS	A		G	CS	MN	SX	WP	S1	H4							FR														
									EOR 65 D1.67 R1.71																																		
0.360	171.360	LEN		30/09/2009	LMC								SS	A		G	MD	CS	LM	MU	S1	H4							FR														
0.030	171.390	LEN		30/09/2009	LMC								SL	B		G					S1	H4							FR														
0.260	171.650	LEN		30/09/2009	LMC								SS	A		G	MD	CS	LM	TO	S1	H4							FR										C	CW			
0.130	171.780	LEN		30/09/2009	LMC								SL	B		G		CA	BN	TU	S1	H4							FR														
0.420	172.200	LEN		30/09/2009	LMC								SS	A		G	MD	CO	LM	TO	S1	H4							FR														
0.110	172.310	LEN		30/09/2009	LMC								SS	A		G	MD				S1	H4							FR														
0.090	172.400	LEN		30/09/2009	LMC								SS	A		G	MD	SX	ND	TO	S1	H4							FR														
0.330	172.730	LEN		30/09/2009	LMC								SS	A		G	MD				S1	H4							FR														
0.200	172.930	LEN		30/09/2009	LMC								SS	A		G	MD	SX	ND	TO	S1	H4							FR														
0.250	173.180	LEN		30/09/2009	LMC								SS	A		G	MD				S1	H4							FR														
0.120	173.300	LEN		30/09/2009	LMC								SS	B		G	FN				S1	H4							FR														
0.700	174.000	LEN		30/09/2009	LMC								SS	A		G	MD	CO	LM	TO	S1	H4							FR														
									EOR 66 D3.00 R3.00																																		
0.120	174.120	LEN		30/09/2009	LMC								SS	A		G	MD	SX	ND	TO	S1	H4							FR														
0.150	174.270	LEN		30/09/2009	LMC								XT	D	K	G					S1	H3							FR														
0.360	174.630	LEN		30/09/2009	LMC								SL	B		G					S1	H3							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.700	175.330	LEN		30/09/2009	LMC								SL	D		G		CS	WI	CO	S1	H3							FR														
0.190	175.520	LEN		30/09/2009	LMC								SL	D		G					S1	H3							FR														
2.020	177.540	LEN		30/09/2009	LMC								XT	D	K	G					S1	H3							FR														
									EOR 67 D2.37 R2.43																																		
0.460	178.000	LEN		30/09/2009	LMC	30862	BR						CO			K		CA	BN	TO	S1								FR										A	CA	VN		
									EOR 68 D0.67 R0.67																																		
0.030	178.030	LEN		30/09/2009	LMC	GM032	BR						C6			K		CA	BN	TO	S1								FR														
0.050	178.080	LEN		30/09/2009	LMC	GM032	BR						CO			K		CA	BN	TO	S1								FR														
0.600	178.680	LEN		30/09/2009	LMC	GM032	BR						C4			K					S1								FR														
0.110	178.790	LEN		30/09/2009	LMC	GM032	BR						C4			K					S2								FR														
0.370	179.160	LEN		30/09/2009	LMC	GM044	BR						C4			K					S2								FR														
0.380	179.540	LEN		30/09/2009	LMC	GM044							SL	B		G		CO	TO		S1	H3							FR														
1.130	180.670	LEN		30/09/2009	LMC								SL	B		G					S1	H3							FR														
0.330	181.000	LEN		30/09/2009	LMC								SS	B		G	MD	WI	SX	BN	S1	H3							FR														
									EOR 69 D3.00 R3.00																																		
0.450	181.450	LEN		30/09/2009	LMC								SS	A		G	MD	WI	CO	WP	S1	H4							FR														
0.180	181.630	LEN		30/09/2009	LMC								SS	B		G	FN	CO	LM	TO	S1	H4							FR											C	CW			
0.140	181.770	LEN		30/09/2009	LMC								SS	A		G	MD	SX	LM	TO	S1	H3							FR														
0.220	181.990	LEN		30/09/2009	LMC								SL	B		G		CO	SX	WP	S1	H3							FR														
0.070	182.060	LEN		30/09/2009	LMC								XT	D	K	G					S1	H3							FR														
0.700	182.760	LEN		30/09/2009	LMC								SL	B		G		CO	FR	TO	S1	H3							FR										C	CA	BN		
0.240	183.000	LEN		30/09/2009	LMC								SL	B		G		CO	LM	TO	S1	H3							FR														
0.340	183.340	LEN		30/09/2009	LMC								SL	B		G		CO	FR	TO	S1	H3							FR										C	CA	VN		
0.160	183.500	LEN		30/09/2009	LMC								SL	B		G		CO	FR	TO	S1	H3							FR														
0.140	183.640	LEN		30/09/2009	LMC								SL	B		G		CS	CO	FR	S1	H3							FR										C	CW			
0.360	184.000	LEN		30/09/2009	LMC								SL	B		G		SZ	LM	TO	S1	H3							FR										C	CW			
									EOR 70 D3.00 R3.00																																		

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Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.230	184.230	LEN		30/09/2009	LMC								SL	B		G		CS	LM	TO	S1	H3							FR														
0.120	184.350	LEN		30/09/2009	LMC								XT	D	K	G					S1	H3							FR														
0.590	184.940	LEN		30/09/2009	LMC								SL	B		G		SZ	LM	TO	S1	H3							FR										C	CO	LM		
0.060	185.000	LEN		30/09/2009	LMC								XT	D	G	K					S1	H3							FR														
0.370	185.370	LEN		30/09/2009	LMC								SL	B		G		CS			S1	H3							FR														
0.250	185.620	LEN		30/09/2009	LMC								SS	A		G	MD	SX	LM	TO	S1	H3							FR														
0.270	185.890	LEN		30/09/2009	LMC								SL	B		G		SZ	LM	TO	S1	H3							FR														
0.110	186.000	LEN		30/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.510	186.510	LEN		30/09/2009	LMC								SL	B		G		SZ	LM	TO	S1	H3							FR														
0.030	186.540	LEN		30/09/2009	LMC								SS	A		G	FN				S1	H4							FR														
0.250	186.790	LEN		30/09/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.210	187.000	LEN		30/09/2009	LMC	GT14							SS	B		G	FN				S1	H3							FR														
									EOR 71 D3.00 R3.05																																		
0.170	187.170	LEN		01/10/2009	LMC								SS	A		G	FN	CO	LM	TO	S1	H3							FR														
0.430	187.600	LEN		01/10/2009	LMC								SS	A		G	MD	CO	LM	TO	S1	H4							FR														
0.070	187.670	LEN		01/10/2009	LMC								SL	B		G		WI	SZ	LM	S1	H3							FR														
0.210	187.880	LEN		01/10/2009	LMC								SS	A		G	FM	WI	CO	LM	S1	H3							FR														
0.050	187.930	LEN		01/10/2009	LMC								SL	B		G		SZ	WP	MU	S1	H3							FR														
0.260	188.190	LEN		01/10/2009	LMC								SS	A		G	FM	SX	ND	MU	S1	H4							FR														
0.140	188.330	LEN		01/10/2009	LMC								SS	A		G	FM	CS	WP	TO	S1	H4							FR														
0.120	188.450	LEN		01/10/2009	LMC								SS	A		G	FM	CO	LM	TO	S1	H4							FR														
0.750	189.200	LEN		01/10/2009	LMC								SS	A		G	FM	CO	LM	MU	S1	H4							FR														
									EOR 72 D2.29 R2.20																																		
0.800	190.000	LEN		01/10/2009	LMC								SS	A		G	FM				S1	H4							FR														
									EOR 73 D0.71 R 0.32																																		
1.610	191.610	LEN		01/10/2009	LMC								SS	A		G	MD				S1	H4							FR														
0.070	191.680	LEN		01/10/2009	LMC								SS	A		G	MD	SX	LM	TO	S1	H4							FR														

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												Rock Descriptor								Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.070	191.750	LEN		01/10/2009	LMC								SS	A		G	MD	CO	LM	TO	S1	H4							FR														
0.560	192.310	LEN		01/10/2009	LMC								SS	A		G	MD	CO	WP	TO	S1	H4							FR														
0.350	192.660	LEN		01/10/2009	LMC								SS	A		G	MD				S1	H4							FR														
									EOR74 D2.70 R3.14																																		
0.340	193.000	LEN		01/10/2009	LMC								SS	A		G	MD				S1	H4							FR														
									EOR 75 D0.30 R0.34																																		
0.510	193.510	LEN		01/10/2009	LMC								SS	A		G	MD				S1	H4							FR														
0.030	193.540	LEN		01/10/2009	LMC								SS	A		G	MD	CO	WP	TO	S1	H4							FR														
0.200	193.740	LEN		01/10/2009	LMC								SL	B		G		CA	VN	MU	S1	H3							FR														
0.050	193.790	LEN		01/10/2009	LMC								SL	B		G		SZ	LN	TO	S1	H3							FR														
0.120	193.910	LEN		01/10/2009	LMC								SL	B		G		SZ	WP	TO	S1	H3							FR														
0.200	194.110	LEN		01/10/2009	LMC								SL	B		G		SZ	BN	TO	S1	H3							FR														
0.040	194.150	LEN		01/10/2009	LMC								SS	A		G	FM				S1	H4							FR														
0.110	194.260	LEN		01/10/2009	LMC								SL	B		G		SZ	LM	TO	S1	H3							FR														
0.280	194.540	LEN		01/10/2009	LMC								SS	A		G	FM	CO	WP	TO	S1	H4							FR														
0.080	194.620	LEN		01/10/2009	LMC								SS	A		G	FN	CS	WP		S1	H3							FR														
0.020	194.640	LEN		01/10/2009	LMC								SS	A		G	FM				S1	H4							FR														
0.030	194.670	LEN		01/10/2009	LMC								SL	B		G		SZ	LM	TO	S1	H3							FR														
0.030	194.700	LEN		01/10/2009	LMC								SS	A		G	FM	CS	WP	TO	S1	H4							FR														
0.130	194.830	LEN		01/10/2009	LMC								SL	B		G		SZ	TO		S1	H3							FR														
0.190	195.020	LEN		01/10/2009	LMC								SS	A		G	MD	CS	LM	TO	S1	H4							FR														
0.660	195.680	LEN		01/10/2009	LMC								SS	A		G	MD	CS	WP	TO	S1	H4							FR														
0.250	195.930	LEN		01/10/2009	LMC								SS	B		G	FN				S1	H3							FR														
									EOR 76 D3.00 R 2.93																																		
0.690	196.620	LEN		01/10/2009	LMC								SL	B		G		SZ	LM	TO	S1	H3							FR														
0.230	196.850	LEN		01/10/2009	LMC	GT15							SS	A		G	FM	CS	LM	TO	S1	H4							FR														
0.140	196.990	LEN		01/10/2009	LMC								SS	D	K	G	FN	CS			S1	H3							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.090	197.080	LEN		01/10/2009	LMC								SS	A		G	FN				S1	H3							FR														
0.100	197.180	LEN		01/10/2009	LMC								SS	D	K	G	FN	CS			S1	H3							FR														
0.200	197.380	LEN		01/10/2009	LMC								SS	A		G	FN	CA	VN	BU	S1	H3							FR														
0.250	197.630	LEN		01/10/2009	LMC								SS	B		G	VF				S1	H3							FR														
0.780	198.410	LEN		01/10/2009	LMC								SS	A		G	FM	SX	LM	TO	S1	H3							FR														
0.590	199.000	LEN		01/10/2009	LMC								SS	A		G	MD				S1	H3							FR														
									EOR 77 D3.00 R3.00																																		
0.710	199.710	LEN		01/10/2009	LMC								SS	A		G	MD	CS	WP	TO	S1	H3							FR														
0.290	200.000	LEN		01/10/2009	LMC								SL	B		G		SZ	LM	TO	S1	H3							FR														
0.030	200.030	LEN		01/10/2009	LMC								SS	A		G	FM	SX	LM	TO	S1	H4							FR														
0.320	200.350	LEN		01/10/2009	LMC								SL	B		G		SZ	LM	TO	S1	H3							FR														
0.080	200.430	LEN		01/10/2009	LMC								SS	B		G	FN				S1	H3							FR														
0.070	200.500	LEN		01/10/2009	LMC								SS	A		G	FM	SX	BN	MU	S1	H4							FR														
0.190	200.690	LEN		01/10/2009	LMC								SS	A		G	FM	SX	WP	TO	S1	H4							FR														
1.310	202.000	LEN		01/10/2009	LMC								SL	B		G		SZ	LM	TO	S1	H3							FR														
									EOR 78 D3.00 R3.00																																		
0.530	202.530	LEN		01/10/2009	LMC								SL	D		G		CA	LM	MU	S1	H3							FR														
0.040	202.570	LEN		01/10/2009	LMC								CA	A	W	G					S1	H4							FR														
2.430	205.000	LEN		01/10/2009	LMC								XT	D	K	G		WI	MZ	LM	S1	H3							FR														
									EOR 79 D3.00 R3.04																																		
0.520	205.520	LEN		01/10/2009	LMC								XT	D	K	G		WI	MZ	LM	S1	H3							FR														
0.050	205.570	LEN		01/10/2009	LMC		BLU						CZ			K		WI	CA	VN	S1	H3							FR														
0.100	205.670	LEN		01/10/2009	LMC	GM045	BLU						C6			K					S1								FR														
0.160	205.830	LEN		01/10/2009	LMC	GM045	BLU						SL	D	K	G		CO			S1	H3							FR														
0.230	206.060	LEN		01/10/2009	LMC	GM045	BLU						C3			K													FR														
0.120	206.180	LEN		01/10/2009	LMC	GM045	BLU						C6																FR														
0.140	206.320	LEN		01/10/2009	LMC	GM045	BLU						C5			K					S1								FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.780	207.100	LEN		01/10/2009	LMC	GM163	BLU						C5			K					S1								FR														
0.060	207.160	LEN		01/10/2009	LMC	GM178	BLU						C5			K					S1								FR														
0.030	207.190	LEN		01/10/2009	LMC	GM178	BL						C3			K					S1								FR														
0.020	207.210	LEN		01/10/2009	LMC	GM178	BL						C1			K					S1								FR														
0.040	207.250	LEN		01/10/2009	LMC	GM178	BL						C6			K					S1								FR														
0.120	207.370	LEN		01/10/2009	LMC	GM178	BL						C5			K		WI	CA	VN	S1								FR														
0.080	207.450	LEN		01/10/2009	LMC	GM178	BL						C4			K					S1								FR														
0.070	207.520	LEN		01/10/2009	LMC	GM178	BL						C3			K													FR														
0.160	207.680	LEN		01/10/2009	LMC	GM178	BL						C4			K													FR														
0.110	207.790	LEN		01/10/2009	LMC	GM178	BV2						C6			K		WI	MZ	LM									FR														
0.070	207.860	LEN		01/10/2009	LMC	GM178	BV2						C6			K		WI	MZ										FR														
0.050	207.910	LEN		01/10/2009	LMC	30863	BV2						C6			K		WI	MZ	LM									FR														
0.050	207.960	LEN		01/10/2009	LMC	30863	BV2						C4			K													FR														
									EOR 80 D3.00 R2.90																																		
0.110	208.070	LEN		01/10/2009	LMC	30863	BV2						C4			K													FR														
0.060	208.130	LEN		01/10/2009	LMC	30863	BV2						SL	B	K	G		CO	BN	MU	S1	H3							FR														
0.020	208.150	LEN		01/10/2009	LMC	30863	BV2						C6			K					S1								FR														
0.020	208.170	LEN		01/10/2009	LMC	30863	BV2						SL	B	K	G		CO			S1	H3							FR														
0.020	208.190	LEN		01/10/2009	LMC	30863	BV2						C6			K					S1								FR														
0.030	208.220	LEN		01/10/2009	LMC	30863	BV2						CS	A	W	G					S1	H4							FR														
0.040	208.260	LEN		01/10/2009	LMC		BV2						CL	A	W	G													FR														
0.150	208.410	LEN		01/10/2009	LMC	GM224	BV2						C6			K					S1								FR														
0.120	208.530	LEN		01/10/2009	LMC	GM224	BV2						C3			K		CA	VN	TO	S1								FR														
0.140	208.670	LEN		01/10/2009	LMC	GM224	BV2						C6			K					S1								FR														
0.080	208.750	LEN		01/10/2009	LMC	GM224	BV2						C6			K		CA	VN	TO	S1								FR														
0.090	208.840	LEN		01/10/2009	LMC	GM224	BV2						C6			K					S1								FR														
0.110	208.950	LEN		01/10/2009	LMC	GM224	BV2						SL	D	K	G		CO			S1	H3							FR														

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Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
												% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier 2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.040	208.990	LEN		01/10/2009	LMC	GM224	VU						C6			K					S1								FR														
0.650	209.640	LEN		01/10/2009	LMC	30864	VU						C4			K		CA	VN	TO	S1								FR														
0.100	209.740	LEN		01/10/2009	LMC	30864	VL						C2			K					S2								FR														
0.260	210.000	LEN		01/10/2009	LMC	30864	VL						C2			K		CA	VN	TO	S1								FR														
0.070	210.070	LEN		01/10/2009	LMC	30864	VL						CA			K		CA	VN	TO	S1								FR														
0.090	210.160	LEN		01/10/2009	LMC	30864	VL						C2			K					S1								FR														
0.330	210.490	LEN		01/10/2009	LMC	GM230	VL						C3			K		CA	VN	TO	S1								FR														
0.030	210.520	LEN		01/10/2009	LMC	GM230	VL						C1			K					S1								FR														
0.090	210.610	LEN		01/10/2009	LMC	GM230	VL						C2			K					S1								FR														
0.060	210.670	LEN		01/10/2009	LMC	GM230	VL						C2			K					S2								FR														
0.170	210.840	LEN		01/10/2009	LMC	GM230	VL						C3			K													FR														
0.120	210.960	LEN		01/10/2009	LMC	GM230	VL						C6			K					S2								FR														
									EOR 81 D3.00 R3.00																																		
0.200	211.160	LEN		01/10/2009	LMC	30865	VL						C2			K					S3								FR														
0.720	211.880	LEN		01/10/2009	LMC	30865	VL						C3			K		CA	VN	TO	S1								FR														
0.650	212.530	LEN		01/10/2009	LMC	GM264	VL						C2			K					S1								FR														
0.040	212.570	LEN		01/10/2009	LMC	GM264	VL						C3			K					S1								FR														
0.040	212.610	LEN		01/10/2009	LMC	GM264	VL						C1			K					S1								FR														
0.300	212.910	LEN		01/10/2009	LMC								XT	D	G	K		CO	FR	TO	S1	H3							FR														
0.190	213.100	LEN		01/10/2009	LMC	GM313	VL1						C3			K					S1								FR														
0.070	213.170	LEN		01/10/2009	LMC	GM313	VL1						C5			K					S1								FR														
0.060	213.230	LEN		01/10/2009	LMC	GM313	VL1						C2			K					S1								FR														
0.140	213.370	LEN		01/10/2009	LMC	GM313	VL1						C6			K		WI	MZ		S2								FR														
0.300	213.670	LEN		01/10/2009	LMC	GM313	VL1						C2			K					S1								FR														
0.190	213.860	LEN		01/10/2009	LMC								SL	D	G	K		CO	FR	TO	S2								FR														
									EOR 82 D3.00 R2.90																																		
0.220	214.080	LEN		02/10/2009	LMC								XT	D	K	G		CO	FR	TO	S1	H2							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.220	214.300	LEN		02/10/2009	LMC								XT	D	G	K		CO	FR	TO	S1	H2							FR														
0.710	215.010	LEN		02/10/2009	LMC								XT	D	G	K		CO	FR	TO	S1	H2							FR														
0.220	215.230	LEN		02/10/2009	LMC								SS	B	G	G	MD	CS	LM	TO	S1	H3							FR														
0.070	215.300	LEN		02/10/2009	LMC								XT	D	G	K		SZ	BN	TU	S1	H2							FR														
0.050	215.350	LEN		02/10/2009	LMC								SS	B	K	G	FN	CS	LM	TO	S1	H3							FR														
0.660	216.010	LEN		02/10/2009	LMC								SS	B		G	MD	CS	BN	MU	S1	H3							FR														
0.190	216.200	LEN		02/10/2009	LMC								SS	B		G		CS	BN	TO	S1	H3							FR														
0.480	216.680	LEN		02/10/2009	LMC								SS	A		G	MD	CS	WP	TO	S1	H4							FR														
0.210	216.890	LEN		02/10/2009	LMC	GT16							SS	A		G		MN	CO	FR	S1	H4							FR														
0.070	216.960	LEN		02/10/2009	LMC								SS	A		G		MN	CO	FR	S1	H4							FR														
									EOR 83 D3.00 R3.10																																		
0.040	217.000	LEN		02/10/2009	LMC								SS	B		G	MC				S1	H4							FR														
1.920	218.920	LEN		02/10/2009	LMC								SS	A		G	MC	MN	CS	WP	S1	H4							FR														
0.070	218.990	LEN		02/10/2009	LMC								SS	B		G	FM	CS	LM	TO	S1	H4							FR														
0.970	219.960	LEN		02/10/2009	LMC								SS	A		G	MC	CO	FR	MN	S1	H4							FR														
									EOR 84 D3.00 R3.00																																		
1.310	221.270	LEN		02/10/2009	LMC								SS	A		G	CS	CS	WP	TO	S1	H3							FR														
0.130	221.400	LEN		02/10/2009	LMC								SS	A		G	CS	SX	ND	TO	S1	H4							FR														
0.400	221.800	LEN		02/10/2009	LMC								SS	A		G	CS	CS	LM	MU	S1	H3							FR														
0.150	221.950	LEN		02/10/2009	LMC								SS	A		G	CS	CO	LM	TO	S1	H3							FR														
0.130	222.080	LEN		02/10/2009	LMC								SS	A		G	CS				S1	H3							FR														
0.220	222.300	LEN		02/10/2009	LMC								SS	A		G	CS	CS	WP	TO	S1	H3							FR														
0.060	222.360	LEN		02/10/2009	LMC								SS	A		G	MD				S1	H3							FR														
0.050	222.410	LEN		02/10/2009	LMC								SS	A		G	CO				S1	H4							FR														
0.060	222.470	LEN		02/10/2009	LMC								SS	A		G	FM				S1	H4							FR														
0.120	222.590	LEN		02/10/2009	LMC								SS	A		G	CS	CO	FR	TO	S1	H4							FR														
0.190	222.780	LEN		02/10/2009	LMC								SS	A		G	FM	CS	WP	TO	S1	H4							FR														

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													Rock Descriptor								Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.040	222.820	LEN		02/10/2009	LMC								SS	A		G	FM	CO	WP	TO	S1	H4							FR														
0.140	222.960	LEN		02/10/2009	LMC								SS	A		G	MD				S1	H4							FR														
									EOR 85 D3.00 R3.05																																		
0.070	223.030	LEN		02/10/2009	LMC								SS	A		G	MC				S1	H4							FR														
0.030	223.060	LEN		02/10/2009	LMC								SS	B		G	VC				S1	H4							FR														
0.990	224.050	LEN		02/10/2009	LMC								SS	A		G	MC	CO	FR	MU	S1	H4							FR														
0.360	224.410	LEN		02/10/2009	LMC								SS	A		G	MC	CO	WP	TU	S1	H4							FR														
0.340	224.750	LEN		02/10/2009	LMC								SS	A		G	FM				S1	H4							FR														
0.130	224.880	LEN		02/10/2009	LMC								SS	A		G	CO				S1	H4							FR														
0.130	225.010	LEN		02/10/2009	LMC								SS	A		G	FM				S1	H4							FR														
0.170	225.180	LEN		02/10/2009	LMC								SS	A		G	MC	CO	FR	TO	S1	H4							FR														
0.050	225.230	LEN		02/10/2009	LMC								SS	A		G	MD	CO	LM	TO	S1	H4							FR														
0.730	225.960	LEN		02/10/2009	LMC								SS	A		G	MC	CO	LM	TO	S1	H4							FR														
									EOR 86 D3.00 R3.00																																		
0.250	226.210	LEN		02/10/2009	LMC								SS	A		G	VC				S1	H3							FR														
0.320	226.530	LEN		02/10/2009	LMC	GT17							SS	A		G	VC				S1	H3							FR														
0.060	226.590	LEN		02/10/2009	LMC								BR	A		G	CO				S1	H3							FR														
0.500	227.090	LEN		02/10/2009	LMC								SS	A		G	FM				S1	H3							FR														
0.170	227.260	LEN		02/10/2009	LMC								BR	D	G	G					S1	H2							FR														
0.110	227.370	LEN		02/10/2009	LMC								SS	A		G		CS	LM	TO	S1	H3							FR														
0.190	227.560	LEN		02/10/2009	LMC								SS	A		G	MD	WI	CO	TU	S1	H3							FR														
0.140	227.700	LEN		02/10/2009	LMC								SS	A		G	CO				S1	H3							FR														
0.440	228.140	LEN		02/10/2009	LMC								SS	A		G	FN	CS	LM	TO	S1	H3							FR														
0.310	228.450	LEN		02/10/2009	LMC								SS	A		G	FN				S1	H3							FR														
0.150	228.600	LEN		02/10/2009	LMC								SS	A		G	FN	CS	LM	TU	S1	H3							FR														
									EOR 87 D2.64 R2.64																																		
0.360	228.960	LEN		02/10/2009	LMC								SS	A		G	FM	SX	ND	TO	S1	H3							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
									EOR 88 D0.36 R0.42																																		
0.210	229.170	LEN		02/10/2009	LMC								SS	A		G	MD				S1	H4							FR														
0.080	229.250	LEN		02/10/2009	LMC								SS	A		G	MD	CO	LM	TO	S1	H4							FR														
0.250	229.500	LEN		02/10/2009	LMC								SS	A		G	MD				S1	H4							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossil/Minerals Abundance	Fossil/Minerals Type	Fossil/Minerals Association	Sedimentary Relationship	Coal Type
2.000	2.000	LEN	F	27/10/2009	LMC								KL																														
1.450	3.450	LEN	F	27/10/2009	LMC								SA	B	B	G		CL				X2							EW														
									EOR 1: Dr 3.00 REC 0.85																																		
1.080	4.530	LEN	F	04/11/2009	LMC								KL																														
0.070	4.600	LEN	F	04/11/2009	LMC								AL	S	G	B		PB	SS			X1							EW														
1.040	5.640	LEN	F	04/11/2009	LMC								MS	B	B	B		SS	CL			X2							EW														
0.610	6.250	LEN	F	04/11/2009	LMC								SA	B	B	B	FM	CL				X3							HW														
0.200	6.450	LEN	F	04/11/2009	LMC								MS	D	R	B		FE	CL			H1							HW														
									EOR 2 DR3.00 REC 1.92																																		
0.900	7.350	LEN	F	04/11/2009	LMC								KL																														
1.800	9.150	LEN	F	04/11/2009	LMC								MS	D	R	B		FE	CL			H1							HW														
0.050	9.200	LEN	F	04/11/2009	LMC								CL	A	W	G		TF				H1							HW														
0.250	9.450	LEN	F	04/11/2009	LMC								BA		R	K						H5							SW														
									EOR 3 DR 3.00 RED 2.10																																		
0.180	9.630	LEN	F	04/11/2009	LMC								BA		R	K						H5							SW														
0.080	9.710	LEN	F	04/11/2009	LMC								CL	A	W	G		TF				H1							SW														
0.770	10.480	LEN	F	04/11/2009	LMC								BA		R	K						H5							SW														
0.160	10.640	LEN	F	04/11/2009	LMC								CL	A	W	G		TF	BA	BN		H1							SW														
0.540	11.180	LEN	F	04/11/2009	LMC								BA		B	K		TF	BN	MU		H4							SW														
0.320	11.500	LEN	F	04/11/2009	LMC								CL	A	W	G		TF	WI	BA		H1							SW														
0.110	11.610	LEN	F	04/11/2009	LMC								BA		B	K		TF	BN	MU		H4							SW														
0.270	11.880	LEN	F	04/11/2009	LMC								CL	A	W	G		TF				H1							SW														
0.570	12.450	LEN	F	04/11/2009	LMC								MS	B	B	B						H2							SW														
									EOR 4 DR3.00 REC 3.00																																		
1.030	13.480	LEN	F	04/11/2009	LMC								MS	B	B	B						H2							SW														
0.070	13.550	LEN	F	04/11/2009	LMC								CL	A	W	G		TF				H1							SW														
0.670	14.220	LEN	F	04/11/2009	LMC								MS	B	B	B						H2							SW														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.160	14.380	LEN	F	04/11/2009	LMC								TF	A	W	G		WI	MZ	BN		H1							SW														
0.420	14.800	LEN	F	04/11/2009	LMC								MS	B	B	B						H3							SW														
0.650	15.450	LEN	F	04/11/2009	LMC								KL																														
									EOR 5 DR 3.00 REC 2.35																																		
4.180	19.630	LEN	F	04/11/2009	LMC								KL																														
									EOR 6 DR 3.00 RED 0.00																																		
0.120	19.750	LEN	F	05/11/2009	LMC								KL																														
0.140	19.890	LEN	F	05/11/2009	LMC								CL	A	W	G		TF											SW														
1.360	21.250	LEN	F	05/11/2009	LMC								MS	B	B	B		CA	VN	MU		H2							SW														
0.440	21.690	LEN	F	05/11/2009	LMC								CL	A	W	G		TF	MZ	BN		H1							SW														
0.090	21.780	LEN	F	05/11/2009	LMC								SS	A	B	G	FM					H2							SW														
0.650	22.430	LEN	F	05/11/2009	LMC								MS	B	B	B						H2							SW														
0.200	22.630	LEN	F	05/11/2009	LMC								SS	A	B	G		WI	MZ	ND		H2							SW														
									EOR 7 DR 3.00 REC 2.88																																		
0.590	23.220	LEN	F	05/11/2009	LMC								SS	A	B	G	FM	WI	MZ	BN		H2							SW														
0.080	23.300	LEN	F	05/11/2009	LMC								SS	A	B	G	FM					H2							SW														
0.330	23.630	LEN	F	05/11/2009	LMC								MS	D	B	B						H1							SW														
									EOR 8 DR 1.00 RED 1.00																																		
0.320	23.950	LEN	F	05/11/2009	LMC								MS	D	B	B						H2							SW														
0.090	24.040	LEN	F	05/11/2009	LMC								SS	B	B	G		WI	MZ	BN		H3							SW														
0.710	24.750	LEN	F	05/11/2009	LMC								MS	D	B	B						H3							SW														
0.170	24.920	LEN	F	05/11/2009	LMC								SL	B	B	G		WI	MZ	BN		H3							SW														
0.710	25.630	LEN	F	05/11/2009	LMC								SS	B	B	G		FE	WI	MZ		H3							SW														
									EOR 9 DR 2.00 REC 2.00																																		
0.450	26.080	LEN	F	05/11/2009	LMC								KL																SW														
2.550	28.630	LEN	F	05/11/2009	LMC								SS	A	E	G						H3							FR														
									EOR 10 DR 3.00 REC 2.55																																		

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
2.620	31.250	LEN	F	05/11/2009	LMC								SS	A	E	G	FM					H3							FR														
0.380	31.630	LEN	F	05/11/2009	LMC								SL	A	E	G						H3							FR														
									EOR 11 DR 3.00 REC 3.00																																		
0.620	32.250	LEN	F	05/11/2009	LMC								SL	A	E	G						H3							FR														
1.200	33.450	LEN	F	05/11/2009	LMC								MS	B	B	B						H2							FR														
0.120	33.570	LEN	F	05/11/2009	LMC								SL	A	E	G		CS	LM	TO		H3							FR														
0.230	33.800	LEN	F	05/11/2009	LMC								MS	B	B	B						H3							FR														
0.530	34.330	LEN	F	05/11/2009	LMC								SS	A	E	G	FN					H3							FR														
									EOR 12 DR 3.00 REC 2.70																																		
0.050	34.380	LEN	F	05/11/2009	LMC								KL																FR														
0.250	34.630	LEN	F	06/11/2009	LMC								SS	A	E	G	FN					H3							FR														
1.130	35.760	LEN	F	06/11/2009	LMC								MS	B	B	B						H3							FR														
0.320	36.080	LEN	F	06/11/2009	LMC								SS	A	E	G	FN	WI	MZ	BN		H3							FR														
0.840	36.920	LEN	F	06/11/2009	LMC								MS	B	B	B		SX	ND	TO		H4							FR														
0.050	36.970	LEN	F	06/11/2009	LMC								SL	A	E	G						H3							FR														
0.260	37.230	LEN	F	06/11/2009	LMC								MS	B	B	B		WI	SX	BN		H3							FR														
									EOR 13 DR 2.60 REC 2.85																																		
1.210	38.440	LEN	F	06/11/2009	LMC								MS	B	B	B						H3							FR														
0.530	38.970	LEN	F	06/11/2009	LMC								SL	B	E	G		WI	MZ	BN		H3							FR														
0.450	39.420	LEN	F	06/11/2009	LMC								MS	B	B	B						H3							FR														
0.510	39.930	LEN	F	06/11/2009	LMC								SL	A	E	G		WI	SD	ND		H4							FR														
0.180	40.110	LEN	F	06/11/2009	LMC	GT 1							SL	A	E	G		WI	SD	ND		H4							FR														
0.220	40.330	LEN	F	06/11/2009	LMC								SL	A	E	G		SD				H4							FR														
									EOR 14 DR 3.10 REC 3.10																																		
0.890	41.220	LEN	F	06/11/2009	LMC								SL	A	E	G						H4							FR														
1.820	43.040	LEN	F	06/11/2009	LMC								SS	A	E	G	FN	WI	SX	LM		H3							FR														
0.250	43.290	LEN	F	06/11/2009	LMC								SS	A	E	G	FM					H3							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
									EOR 15 DR 2.96 REC 2.96																																		
1.570	44.860	LEN	F	06/11/2009	LMC								SS	A	E	G	FM					H3							FR														
0.470	45.330	LEN	F	06/11/2009	LMC								SL	A	E	G		WI	MZ	BN		H3							FR														
0.380	45.710	LEN	F	06/11/2009	LMC								MS	D	B	B		SX	BN	TO		H3							FR														
0.090	45.800	LEN	F	06/11/2009	LMC								SL	A	E	G						H3							FR														
									EOR 16 DR 3.00 REC 2.51																																		
0.220	46.020	LEN	F	06/11/2009	LMC								SS	A	E	G	FM					H3							FR														
0.750	46.770	LEN	F	06/11/2009	LMC								MS	B	B	B						H3							FR														
0.470	47.240	LEN	F	06/11/2009	LMC								SL	A	B	G		WI	MZ	TO		H3							FR														
1.030	48.270	LEN	F	06/11/2009	LMC								MS	B	B	B						H3							FR														
0.210	48.480	LEN	F	06/11/2009	LMC								SL	A	B	G		WI	MZ	BN		H3							FR														
0.500	48.980	LEN	F	06/11/2009	LMC								MS	B	B	B						H3							FR														
									EOR 17 DR 2,69 REC 3.14																																		
0.180	49.160	LEN	F	06/11/2009	LMC								MS	B	B	B						H3							FR														
0.030	49.190	LEN	F	06/11/2009	LMC								SL	A	E	G						H3							FR														
0.740	49.930	LEN	F	06/11/2009	LMC								MS	B	B	B						H3							FR														
									EOR 18 DR 0.95 REC0.95																																		
0.280	50.210	LEN	F	06/11/2009	LMC								MS	B	B	B						H3							FR														
0.150	50.360	LEN	F	06/11/2009	LMC								SS	A	E	G	FN					H3							FR														
2.270	52.630	LEN	F	06/11/2009	LMC								SL	A	E	G		WI	MZ	LM		H3							FR														
									EOR 19 DR 2.70 REC 2.82																																		
1.480	54.110	LEN	F	06/11/2009	LMC								SL	A	B	G		WI	MZ	LM		H3							FR														
0.200	54.310	LEN	F	06/11/2009	LMC								SS	A	E	G	FN					H3							FR														
0.120	54.430	LEN	F	06/11/2009	LMC								SL	A	B	G		WI	MZ			H3							FR														
									EOR 20 DR 1.80 REC 1.70																																		
0.770	55.200	LEN	F	06/11/2009	LMC								SL	A	B	G		WI	MZ	SN		H3							FR														
									EOR 21 DR 1.20 REC 0.77																																		

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossil/Minerals Abundance	Fossil/Minerals Type	Fossil/Minerals Association	Sedimentary Relationship	Coal Type
0.430	55.630	LEN	F	06/11/2009	LMC								SL	A	B	G		WI	MZ	BN		H3							FR														
0.180	55.810	LEN	F	06/11/2009	LMC								SS	A	B	G	FN					H3							FR														
0.410	56.220	LEN	F	06/11/2009	LMC								MS	B	B	B		WI	SX	TO		H3							FR														
0.190	56.410	LEN	F	06/11/2009	LMC	GT 2							MS	B	B	B		WI	SX	TO		H3							FR														
0.530	56.940	LEN	F	06/11/2009	LMC								MS	B	B	B		WI	SX	TO		H3							FR														
0.090	57.030	LEN	F	06/11/2009	LMC								SS	A	B	G	FN	WI	MZ	TO		H3							FR														
0.060	57.090	LEN	F	06/11/2009	LMC								MS	B	B	B		WI	SX			H3							FR														
0.650	57.740	LEN	F	06/11/2009	LMC								SS	A	E	G	FN	SX	LM	TO		H3							FR														
0.890	58.630	LEN	F	06/11/2009	LMC								MS	B	B	B		WI	SX	TO		H3							FR														
									EOR 22 DR 3.00 REC 3.00																																		
0.370	59.000	LEN	F	06/11/2009	LMC								MS	B	B	B		WI	SX			H3							FR														
0.330	59.330	LEN	F	06/11/2009	LMC								SL	B	B	G		WI	MZ			H3							FR														
0.160	59.490	LEN	F	06/11/2009	LMC								MS	B	B	B		WI	SX			H3							FR														
0.760	60.250	LEN	F	06/11/2009	LMC								SS	A	E	G	FM	WI	SX	MZ		H3							FR														
1.380	61.630	LEN	F	06/11/2009	LMC								MS	B	B	B		WI	SX	TO		H3							FR														
									EOR 23 DR 3.00 REC 3.00																																		
0.310	61.940	LEN	F	06/11/2009	LMC								SS	A	E	G	FM					H3							FR														
0.100	62.040	LEN	F	06/11/2009	LMC								MS	B	B	B		WI	SX	TO		H3							FR														
0.110	62.150	LEN	F	06/11/2009	LMC								SS	A	E	G	FM	WI	MZ			H3							FR														
0.310	62.460	LEN	F	06/11/2009	LMC								MS	B	B	B		WI	SX			H3							FR														
0.070	62.530	LEN	F	06/11/2009	LMC								SS	A	E	G	FM	WI	MZ			H3							FR														
0.100	62.630	LEN	F	06/11/2009	LMC								MS	B	B	B		WI	SX			H3							FR														
0.300	62.930	LEN	F	06/11/2009	LMC								SS	A	E	G	MD					H3							FR														
0.380	63.310	LEN	F	06/11/2009	LMC								MS	B	B	B		WI	SX			H3							FR														
0.550	63.860	LEN	F	06/11/2009	LMC								MS	B	B	B						H3							FR														
									EOR 24 DR 3.00 REC 2,24																																		
0.130	63.990	LEN	F	07/11/2009	LMC								MS	B	B	B		WI	SX			H3							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.270	64.260	LEN	F	07/11/2009	LMC								SS	A	E	G		WI	SX	BN		H3							FR														
0.260	64.520	LEN	F	07/11/2009	LMC								MS	B	B	B		WI	SX	TO		H3							FR														
0.220	64.740	LEN	F	07/11/2009	LMC								SS	A	E	G		WI	SX			H3							FR														
0.730	65.470	LEN	F	07/11/2009	LMC								MS	B	B	B		WI	SX	TO		H3							FR														
0.250	65.720	LEN	F	07/11/2009	LMC								SS	A	E	G		WI	SX			H3							FR														
0.500	66.220	LEN	F	07/11/2009	LMC								MS	B	B	B		WI	SX			H3							FR														
0.210	66.430	LEN	F	07/11/2009	LMC								SS	A	E	G		WI	MZ	TO		H3							FR														
0.340	66.770	LEN	F	07/11/2009	LMC								MS	B	B	B		WI	SX			H3							FR														
									EOR 25 DR 2.14 REC 2.91 END CASING																																		
0.140	66.910	LEN	F	07/11/2009	LMC								MS	B	B	B		WI	SX			H3							FR														
0.340	67.250	LEN	F	07/11/2009	LMC								SS	A	E	G	FM					H3							FR														
0.650	67.900	LEN	F	07/11/2009	LMC								MS	B	E	B		SX	SZ	TO		H3							FR														
0.600	68.500	LEN	F	07/11/2009	LMC								SS	A	E	G	FM	WI	SX	TO		H3							FR														
0.050	68.550	LEN	F	07/11/2009	LMC								MS	B	B	B						H3							FR														
0.420	68.970	LEN	F	07/11/2009	LMC								SS	A	E	G	MD					H3							FR														
0.180	69.150	LEN	F	07/11/2009	LMC								MS	B	B	B		SX	BN	TO		H3							FR														
1.070	70.220	LEN	F	07/11/2009	LMC								SS	A	E	G	MD	SX	BN	TO		H3							FR														
0.150	70.370	LEN	F	07/11/2009	LMC								MS	B	B	B		SX	WP	TO		H3							FR														
0.260	70.630	LEN	F	07/11/2009	LMC								SS	A	E	G	FM					H3							FR														
									EOR 26 DR 3.86 RED 3.86																																		
0.160	70.790	LEN	F	07/11/2009	LMC								SS	A	E	G	FM					H3							FR														
0.150	70.940	LEN	F	07/11/2009	LMC								SL	A	B	G		WI	MZ	BN		H3							FR														
0.290	71.230	LEN	F	07/11/2009	LMC								MS	B	E	B		WI	SX	TO		H3							FR														
0.400	71.630	LEN	F	07/11/2009	LMC								SS	A	E	G	FM	WI	MZ	TO		H3							FR														
0.380	72.010	LEN	F	07/11/2009	LMC								SS	A	E	G	FN	WI	MZ	TO		H3							FR														
0.280	72.290	LEN	F	07/11/2009	LMC								MS	B	E	B		WI	SX	TO		H3							FR														
0.120	72.410	LEN	F	07/11/2009	LMC								SS	A	E	G	FM	WI	SX	TO		H3							FR														

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Hole LEN241PC

												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.200	72.610	LEN	F	07/11/2009	LMC								MS	B	E	B		WI	SX	TO		H3							FR														
1.020	73.630	LEN	F	07/11/2009	LMC								SS	A	E	G	FN	WI	MZ			H3							FR														
0.200	73.830	LEN	F	07/11/2009	LMC								MS	A	B	B		WI	SX	TO		H3							FR														
0.360	74.190	LEN	F	07/11/2009	LMC								SS	A	E	G	FN	WI	MZ			H3							FR														
0.200	74.390	LEN	F	07/11/2009	LMC								MS	B	B	B		WI	SX	WP		H3							FR														
0.740	75.130	LEN	F	07/11/2009	LMC								SS	A	E	G	FN	WI	MZ	TO		H3							FR														
0.130	75.260	LEN	F	07/11/2009	LMC								MS	B	E	B		WI	SX	TO		H3							FR														
0.150	75.410	LEN	F	07/11/2009	LMC								SS	A	E	G	FN	WI	MZ	TO		H3							FR														
									EOR 27 DR 4.78 REC 4.78																																		
0.280	75.690	LEN	F	07/11/2009	LMC								SS	A	E	G	FN	WI	MZ	TO		H3							FR														
0.210	75.900	LEN	F	07/11/2009	LMC								MS	B	E	B		WI	SX	TO		H3							FR														
0.120	76.020	LEN	F	07/11/2009	LMC								SS	B	E	G	FN	WI	MZ	TO		H3							FR														
0.330	76.350	LEN	F	07/11/2009	LMC								MS	B	E	B		WI	SX	TO		H3							FR														
1.200	77.550	LEN	F	07/11/2009	LMC								SS	A	E	G	FM					H3							FR														
0.680	78.230	LEN	F	07/11/2009	LMC								SS	A	E	G	MD	CS	LM	TO		H3							FR														
1.400	79.630	LEN	F	07/11/2009	LMC								SS	A	E	G	MD	SX	TU			H3							FR														
									EOR 28 DR 4.24 REC 4.24																																
0.250	79.880	LEN	F	07/11/2009	LMC								SS	A	E	G	FM	CS	LM	TO		H3							FR														
0.880	80.760	LEN	F	07/11/2009	LMC								SS	A	E	G	MD	SX	ND	TO		H3							FR														
0.470	81.230	LEN	F	07/11/2009	LMC								SS	A	W	G	CS	SX	ND	TO		H3							FR														
0.540	81.770	LEN	F	07/11/2009	LMC								SS	A	E	G	FM	CS	BN	TO		H3							FR														
0.710	82.480	LEN	F	07/11/2009	LMC								SL	A	E	G		WI	SZ	WP		H3							FR														
0.360	82.840	LEN	F	07/11/2009	LMC								SS	A	E	G	FM	WI	SX	LM		H3							FR														
0.100	82.940	LEN	F	07/11/2009	LMC								SL	B	E	G		WI	SZ	LM		H3							FR														
0.450	83.390	LEN	F	07/11/2009	LMC								SS	A	E	G	FN	SX	ND	MU		H4							FR														
0.080	83.470	LEN	F	07/11/2009	LMC								SL	B	E	G		CL	TU			H3							FR														
1.870	85.340	LEN	F	07/11/2009	LMC								SS	A	E	G	FN	SX	BN	TU		H4							FR														

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Hole LEN241PC

												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossil/Minerals Abundance	Fossil/Minerals Type	Fossil/Minerals Association	Sedimentary Relationship	Coal Type
0.160	85.500	LEN	F	07/11/2009	LMC								SL	B	E	G						H3							FR														
0.130	85.630	LEN	F	07/11/2009	LMC								SS	A	E	G	CS	SX	WP	TO		H4							FR														
									EOR 29 DR 6.00 REC 6.00																																		
6.000	91.630	LEN	F	07/11/2009	LMC								SS	A	E	G	MD					H4							FR														
									EOR 30 DR 6.00 REC 6.00																																		
2.630	94.260	LEN	F	07/11/2009	LMC								SS	A	E	G	MD					H4							FR														
0.270	94.530	LEN	F	07/11/2009	LMC								SS	A	G	G	FM					H3							FR														
0.250	94.780	LEN	F	07/11/2009	LMC								SS	A	W	G	MD	CA				H4							FR														
0.240	95.020	LEN	F	07/11/2009	LMC								SS	A	G	G	FM					H4							FR														
0.810	95.830	LEN	F	07/11/2009	LMC								SS	A	E	G	FN					H3							FR														
0.090	95.920	LEN	F	07/11/2009	LMC								SS	A	E	G	FM	CO	WP	TO		H3							FR														
0.400	96.320	LEN	F	07/11/2009	LMC								SS	A	E	G	FN	SX	LM	TO		H3							FR														
1.310	97.630	LEN	F	07/11/2009	LMC								SS	S	E	G	FM	WI	CO	WP		H4							FR														
									EOR 31 DR 600 REC 6.00																																		
0.210	97.840	LEN	F	08/11/2009	LMC								SS	A	W	G	CS					H4							FR														
2.300	100.140	LEN	F	08/11/2009	LMC								SS	A	W	G	CS					H4							FR														
0.170	100.310	LEN	F	08/11/2009	LMC								SS	A	E	G	MD					H4							FR														
0.180	100.490	LEN	F	08/11/2009	LMC								SL	B	E	G						H3							FR														
0.730	101.220	LEN	F	08/11/2009	LMC								SS	A	E	G	FN					H3							FR														
0.150	101.370	LEN	F	08/11/2009	LMC								SL	A	E	G						H3							FR														
2.260	103.630	LEN	F	08/11/2009	LMC								SS	A	E	G	FN					H3							FR														
									EOR 32 DR 6.00 REC 6.00																																		
0.300	103.930	LEN	F	08/11/2009	LMC								SS	A	W	G	FM					H4							FR														
1.110	105.040	LEN	F	08/11/2009	LMC								SS	A	E	G	FM	SX	ND	TO		H4							FR														
0.280	105.320	LEN	F	08/11/2009	LMC								SS	A	E	G	FM	SX	ND	TO		H4							FR														
0.960	106.280	LEN	F	08/11/2009	LMC								SS	A	E	G	FM					H4							FR														
0.860	107.140	LEN	F	08/11/2009	LMC								SS	A	W	G	MD	SS	ND	TO		H4							FR														

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													Rock Descriptor								Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
2.490	109.630	LEN	F	08/11/2009	LMC								SS	A	E	G	FM	SX	BN	TO		H4							FR														
									EOR33 DR6.00 REC 6.00																																		
2.200	111.830	LEN	F	08/11/2009	LMC								SS	A	W	G	MD					H4							FR														
0.130	111.960	LEN	F	08/11/2009	LMC								SL	B	E	G		SX	ND			H3							FR														
1.080	113.040	LEN	F	08/11/2009	LMC								SS	A	W	G	FM	MN	SD	ND		H4							FR														
0.090	113.130	LEN	F	08/11/2009	LMC								SL	B	E	G		CL				H3							FR														
1.730	114.860	LEN	F	08/11/2009	LMC								SS	B	E	G	FN	WI	SX	LM		H3							FR														
0.060	114.920	LEN	F	08/11/2009	LMC								SL	B	E	G		SZ	TO			H3							FR														
0.710	115.630	LEN	F	08/11/2009	LMC								SS	A	E	G	FM	WI	SX	LM		H3							FR														
									EOR 34 DR 6.00 REC 6.00																																		
1.190	116.820	LEN	F	08/11/2009	LMC								SS	A	E	G	FM					H4							FR														
0.200	117.020	LEN	F	08/11/2009	LMC								SL	B	E	G		MZ	TO			H3							FR														
0.570	117.590	LEN	F	08/11/2009	LMC								MS	B	B	B		SX	TO			H3							FR														
0.100	117.690	LEN	F	08/11/2009	LMC								SL	B	E	G		MZ	TO			H3							FR														
0.440	118.130	LEN	F	08/11/2009	LMC								MS	B	B	B		SX	TO			H3							FR														
0.390	118.520	LEN	F	08/11/2009	LMC								SS	A	E	G	FN	SX	LM	TO		H3							FR														
0.100	118.620	LEN	F	08/11/2009	LMC								MS	B	B	B		WI	SX			H3							FR														
0.150	118.770	LEN	F	08/11/2009	LMC								SL	A	E	G		WI	MZ			H3							FR														
0.420	119.190	LEN	F	08/11/2009	LMC								MS	B	B	B		SX	BN	TO		H3							FR														
0.360	119.550	LEN	F	08/11/2009	LMC								SL	A	E	G		MZ	BN	MU		H3							FR														
0.130	119.680	LEN	F	08/11/2009	LMC								MS	B	B	B		WI	SX			H3							FR														
0.350	120.030	LEN	F	08/11/2009	LMC								SS	A	E	G	FN	WI	MZ	TO		H3							FR														
0.170	120.200	LEN	F	08/11/2009	LMC								MS	B	B	B		WI	SX			H3							FR														
0.360	120.560	LEN	F	08/11/2009	LMC								SS	A	E	G	FN	WI	SX	LM		H3							FR														
0.090	120.650	LEN	F	08/11/2009	LMC								MS	B	B	B						H3							FR														
0.380	121.030	LEN	F	08/11/2009	LMC								SS	A	E	G	FN	WI	SX	LM		H3							FR														
0.460	121.490	LEN	F	08/11/2009	LMC								MS	B	B	B		SX	WP	TO		H3							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.140	121.630	LEN	F	08/11/2009	LMC								SS	A	E	G	FM	WI	MZ	TO		H3							FR														
									EOR 35 DR. 6.00 REC 6.00																																		
0.170	121.800	LEN	F	08/11/2009	LMC								SS	A	E	G	FM	WI	MZ	BN		H3							FR														
0.070	121.870	LEN	F	08/11/2009	LMC								MS	B	B	B		SX	WP	TO		H3							FR														
0.840	122.710	LEN	F	08/11/2009	LMC								SS	A	E	G	FN	MZ	BN	BU		H3							FR														
0.530	123.240	LEN	F	08/11/2009	LMC								SS	A	E	G	MD	SX	LM	TO		H4							FR														
2.020	125.260	LEN	F	08/11/2009	LMC								SS	A	E	G	FM	SX	LM	TO		H4							FR														
0.870	126.130	LEN	F	08/11/2009	LMC								SS	A	E	G	FM	SX	ND	BN		H4							FR														
0.330	126.460	LEN	F	08/11/2009	LMC								SL	B	E	G		CA	VN	TO		H4							FR														
1.170	127.630	LEN	F	08/11/2009	LMC								SL	B	E	G		SZ	BN	TO		H3							FR														
									EOR 36 DR 6.00 REC 6.00																																		
0.420	128.050	LEN	F	08/11/2009	LMC								SS	A	E	G	FN	WI	SX	LM		H3							FR														
0.070	128.120	LEN	F	08/11/2009	LMC								MS	B	B	B		WI	SX	TO		H3							FR														
1.310	129.430	LEN	F	08/11/2009	LMC								SS	A	E	G	FN	SX	LM			H3							FR														
0.300	129.730	LEN	F	08/11/2009	LMC								MS	B	B	B		WI	SX	WP		H3							FR														
0.270	130.000	LEN	F	08/11/2009	LMC								SS	A	E	G	FN	WI	SX	LM		H3							FR														
2.770	132.770	LEN	F	08/11/2009	LMC								SS	A	E	G	MD	WI	SX	LM		H3							FR														
0.860	133.630	LEN	F	08/11/2009	LMC								SS	A	E	G	CS	WI	SX	LM		H4							FR														
									EOR 37 DR 6.00 REC 6.00																																		
1.270	134.900	LEN	F	08/11/2009	LMC								SS	A	G	G	FM					H4							FR														
0.080	134.980	LEN	F	08/11/2009	LMC								SS	A	W	G	MD	CA				H4							FR														
0.130	135.110	LEN	F	08/11/2009	LMC								SL	B	E	G						H3							FR														
0.420	135.530	LEN	F	08/11/2009	LMC								MS	B	B	B		SX	WP	TO		H3							FR														
0.250	135.780	LEN	F	08/11/2009	LMC								SL	B	E	G		MZ	BN	BU		H3							FR														
0.130	135.910	LEN	F	08/11/2009	LMC								MS	B	B	B		SX	WP	TO		H3							FR														
0.060	135.970	LEN	F	08/11/2009	LMC								SS	A	E	G	FM					H3							FR														
0.080	136.050	LEN	F	08/11/2009	LMC								MS	B	B	B		SX	WP	TO		H3							FR														

LENTON
Lithology Log

Hole LEN241PC

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												Rock Descriptor								Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.130	136.180	LEN	F	08/11/2009	LMC								SL	B	E	G		MZ	BN	TO		H3							FR														
0.170	136.350	LEN	F	08/11/2009	LMC								SS	A	E	G	FM	SX	WP	TO		H3							FR														
0.150	136.500	LEN	F	08/11/2009	LMC								MS	B	B	B		SX	WP	TO		H3							FR														
0.110	136.610	LEN	F	08/11/2009	LMC								SS	A	E	G	FN	MZ	SX	WP		H3							FR														
0.290	136.900	LEN	F	08/11/2009	LMC								MS	B	B	B		SX	WP	BU		H3							FR														
0.090	136.990	LEN	F	08/11/2009	LMC								SL	B	E	G		SZ	LM	TO		H3							FR														
0.270	137.260	LEN	F	08/11/2009	LMC								MS	B	B	B		SX	WP	TO		H3							FR														
0.160	137.420	LEN	F	08/11/2009	LMC								SS	A	E	G	FN	SX	WP	TO		H3							FR														
0.280	137.700	LEN	F	08/11/2009	LMC								MS	B	B	B		SX	BN	MU		H3							FR														
0.170	137.870	LEN	F	08/11/2009	LMC								SL	A	E	G		MZ	TO			H3							FR														
0.390	138.260	LEN	F	08/11/2009	LMC								MS	B	B	B		SX	WP	TO		H3							FR														
0.300	138.560	LEN	F	08/11/2009	LMC								SS	A	E	G	FM	SX	WP	TO		H3							FR														
									EOR 39 DR 4.93 REC 4.93																																		
0.400	138.960	LEN	F	08/11/2009	LMC								MS	B	B	B		SX	WP	TO		H3							FR														
0.950	139.910	LEN	F	08/11/2009	LMC								SL	B	E	G		MZ	TO			H3							FR														
1.320	141.230	LEN	F	08/11/2009	LMC								MS	B	B	B		SX	WP	TO		H3							FR														
0.230	141.460	LEN	F	08/11/2009	LMC								SS	A	E	G	FM	SX	TO			H3							FR														
0.930	142.390	LEN	F	08/11/2009	LMC								MS	B	B	B		SX	TO			H3							FR														
									EOR 40 DR 3.83 REC 3.83																																		
0.240	142.630	LEN	F	08/11/2009	LMC								MS	B	B	B		WI	SX	TO		H3							FR														
0.290	142.920	LEN	F	08/11/2009	LMC								SS	A	E	G	FN	MZ	BN	TO		H3							FR														
1.790	144.710	LEN	F	08/11/2009	LMC								SS	A	E	G	FM	WI	MZ	BN		H3							FR														
0.190	144.900	LEN	F	08/11/2009	LMC								MS	B	B	B		WI	SX	TO		H3							FR														
0.820	145.720	LEN	F	08/11/2009	LMC								SS	A	E	G	MD	SX	LM	TO		H4							FR														
0.460	146.180	LEN	F	08/11/2009	LMC								MS	B	B	B		SX	LM	TO		H3							FR														
1.060	147.240	LEN	F	08/11/2009	LMC								SL	A	E	G		MZ	WP	TO		H3							FR														
0.310	147.550	LEN	F	08/11/2009	LMC								MS	B	B	B		SX	WP	TO		H3							FR														

LENTON
Lithology Log

												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.370	147.920	LEN	F	08/11/2009	LMC								SS	A	E	G	MD	SX	WP	TO		H4							FR														
0.330	148.250	LEN	F	08/11/2009	LMC								MS	B	B	B						H3							FR														
0.140	148.390	LEN	F	08/11/2009	LMC								KL																FR														
									EOR 41 DR 6.00 REC 5.86																																		
0.240	148.630	LEN	F	08/11/2009	LMC								MS	B	B	B						H3							FR														
0.100	148.730	LEN	F	21/11/2009	LMC								MS	B	B	B						H3							FR														
0.510	149.240	LEN	F	21/11/2009	LMC								SL	A	E	G		WI	MZ	TO		H3							FR														
0.270	149.510	LEN	F	21/11/2009	LMC								SS	A	E	G	FN					H3							FR														
0.150	149.660	LEN	F	21/11/2009	LMC								SL	A	E	G						H3							FR														
1.410	151.070	LEN	F	21/11/2009	LMC								SS	A	E	G	FN	MZ	BN	BU		H3							FR														
2.320	153.390	LEN	F	21/11/2009	LMC								SS	A	W	G	MD	SX	ND	BU		H3							FR														
0.610	154.000	LEN	F	21/11/2009	LMC								SS	A	E	G	FN					H4							FR														
0.440	154.440	LEN	F	21/11/2009	LMC								SS	A	E	G	FM					H4							FR														
0.040	154.480	LEN	F	21/11/2009	LMC								MS	B	B	B						H3							FR														
0.140	154.620	LEN	F	21/11/2009	LMC								SL	A	E	G						H3							FR														
0.470	155.090	LEN	F	21/11/2009	LMC								MS	B	B	B		SX	TO			H3							FR														
0.540	155.630	LEN	F	21/11/2009	LMC								SS	A	E	G	FM	SX	LM	MU		H3							FR														
0.080	155.710	LEN	F	21/11/2009	LMC								MS	B	B	B		SX	TO			H3							FR														
0.300	156.010	LEN	F	21/11/2009	LMC								SS	A	E	G	FM					H3							FR														
0.340	156.350	LEN	F	21/11/2009	LMC								SL	A	E	G						H3							FR														
0.190	156.540	LEN	F	21/11/2009	LMC								MS	B	B	B						H3							FR														
0.150	156.690	LEN	F	21/11/2009	LMC								SL	B	E	G		MZ	TO			H3							FR														
0.210	156.900	LEN	F	21/11/2009	LMC								SS	A	E	G	FM					H3							FR														
0.190	157.090	LEN	F	21/11/2009	LMC								SL	B	E	G		MZ	TO			H3							FR														
0.090	157.180	LEN	F	21/11/2009	LMC								SS	A	E	G	FM					H3							FR														
0.550	157.730	LEN	F	21/11/2009	LMC								MS	B	B	B		SX	TO			H3							FR														
0.090	157.820	LEN	F	21/11/2009	LMC								SS	A	E	G	FM					H3							FR														

LENTON
Lithology Log

Hole LEN241PC

												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossil/Minerals Abundance	Fossil/Minerals Type	Fossil/Minerals Association	Sedimentary Relationship	Coal Type
0.220	158.040	LEN	F	21/11/2009	LMC								MS	B	B	B						H3							FR														
									EOR 43 DR 3.56 REC 3.50																																		
0.030	158.070	LEN	F	21/11/2009	LMC								MS	B	B	B						H3							FR														
0.360	158.430	LEN	F	21/11/2009	LMC								SS	A	E	G	FN	MZ	BN	MU		H3							FR														
0.120	158.550	LEN	F	21/11/2009	LMC								SL	A	E	G		MZ	TO			H3							FR														
0.420	158.970	LEN	F	21/11/2009	LMC								MS	B	B	B		SX	BN	BU		H3							FR														
0.260	159.230	LEN	F	21/11/2009	LMC								SS	A	E	G	FM	SX	BN	TO		H3							FR														
0.580	159.810	LEN	F	21/11/2009	LMC								MS	B	B	B		SX	BU			H3							FR														
0.300	160.110	LEN	F	21/11/2009	LMC								SL	A	E	G		MZ	TO			H3							FR														
0.390	160.500	LEN	F	21/11/2009	LMC								MS	B	B	B		SX	ND	TO		H3							FR														
0.280	160.780	LEN	F	21/11/2009	LMC								SL	A	E	G		MZ	TO			H3							FR														
									EOR 44 DR 2.74 REC 2.80																																		
2.060	162.840	LEN	F	21/11/2009	LMC								SS	A	E	G	FM					H3							FR														
0.160	163.000	LEN	F	21/11/2009	LMC								SS	A	E	G	FM					H3							FR														
0.590	163.590	LEN	F	21/11/2009	LMC								MS	B	B	B						H3							FR														
0.270	163.860	LEN	F	21/11/2009	LMC								SL	A	E	G		MZ	TO			H3							FR														
0.540	164.400	LEN	F	21/11/2009	LMC								SL	A	E	G		MZ	BN	MU		H3							FR														
0.280	164.680	LEN	F	21/11/2009	LMC								MS	B	B	B						H3							FR														
0.160	164.840	LEN	F	21/11/2009	LMC								SL	A	E	G		MZ	LM	TO		H3							FR														
0.090	164.930	LEN	F	21/11/2009	LMC								MS	B	B	B						H3							FR														
0.100	165.030	LEN	F	21/11/2009	LMC								KL																FR														
									EOR 45 DR 4.25 REC 4.15																																		
0.300	165.330	LEN	F	01/12/2009	LMC								SS	A	E	G	FM					H3							FR														
0.110	165.440	LEN	F	01/12/2009	LMC								MS	B	B	B						H3							FR														
0.150	165.590	LEN	F	01/12/2009	LMC								SS	A	E	G						H3							FR														
0.170	165.760	LEN	F	01/12/2009	LMC								MS	B	B	B		WI	SZ	TO		H3							FR														
0.680	166.440	LEN	F	01/12/2009	LMC								MS	B	B	B		WI	SX	TO		H3							FR														

LENTON
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Hole LEN241PC

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Disc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Disc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.190	166.630	LEN	F	01/12/2009	LMC								SS	A	E	G						H3							FR														
									EOR 46 DR 1.60 REC 1.60																																		
0.600	167.230	LEN	F	01/12/2009	LMC								SS	A	E	G	FM	WI	MZ	BN		H3							FR														
0.260	167.490	LEN	F	01/12/2009	LMC								MS	B	B	B		SZ	BN	TO		H3							FR														
1.190	168.680	LEN	F	01/12/2009	LMC								SS	A	E	G	FN	WI	SX	BN		H3							FR														
0.270	168.950	LEN	F	01/12/2009	LMC								MS	B	B	B						H3							FR														
0.820	169.770	LEN	F	01/12/2009	LMC								SS	A	E	G	FM					H3							FR														
0.100	169.870	LEN	F	01/12/2009	LMC								MS	B	B	B						H3							FR														
0.450	170.320	LEN	F	01/12/2009	LMC								SS	A	E	G	FN					H3							FR														
0.090	170.410	LEN	F	01/12/2009	LMC								MS	B	B	B						H3							FR														
0.390	170.800	LEN	F	01/12/2009	LMC								SL	A	E	G		WI	SZ	LM		H3							FR														
0.260	171.060	LEN	F	01/12/2009	LMC								MS	B	B	B						H3							FR														
0.550	171.610	LEN	F	01/12/2009	LMC								SS	A	E	G	FM					H3							FR														
0.060	171.670	LEN	F	01/12/2009	LMC								KL																FR														
									EOR 47 DR 5.04 REC 4.98																																		
1.010	172.680	LEN	F	01/12/2009	LMC								SS	A	E	G	FM	MZ	TO			H3							FR														
0.900	173.580	LEN	F	01/12/2009	LMC								SL	A	E	W		MZ	BN	MU		H3							FR														
0.220	173.800	LEN	F	01/12/2009	LMC								MS	A	B	B		WI	SX	LM		H3							FR														
1.180	174.980	LEN	F	01/12/2009	LMC								SL	A	E	W		WI	MZ	LM		H3							FR														
0.950	175.930	LEN	F	01/12/2009	LMC								SL	A	E	G						H3							FR														
									EOR 48+49 DR 4.26 REC 4.26																																		
1.650	177.580	LEN	F	02/12/2009	LMC								SL	A	E	G		WI	LM			H3							FR														
1.810	179.390	LEN	F	02/12/2009	LMC								SL	A	E	G		WI	SZ	LM		H3							FR														
2.170	181.560	LEN	F	02/12/2009	LMC								SS	A	E	G	FM	WI	SX	LM		H3							FR														
									EOR 50 DR 5.70 REC 5.62																																		
2.320	183.880	LEN	F	02/12/2009	LMC								SS	A	W	G	FM	SX	LM	MU		H4							FR														
1.860	185.740	LEN	F	02/12/2009	LMC								SS	A	W	G	CS	CO	GN	MU		H4							FR														

26-Oct-2010 08:41:05

LogCheck Software System

LENTON
Lithology Log

												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossil/Minerals Abundance	Fossil/Minerals Type	Fossil/Minerals Association	Sedimentary Relationship	Coal Type
1.890	187.630	LEN	F	02/12/2009	LMC								SS	A	E	G	FN	WI	SX	LM		H4							FR														
									EOR 51 DR 6.00 REC 6.08																																		
2.800	190.430	LEN	F	02/12/2009	LMC								SS	A	E	G	FM	WI	SX	LM		H4							FR														
0.120	190.550	LEN	F	02/12/2009	LMC								SL	A	W	G						H3							FR														
0.850	191.400	LEN	F	02/12/2009	LMC								SS	A	E	G	FM	WI	SX	ND		H3							FR														
0.100	191.500	LEN	F	02/12/2009	LMC								SL	A	W	G						H3							FR														
0.250	191.750	LEN	F	02/12/2009	LMC								SS	A	E	G	FM					H3							FR														
0.150	191.900	LEN	F	02/12/2009	LMC								SL	A	W	G						H3							FR														
0.330	192.230	LEN	F	02/12/2009	LMC								SS	A	E	G	CS	SX	ND	TO		H3							FR														
0.240	192.470	LEN	F	02/12/2009	LMC								SL	B	E	G		SZ	LM			H3							FR														
1.160	193.630	LEN	F	02/12/2009	LMC								SS	A	E	G	MD	SX	ND	MU		H3							FR														
									EOR 52 DR 6.00 REC 6.00																																		
3.220	196.850	LEN	F	02/12/2009	LMC								SS	A	W	G	FM	CL	BN	MU		H4							FR									0	R	CA	VN		
2.780	199.630	LEN	F	02/12/2009	LMC								SL	B	E	G		SX	WP	TO		H3							FR														
									EOR 53 DR 6.00 REC 6.00																																		
0.300	199.930	LEN	F	02/12/2009	LMC								SL	B	E	G						H3							FR														
0.610	200.540	LEN	F	02/12/2009	LMC								SL	A	W	G		LM				H3							FR														
0.740	201.280	LEN	F	02/12/2009	LMC								MS	B	E	B		WI	SX	TO		H3							FR														
0.300	201.580	LEN	F	02/12/2009	LMC								SL	A	E	G						H3							FR														
0.550	202.130	LEN	F	02/12/2009	LMC								SL	A	W	G						H3							FR														
1.050	203.180	LEN	F	02/12/2009	LMC								SS	A	E	G	MD					H4							FR														
0.130	203.310	LEN	F	02/12/2009	LMC								SL	A	G	G						H3							FR														
0.850	204.160	LEN	F	02/12/2009	LMC								SS	A	W	G	MD					H4							FR														
0.170	204.330	LEN	F	02/12/2009	LMC								SL	B	G	G		SZ	LN	TO		H3							FR														
1.300	205.630	LEN	F	02/12/2009	LMC								SS	A	E	G						H3							FR														
									EOR 54 DR 6.00 REC 6.00																																		
0.720	206.350	LEN	F	02/12/2009	LMC								SL	A	E	G						H3							FR														

LENTON
Lithology Log

Hole LEN241PC

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.310	206.660	LEN	F	02/12/2009	LMC								SL	A	W	G		LM				H3							FR														
0.370	207.030	LEN	F	02/12/2009	LMC								SS	B	G	G						H4							FR														
0.500	207.530	LEN	F	02/12/2009	LMC								SL	A	E	G		SZ	WP	TO		H3							FR														
1.060	208.590	LEN	F	02/12/2009	LMC								SS	A	E	G	FM	SX	WP	TO		H3							FR														
0.370	208.960	LEN	F	02/12/2009	LMC								SL	B	E	G		MZ	TO			H3							FR														
0.490	209.450	LEN	F	02/12/2009	LMC								SS	A	E	G	FN	SX	LM	TO		H3							FR														
0.450	209.900	LEN	F	02/12/2009	LMC								SL	A	W	G		MZ	BU			H2							FR														
0.580	210.480	LEN	F	02/12/2009	LMC								SL	B	G							H3							FR														
0.310	210.790	LEN	F	02/12/2009	LMC								SS	A	E	G	FN					H3							FR														
0.840	211.630	LEN	F	02/12/2009	LMC								SL	A	W	G						H3							FR														
									EOR 55 DR 6.00 REC 6.09																																		
1.200	212.830	LEN	F	02/12/2009	GJC						D		SS	B	E	G	FN	LT	FR		S1	H4							FR						V	M	A	60					
2.090	214.920	LEN	F	02/12/2009	GJC						D		SS	A	E	G	FM	LT			S2	H4							FR														
1.620	216.540	LEN	F	02/12/2009	GJC						D		SL	D	E	G		OC	FE	BZ	S2	H3							FR														
0.690	217.230	LEN	F	02/12/2009	GJC						D		SL	M	R	E		FE	IP		S2	H3							FR														
0.400	217.630	LEN	F	02/12/2009	GJC						D		SL	B	E	G	FN	OC	SS	LM	S1	H3							FR														
0.760	218.390	LEN	F	07/12/2009	GJC						D		SL	B	E	G		OC	SS	LM	S1	H3							FR														
									minor ferruginous blebs																																		
0.050	218.440	LEN	F	07/12/2009	GJC						D		SS	B	E	G	FN	LT			S1	H4							FR														
0.910	219.350	LEN	F	07/12/2009	GJC						D		SL	B	E	G		FE	BZ		S2	H3							FR														
0.110	219.460	LEN	F	07/12/2009	GJC						D		SS	B	E	G	FN	CA	VN	WP	S1	H4							FR														
1.430	220.890	LEN	F	07/12/2009	GJC						D		SL	M	E	G		CM	SS	LM	S1	H3							FR														
0.210	221.100	LEN	F	07/12/2009	GJC						D		SS	A	E	G	FN	SL	BN	BU	S1	H4							FR														
0.450	221.550	LEN	F	07/12/2009	GJC						D		SL	B	E	G		CM	SS	LM	S1	H3							FR														
0.320	221.870	LEN	F	07/12/2009	GJC						D		SS	A	E	G	FN	LT	MN	SX	S1	H4							FR														
									fining upwards																																		
0.180	222.050	LEN	F	07/12/2009	GJC						D		SL	M	R	E		FE	TO		S1	H3							FR														

												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.300	222.350	LEN	F	07/12/2009	GJC						D		SL	B	E	G		SS	IP		S2	H3							FR														
1.020	223.370	LEN	F	07/12/2009	GJC						D		SS	M	E	G	FM	LT			S2	H4							FR														
									fining upwards																																		
0.070	223.440	LEN	F	07/12/2009	GJC						D		SL	M	E	G		MN	FE	ST	S2	H3							FR														
0.050	223.490	LEN	F	07/12/2009	GJC						D		KL																FR														
0.140	223.630	LEN	F	07/12/2009	GJC						D		SL	B	E	G					S2	H3							FR														
									recovered																																		
0.340	223.970	LEN	F	07/12/2009	GJC						D		SL	B	E	G		FE	MZ	BZ	S1	H3							FR														
1.110	225.080	LEN	F	07/12/2009	GJC						D		SL	M	E	G		SS	BN	TO	S1	H3							FR														
0.080	225.160	LEN	F	07/12/2009	GJC						D		SL	M	E	G					S3	H2							FR														
0.170	225.330	LEN	F	07/12/2009	GJC						D		SL	M	R	E		FE	MZ		S2	H3							FR														
1.770	227.100	LEN	F	07/12/2009	GJC						D		SL	M	R	E		FE	IP		S1	H3							FR														
0.030	227.130	LEN	F	07/12/2009	GJC						D		MS	D	B	R		FE			S1	H3							FR														
0.250	227.380	LEN	F	07/12/2009	GJC						D		SL	B	E	G		FE	BZ		S1	H3							FR														
0.750	228.130	LEN	F	07/12/2009	GJC						D		MS	D	B	R		FE	SL	PA	S1	H3							FR														
0.560	228.690	LEN	F	07/12/2009	GJC						D		SS	V	E	G	VF	SL	BN		S1	H4							FR										R	CA	VN		
0.340	229.030	LEN	F	07/12/2009	GJC						D		SL	D	E	G		FE	MZ	BZ	S1	H3							FR														
0.300	229.330	LEN	F	07/12/2009	GJC						D		MS	D	B	R		FE			S2	H2							FR										R	CA	VN		
0.300	229.630	LEN	F	07/12/2009	GJC						D		SL	B	E	G		FE	MZ	TU	S1	H3							FR														
0.330	229.960	LEN	F	07/12/2009	GJC						D		MS	D	B	R		FE	SL	IP	S1	H3							FR														
0.150	230.110	LEN	F	07/12/2009	GJC						D		SL	B	E	G		FE	MZ	BZ	S1	H3							FR														
0.030	230.140	LEN	F	07/12/2009	GJC						D		MS	D	B	R		FE			S1	H3							FR														
									sharp/wavy base																																		
0.460	230.600	LEN	F	07/12/2009	GJC						D		SS	B	E	G	FV	SL	LM		S1	H3							FR														
0.190	230.790	LEN	F	07/12/2009	GJC						D		MS	D	B	R		FE	ET	SL	S2	H3							FR														
									fretting slighty at top - drilling induced																																		
0.440	231.230	LEN	F	07/12/2009	GJC						D		SL	B	E	G		CM	SS	BN	S1	H3							FR														

LENTON
Lithology Log

Hole LEN241PC

												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossil/Minerals Abundance	Fossil/Minerals Type	Fossil/Minerals Association	Sedimentary Relationship	Coal Type
									lithic sandstone																																		
0.210	231.440	LEN	F	07/12/2009	GJC						D		MS	D	B	R		SL	BU		S1	H3							FR														
0.280	231.720	LEN	F	07/12/2009	GJC						D		SL	B	E	G		MN	SS	LM	S1	H3							FR														
									mudstone at base of unit																																		
0.170	231.890	LEN	F	07/12/2009	GJC						D		MS	D	B	R		SL			S1	H3							FR		F												
0.120	232.010	LEN	F	07/12/2009	GJC						D		SL	B	E	G					S1	H3							FR														
0.500	232.510	LEN	F	07/12/2009	GJC						D		SS	A	E	G	FN	LT			S1	H4							FR														
0.170	232.680	LEN	F	07/12/2009	GJC						D		SL	B	E	G		TH	SS	BN	S1	H3							FR														
0.180	232.860	LEN	F	07/12/2009	GJC						D		MS	D	B	R		SL	BU		S2	H2							FR		F												
0.110	232.970	LEN	F	07/12/2009	GJC						D		SL	B	E	G					S1	H3							FR														
0.310	233.280	LEN	F	07/12/2009	GJC						D		SL	B	E	G		CM	SS	BN	S1	H3							FR														
0.830	234.110	LEN	F	07/12/2009	GJC						D		SL	M	R	E		CM	FE	MZ	S2	H3							FR										M	CA	VN		
0.750	234.860	LEN	F	07/12/2009	GJC						D		SS	M	E	G	FN	CM	SX	BN	S1	H3							FR														
0.670	235.530	LEN	F	07/12/2009	GJC						D		SL	M	R	E		MZ	BZ	MU	S1	H3							FR														
0.100	235.630	LEN	F	07/12/2009	GJC						D		SS	A	E	G	FV				S1	H4							FR														
0.490	236.120	LEN	F	08/12/2009	GJC						D		SL	B	E	G		MN	SS	LM	S1	H3							FR														
0.280	236.400	LEN	F	08/12/2009	GJC						D		SL	M	R	E		FE	MZ	BZ	S2	H3							FR														
									calcite vein middle of unit																																		
1.090	237.490	LEN	F	08/12/2009	GJC						D		SL	B	E	G		OC	SZ	BN	S1	H3							FR														
0.060	237.550	LEN	F	08/12/2009	GJC						D		SL	M	E	G		CA	CE		S1	H3							FR								B		A	CA	SR	TO	
									Base of Triassic..?																																		
0.400	237.950	LEN	F	08/12/2009	GJC						D		SS	B		G	FN	LT			S1	H4							FR														
									silty bands																																		
0.300	238.250	LEN	F	08/12/2009	GJC						D		SL	D		G					S2	H3							FR										R	CA	BN		
3.380	241.630	LEN	F	08/12/2009	GJC						D		SS	A		G	FM	LT			S2	H3							FR										M	CA	BN		
									with cross bedding and fining upward phases																																		
0.600	242.230	LEN	F	08/12/2009	GJC						D		SS	B		G	MD				S2	H3							FR										A	CA	VN		

												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossil/Minerals Abundance	Fossil/Minerals Type	Fossil/Minerals Association	Sedimentary Relationship	Coal Type
									rare silty pods																																		
0.080	242.310	LEN	F	08/12/2009	GJC						D		SS	V		G	MD	LI			S2	H3							FR								B						
									coarse grained calcite infilling fracture																																		
2.330	244.640	LEN	F	08/12/2009	GJC						D		SS	B		G	FM	LI	SL	PO	S2	H4							FR														
0.410	245.050	LEN	F	08/12/2009	GJC						D		SL	D		G					S1	H3							FR														
0.070	245.120	LEN	F	08/12/2009	GJC						D		SL	D	K	G		LI			S1	H4							FR														
									? - harder and darker than other siltstone bands																																		
2.300	247.420	LEN	F	08/12/2009	GJC						D		SL	V	E	G		RA	MZ	BZ	S1	H3							FR														
0.210	247.630	LEN	F	08/12/2009	GJC						D		SS	B		G	FV	SL	BN		S1	H4							FR														
1.140	248.770	LEN	F	08/12/2009	GJC						D		SL	B		G		OC	SZ	BN	S1	H3							FR										M	CA	BN		
									slight greenish hue																																		
0.580	249.350	LEN	F	08/12/2009	GJC						D		SS	B		G	FV	CM	SX	BN	S1	H4							FR														
0.150	249.500	LEN	F	08/12/2009	GJC						D		SS	B		G	FN				S1	H4							FR														
0.170	249.670	LEN	F	08/12/2009	GJC						D		SL	B		G		RA	CA	BN	S2	H3							FR														
1.540	251.210	LEN	F	08/12/2009	GJC						D		SS	B		G	FM	LI			S2	H3							FR										C	CA	VN		
									fining upwards																																		
0.080	251.290	LEN	F	08/12/2009	GJC						D		SL	D		G		CA	BN		S2	H3							FR														
0.430	251.720	LEN	F	08/12/2009	GJC						D		SS	B		G	MD				S2	H3							FR														
									coarse grained calcite vein - infilling filling fracture																																		
0.200	251.920	LEN	F	08/12/2009	GJC						D		SL	D		G		SS	PO		S2	H3							FR														
									soft sediment deformation																																		
0.450	252.370	LEN	F	08/12/2009	GJC						D		SS	B		G	FM	SL	BN	MU	S1	H3							FR										C	CA	VN		
0.120	252.490	LEN	F	08/12/2009	GJC						D		SL	D		G		CM	SZ	BN	S1	H3							FR														
0.060	252.550	LEN	F	08/12/2009	GJC						D		SS	B		G	FN				S1	H4							FR														
0.420	252.970	LEN	F	08/12/2009	GJC						D		SL	B	E	G					S1	H4							FR										R	CA	BN		
									glauconitic inpart?																																		
0.660	253.630	LEN	F	08/12/2009	GJC						D		SS	B		G	FN	OC	SX	BN	S1	H4							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.560	254.190	LEN	F	08/12/2009	GJC						D		SL	V	E	G		CM	LM		S1	H3							FR										R	CA	BN		
									rare siderite nodules																																		
0.030	254.220	LEN	F	08/12/2009	GJC						D		SL	M	K	G		CS	FR	TO	S1	H3							FR														
0.150	254.370	LEN	F	08/12/2009	GJC						D		SS	B		G	FV	MN	SX	LM	S1	H4							FR														
0.380	254.750	LEN	F	08/12/2009	GJC						D		SL	B	E	G		SS	TU		S1	H3							FR														
									thin bands of silty pods, near top of unit																																		
0.180	254.930	LEN	F	08/12/2009	GJC						D		SS	A	E	G	FV				S2	H3							FR								B						
									fine calcite stringers/veins																																		
0.910	255.840	LEN	F	08/12/2009	GJC						D		SL	B	E	G		LI	BZ		S2	H3							FR										C	CA	IF		
2.320	258.160	LEN	F	08/12/2009	GJC						D		SS	A		G	FM	SL	TU	LT	S1	H4							FR														
									limonitic pods																																		
0.110	258.270	LEN	F	08/12/2009	GJC						D		SS	B		G	MD	SD			S2	H5							FR														
1.360	259.630	LEN	F	08/12/2009	GJC						D		SS	A		G	FM	LT	SD	BZ	S1	H4							FR														
2.700	262.330	LEN	F	08/12/2009	GJC						D		SS	A		G	CS	LT			S1	H4							FR										C	CA	BN		
									coarse grained calcite																																		
0.290	262.620	LEN	F	08/12/2009	GJC						D		SS	A		G	FM				S1	H4							FR														
0.030	262.650	LEN	F	08/12/2009	GJC						D		SL	D		G		LM			S2	H3							FR														
1.070	263.720	LEN	F	08/12/2009	GJC						D		SS	A		G	MC	LT			S1	H4							FR														
									fining upwards, silty pods top of unit																																		
1.910	265.630	LEN	F	08/12/2009	GJC						D		SL	V	E	G		CM	LM		S2	H3							FR								B		M	CA	VN		
									brittle																																		
0.550	266.180	LEN	F	08/12/2009	GJC						D		SL	B	E	G		OC	CA	WP	S1	H3							FR														
0.410	266.590	LEN	F	08/12/2009	GJC						D		SL	V	E	G		CM	SS	BN	S1	H3							FR														
0.240	266.830	LEN	F	08/12/2009	GJC						D		SL	B	E	G		LM	SD	BZ	S1	H4							FR														
0.050	266.880	LEN	F	08/12/2009	GJC						D		SS	M		G	FN				S1	H4							FR														
0.600	267.480	LEN	F	08/12/2009	GJC						D		SL	B		G		SS	IP		S1	H3							FR										C	CA	VN		
									sideritic nodules base of unit																																		

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossil/Mineral Abundance	Fossil/Mineral Type	Fossil/Mineral Association	Sedimentary Relationship	Coal Type
0.140	267.620	LEN	F	08/12/2009	GJC						D		SS	B		G	FN	SD	ND		S1	H3							FR														
0.580	268.200	LEN	F	08/12/2009	GJC						D		SL	V	E	G					S2	H2							FR										A	CA	VN		
									coarse calcite infill																																		
0.030	268.230	LEN	F	08/12/2009	GJC						D		SS	B		G	FV				S1	H3							FR														
3.140	271.370	LEN	F	08/12/2009	GJC						D		SL	V		G		OC	LM		S2	H3							FR														
									brecciated inpart with calcite infill																																		
0.260	271.630	LEN	F	08/12/2009	GJC						D		SS	A		G	FM				S1	H4							FR														
		LEN	F	08/12/2009	GJC						D																		FR														
0.630	272.260	LEN	F	08/12/2009	GJC						D		SS	A		G	FN				S1	H4							FR										S	CA	VN		
1.370	273.630	LEN	F	08/12/2009	GJC						D		SS	A		G	MD	LT			S2	H4							FR										C	CA	VN		
									rare silty pods																																		
1.100	274.730	LEN	F	08/12/2009	GJC						D		SS	A		G	MD	LT			S2	H3							FR										A	CA	IF		
									calcite infilled joints																																		
0.380	275.110	LEN	F	08/12/2009	GJC						D		SS	V		G	CS	OC	SL	PO	S1	H4							FR														
0.580	275.690	LEN	F	08/12/2009	GJC						D		SS	A		G	FM	OC	SL	LM	S2	H3							FR														
0.440	276.130	LEN	F	08/12/2009	GJC						D		SS	A		G	MD	SX	BZ	TO	S1	H4							FR														
									coaly lenses middle of unit																																		
1.450	277.580	LEN	F	08/12/2009	GJC						D		SS	A		G	FM	OC	SZ	BZ	S2	H4							FR														
0.050	277.630	LEN	F	08/12/2009	GJC						D		SL	B	N	G					S1	H3							FR														
		LEN	F	08/12/2009	GJC						D																		FR														
0.170	277.800	LEN	F	08/12/2009	GJC						D		SL	B	E	G		CM	CS	FR	S1	H3							FR														
									limonitic fragments																																		
1.260	279.060	LEN	F	08/12/2009	GJC						D		SL	B	E	G		SP	BZ		S2	H3							FR														
									sandy bands base of unit																																		
0.360	279.420	LEN	F	08/12/2009	GJC						D		SS	V		G	FM	SL	FR	TU	S1	H3							FR														
									coarser towards top of unit																																		
0.080	279.500	LEN	F	08/12/2009	GJC						D		SL	B	E	G					S2	H3							FR								B						

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossil/Minerals Abundance	Fossil/Minerals Type	Fossil/Minerals Association	Sedimentary Relationship	Coal Type
									with calcite infilling veins/stringers																																		
0.270	279.770	LEN	F	08/12/2009	GJC						D		SS	V		G	FN	CM	SX	LM	S1	H4							FR														
0.890	280.660	LEN	F	08/12/2009	GJC						D		SL	D		G		CM	SZ	BN	S1	H3							FR														
									laminated inpart																																		
0.200	280.860	LEN	F	08/12/2009	GJC						D		SS	B		G	FN	CM	LM		S2	H3							FR														
									calcite band middle of unit																																		
1.260	282.120	LEN	F	08/12/2009	GJC						D		SL	B		G		CM	SZ	BN	S1	H4							FR														
									laminated																																		
0.190	282.310	LEN	F	08/12/2009	GJC						D		SS	A		G	FN	SL	BZ	MU	S1	H4							FR														
									siltstone band middle of unit																																		
0.480	282.790	LEN	F	08/12/2009	GJC						D		SL	D		G					S2	H3							FR														
									Brecciated @ 281.4 with common calcite infill/veining																																		
0.650	283.440	LEN	F	08/12/2009	GJC						D		SS	B		G	FN	AB	SX	BN	S1	H3							FR														
0.060	283.500	LEN	F	08/12/2009	GJC						D		SS	B		G	CS	LT			S1	H3							FR														
0.130	283.630	LEN	F	08/12/2009	GJC						D		SS	B		G	MD	SL	IP		S1	H3							FR														
		LEN	F	08/12/2009	GJC						D																		FR														
0.940	284.570	LEN	F	08/12/2009	GJC						D		SS	V		G	CS	OC	SL	PO	S1	H4							FR														
									wavy base																																		
0.370	284.940	LEN	F	08/12/2009	GJC						D		SL	B		G					S2	H3							FR														
0.040	284.980	LEN	F	08/12/2009	GJC						D		SS	A		G	FN				S1	H4							FR														
0.400	285.380	LEN	F	08/12/2009	GJC						D		SL	B	N	G					S1	H3							FR														
2.090	287.470	LEN	F	08/12/2009	GJC						D		SL	B	E	G		OC	LM		S1	H3							FR										M	CA	WP		
0.260	287.730	LEN	F	08/12/2009	GJC						D		SS	B	E	G	FV				S1	H4							FR														
0.420	288.150	LEN	F	08/12/2009	GJC						D		SS	B		G					S1	H4							FR														
1.480	289.630	LEN	F	08/12/2009	GJC						D		SL	B		G		CM	SL	LM	S1	H3							FR														
									calcite veining throughout																																		
0.230	289.860	LEN	F	09/12/2009	GJC						D		SL	B	E	G		CS	BN	MU	S1	H3							FR														

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LogCheck Software System

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.200	290.060	LEN	F	09/12/2009	GJC						D		SL	B		G		CS	WP	BZ	S1	H3							FR										C	CA	VN		
									fractures infilling with calcite																																		
0.540	290.600	LEN	F	09/12/2009	GJC						D		SS	B		G	FN	CM	SX	BN	S2	H3							FR										C	CA	VN		
0.380	290.980	LEN	F	09/12/2009	GJC						D		SL	D		G		MN	LM		S2	H3							FR						F				C	CA	VN		
0.190	291.170	LEN	F	09/12/2009	GJC						D		SL	B		G					S2	H2							FR														
									Mixed with unit above/sheared inpart																																		
0.440	291.610	LEN	F	09/12/2009	GJC						D		SS	A		G	FM				S2	H3							FR						F				M	CA	VN		
									faulting at base of unit																																		
0.180	291.790	LEN	F	09/12/2009	GJC						D		SL	D		G		CM	LM		S2	H3							FR														
0.310	292.100	LEN	F	09/12/2009	GJC						D		SL	V		G		CS	FR		S2	H3							FR														
									with bioturbation?																																		
2.510	294.610	LEN	F	09/12/2009	GJC						D		SS	A		G	MD				S2	H4							FR														
									fining upwards																																		
0.780	295.390	LEN	F	09/12/2009	GJC						D		SL	D	N	G		LI	ND	MU	S2	H3							FR														
0.240	295.630	LEN	F	09/12/2009	GJC						D		SL	B	N	G		CS	ST		S2	H3							FR														
		LEN	F	09/12/2009	GJC						D																		FR														
0.230	295.860	LEN	F	09/12/2009	GJC						D		SL	B	E	G					S2	H3							FR														
									coarse calcite infilling rare veins																																		
0.090	295.950	LEN	F	09/12/2009	GJC						D		SS	B		G	FV				S1	H4							FR														
1.900	297.850	LEN	F	09/12/2009	GJC						D		SL	V	E	G		OC	CS	FR	S1	H3							FR														
									Limonitic staining, Sandy at base of unit																																		
1.380	299.230	LEN	F	09/12/2009	GJC						D		SS	B		G	FV	TH	BN	SX	S1	H4							FR														
									gradational																																		
0.550	299.780	LEN	F	09/12/2009	GJC						D		SL	D		G		CM	SZ	BN	S2	H3							FR										M	CA	VN		
0.180	299.960	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	MN	SX	LN	S1	H3							FR														
									carbonaceous inpart																																		
0.070	300.030	LEN	F	09/12/2009	GJC						D		SL	D		G		SZ	MU		S2	H3							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossil/Mineral Abundance	Fossil/Mineral Type	Fossil/Mineral Association	Sedimentary Relationship	Coal Type
1.600	301.630	LEN	F	09/12/2009	GJC						D		SS	A		G	MC	OC	SL	PO	S1	H4							FR														
		LEN	F	09/12/2009	GJC						D																		FR														
0.110	301.740	LEN	F	09/12/2009	GJC						D		SS	A		G	CS	MN	SL	PO	S1	H4							FR														
0.430	302.170	LEN	F	09/12/2009	GJC						D		SL	D	N	G		CS	WP	TU	S2	H3							FR														
									common fractures																																		
0.520	302.690	LEN	F	09/12/2009	GJC						D		SL	M	E	G		LI	BZ	BU	S1	H3							FR														
									carby middle of unit																																		
0.130	302.820	LEN	F	09/12/2009	GJC						D		SS	B		G	FV				S1	H3							FR														
0.320	303.140	LEN	F	09/12/2009	GJC						D		SS	B	E	G	FN				S1	H4							FR														
1.080	304.220	LEN	F	09/12/2009	GJC						D		SL	V	E	G		LI	CS	WP	S1	H3							FR														
									gradational lower contact																																		
1.150	305.370	LEN	F	09/12/2009	GJC						D		SS	A		G	FM	RA	CS	LN	S1	H4							FR														
0.390	305.760	LEN	F	09/12/2009	GJC						D		SS	A		G	FM	CM	SX	BN	S1	H3							FR														
									and laminations																																		
0.480	306.240	LEN	F	09/12/2009	GJC						D		SL	D		G		CM	SZ	LM	S2	H3							FR										R	CA	BN		
									with cross bedding top of unit																																		
0.390	306.630	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	SP	SX	LM	S2	H4							FR														
5.030	311.660	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	SP	SX	LM	S2	H4							FR														
									rare coaly stringers																																		
0.790	312.450	LEN	F	09/12/2009	GJC						D		CS	V	N	G		SL			PU	H2							FR														
									swelling clays - accounts for exp in core recovery																																		
0.330	312.780	LEN	F	09/12/2009	GJC						D		SL	D		G					S1	H3							FR														
0.850	313.630	LEN	F	09/12/2009	GJC						D		SS	A		G	FM	SX	LM	TU	S1	H4							FR														
		LEN	F	09/12/2009	GJC						D																		FR														
1.220	314.850	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	OC	SX	LM	S1	H4							FR										R	CA	VN		
0.110	314.960	LEN	F	09/12/2009	GJC						D		SL	D		G		CS	IP		S2	H3							FR														
0.370	315.330	LEN	F	09/12/2009	GJC						D		SL	B		G		CS	BZ		S1	H4							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossil/Minerals Abundance	Fossil/Minerals Type	Fossil/Minerals Association	Sedimentary Relationship	Coal Type
limonitic fragments																																											
0.360	315.690	LEN	F	09/12/2009	GJC						D		SS	B		G	FV	OC	SX	BN	S1	H4							FR														
soft sediment deformation, rip up clasts																																											
0.250	315.940	LEN	F	09/12/2009	GJC						D		SL	D	N	G		LM			S1	H4							FR														
0.490	316.430	LEN	F	09/12/2009	GJC						D		SS	V	F	G	FN	SL	IP		S2	H4							FR														
0.240	316.670	LEN	F	09/12/2009	GJC						D		SL	V		G		SS	BN	MU	S1	H3							FR														
soft sediment deformation, rip up clasts																																											
0.320	316.990	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	SL	LM	TU	S1	H4							FR														
0.050	317.040	LEN	F	09/12/2009	GJC						D		SL	D		G		SH			S1	H3							FR														
0.220	317.260	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	LT	SL	PO	S1	H4							FR														
0.120	317.380	LEN	F	09/12/2009	GJC						D		SL	B		G		SS	IP	SH	S1	H3							FR														
Calcite band base of unit																																											
0.230	317.610	LEN	F	09/12/2009	GJC						D		SL	B	N	G		CS	WP	TU	S2	H2							FR														
0.340	317.950	LEN	F	09/12/2009	GJC						D		SS	B		G	FN	MN	SX	LM	S1	H4							FR														
0.460	318.410	LEN	F	09/12/2009	GJC						D		SL	B	E	G		LM			S1	H3							FR														
1.060	319.470	LEN	F	09/12/2009	GJC						D		SL	M		G		SH			PU	H2							FR														
0.120	319.590	LEN	F	09/12/2009	GJC						D		KL																FR														
0.350	319.940	LEN	F	09/12/2009	GJC						D		SS	B	E	G	FN	SL	IP		S2	H3							FR														
4cm recovery from previous run																																											
0.230	320.170	LEN	F	09/12/2009	GJC						D		SL	B	E	G		CS	FR	PO	S2	H3							FR														
0.310	320.480	LEN	F	09/12/2009	GJC						D		SS	A	N	G	FN	SL	BU		S2	H3							FR										R	CA	LN		
0.310	320.790	LEN	F	09/12/2009	GJC						D		SS	V		G	FV				S3	H2							FR								B						
very coarse calcite infill - veining and bands																																											
0.080	320.870	LEN	F	09/12/2009	GJC						D		SS	B	N	G	FN				S1	H3							FR														
Pervasive calcite fragments disseminated throughout																																											
1.660	322.530	LEN	F	09/12/2009	GJC						D		SS	V		G	FN	MN	SL	LM	S1	H4							FR														
Limonitic fragments																																											

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.440	322.970	LEN	F	09/12/2009	GJC						D		SS	B		G	FN	CM	SL	LM	S2	H3							FR														
0.360	323.330	LEN	F	09/12/2009	GJC						D		SS	B		G	FM	AB	SX	LM	S2	H3							FR										M	CA	VN		
0.670	324.000	LEN	F	09/12/2009	GJC						D		SS	A		G	MC	SL	LM	TU	S2	H3							FR														
									silty pods base of unit																																		
0.830	324.830	LEN	F	09/12/2009	GJC						D		SL	B	N	G		CS	FR	TO	S2	H3							FR														
0.430	325.260	LEN	F	09/12/2009	GJC						D		SL	B	N	G		SD			S1	H4							FR														
0.300	325.560	LEN	F	09/12/2009	GJC						D		SL	B		G		OC	LM		S2	H3							FR														
0.070	325.630	LEN	F	09/12/2009	GJC						D		KL																FR														
1.300	326.930	LEN	F	09/12/2009	GJC						D		SL	B	E	G		SS	BN	TO	S2	H3							FR														
									rare sideritic nodules																																		
1.100	328.030	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	CM	SL	LM	S1	H4							FR														
									minor cross bedding																																		
0.160	328.190	LEN	F	09/12/2009	GJC						D		SL	B	N	G		CS	WP		S2	H2							FR														
0.230	328.420	LEN	F	09/12/2009	GJC						D		SS	B	N	G	FN	SL	TO		S1	H3							FR														
0.290	328.710	LEN	F	09/12/2009	GJC						D		SL	V	N	G		CS	TU		S2	H2							FR										R	CA	BN		
									faulted middle of unit and at the base																																		
0.730	329.440	LEN	F	09/12/2009	GJC						D		SS	B		G	FV	CM	SS	LM	S1	H3							FR														
									limonitic blebs																																		
0.120	329.560	LEN	F	09/12/2009	GJC						D		SS	A		G	FN				S1	H4							FR														
0.180	329.740	LEN	F	09/12/2009	GJC						D		SH	V	K	G		SS	ET	SL	S1	H3							FR														
0.450	330.190	LEN	F	09/12/2009	GJC						D		SS	A		G	MC	SL	LM	TO	S1	H3							FR														
0.220	330.410	LEN	F	09/12/2009	GJC						D		SL	D		G		SS	IP		S1	H3							FR														
1.220	331.630	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	CM	SL	PO	S2	H4							FR										M	CA	VN		
									with carbonaceous lenses																																		
		LEN	F	09/12/2009	GJC						D																		FR														
2.780	334.410	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	OC	CO	LM	S1	H4							FR														
									Carbonaceous laminations widely spaced.																																		

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossil/Minerals Abundance	Fossil/Minerals Type	Fossil/Minerals Association	Sedimentary Relationship	Coal Type
0.200	334.610	LEN	F	09/12/2009	GJC						D		SL	D		G		MD	CS	IP	S2	H2							FR										M	CA	VN		
0.120	334.730	LEN	F	09/12/2009	GJC						D		SL	B	N	G		CS	WP		S2	H4							FR										C	CA	IF		
0.290	335.020	LEN	F	09/12/2009	GJC						D		SS	B		G	FV	SL	LM		S1	H4							FR														
0.080	335.100	LEN	F	09/12/2009	GJC						D		SL	B	N	G		ST			S1	H4							FR														
0.450	335.550	LEN	F	09/12/2009	GJC						D		SS	B		G	FV	SL	BN	TO	S1	H4							FR														
0.330	335.880	LEN	F	09/12/2009	GJC						D		SL	D		G		CS	ST		S2	H3							FR														
0.320	336.200	LEN	F	09/12/2009	GJC						D		SL	D		G		MD	IP		S2	H2							FR														
									Fretted																																		
0.430	336.630	LEN	F	09/12/2009	GJC						D		SL	B		G		SS	BN	TO	S1	H3							FR														
0.250	336.880	LEN	F	09/12/2009	GJC						D		SS	A		G	FM				S2	H3							FR														
									faulted at base of unit																																		
0.790	337.670	LEN	F	09/12/2009	GJC						D		SL	V		G		SS	IP		S2	H3							FR														
		LEN	F	09/12/2009	GJC						D																		FR														
2.420	340.090	LEN	F	09/12/2009	GJC						D		SL	V		G		CM	SS	BN	S1	H3							FR														
									Common carbonaceous whisps																																		
0.530	340.620	LEN	F	09/12/2009	GJC						D		SS	B		G	FN	CM	SL	BZ	S1	H3							FR										M	CA	VN		
0.150	340.770	LEN	F	09/12/2009	GJC						D		SL	D		G		LM			S1	H3							FR														
0.870	341.640	LEN	F	09/12/2009	GJC						D		SS	B		G	FV	CS	WP	BU	S1	H3							FR														
									limonitic base of unit																																		
2.030	343.670	LEN	F	09/12/2009	GJC						D		SS	A		G	MC	SL	BN	TU	S1	H4							FR										R	CA	VN		
		LEN	F	09/12/2009	GJC						D																		FR														
1.820	345.490	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	OC	SS	LM	S1	H4							FR														
									lithic, minor quartz																																		
0.100	345.590	LEN	F	09/12/2009	GJC						D		SS	V		G	FM	CO	LN	MU	S1	H3							FR														
									silty inpart																																		
1.040	346.630	LEN	F	09/12/2009	GJC						D		SL	D		G		OC	LM		S2	H2							FR														
									Abundant Calcite veins and lenses																																		

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Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength
0.400	347.030	LEN	F	09/12/2009	GJC						D		SS	B		G	FN	OC	SX	BN	S2	H3
0.670	347.700	LEN	F	09/12/2009	GJC						D		SL	D		G					S2	H2
									brecciated shear zone with coarse calcite infill													
0.140	347.840	LEN	F	09/12/2009	GJC						D		SS	B		G	FV	SL	IP		S1	H2
									common calcite stringers													
0.270	348.110	LEN	F	09/12/2009	GJC						D		SL	D		G		AB	CA	BN	S2	H2
									common calcite stringers													
0.020	348.130	LEN	F	09/12/2009	GJC						D		CA			W					S2	H1
0.860	348.990	LEN	F	09/12/2009	GJC						D		SL	D		G		AB	CA	BN	S2	H2
									common calcite stringers													
0.280	349.270	LEN	F	09/12/2009	GJC						D		SS	B	E	G	FN				S2	H3
0.400	349.670	LEN	F	09/12/2009	GJC						D		SL	D		G					S2	H2
									calcite veining top of unit													
		LEN	F	09/12/2009	GJC						D											
0.090	349.760	LEN	F	09/12/2009	GJC						D		SL	D		G		CS	FR	TO	S2	H2
									Divaricating Calcite band													
0.230	349.990	LEN	F	09/12/2009	GJC						D		SL	B	N	G		CS	ST		S1	H3
0.050	350.040	LEN	F	09/12/2009	GJC						D		SL	D		G					S1	H3
									Divaricating Calcite band top of unit													
0.180	350.220	LEN	F	09/12/2009	GJC						D		SS	B		G	FN	CM	SL	BN	S1	H3
0.330	350.550	LEN	F	09/12/2009	GJC						D		SL	D		G		SS	BN		S1	H2
0.430	350.980	LEN	F	09/12/2009	GJC						D		SS	B	E	G	FM	CM	SL	BN	S1	H3
									fining upwards, faulted at base													
1.730	352.710	LEN	F	09/12/2009	GJC						D		SL	V		G		MN	CS	WP	S2	H2
0.690	353.400	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	SL	BU		S1	H3
									Coarse calcite infilling fractures base of unit													
0.180	353.580	LEN	F	09/12/2009	GJC						D		SL	D		G					S2	H2

Interval Base Depth	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc	Tectonic Structure Dip	Fossil/Mineral Abundance	Fossil/Mineral Type	Fossil/Mineral Association	Sedimentary Relationship	Coal Type
347.030							FR														
347.700							FR														
347.840							FR														
348.110							FR														
348.130							FR			45											
348.990							FR														
349.270							FR										M	CA	VN		
349.670							FR														
							FR														
349.760							FR										M	CA	BN		
349.990							FR														
350.040							FR										C	CA	BN		
350.220							FR														
350.550							FR														
350.980							FR										C	CA	VN		
352.710							FR								B		C	CA	IF		
353.400							FR														
353.580							FR										C	CA	VN		

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.070	353.650	LEN	F	09/12/2009	GJC						D		SS	B		G	MD				S1	H3							FR										A	CA	VN		
0.300	353.950	LEN	F	09/12/2009	GJC						D		SL	D		G					S2	H2							FR										A	CA	IF		
									numerous fractures																																			
0.150	354.100	LEN	F	09/12/2009	GJC						D		SS	B		G	MD				S1	H3							FR														
									faulted at base																																			
0.040	354.140	LEN	F	09/12/2009	GJC						D		CA			W					S1	H1							FR														
									fault plane?																																			
0.210	354.350	LEN	F	09/12/2009	GJC						D		SL	D		G					S2	H2							FR										A	CA	VN		
0.150	354.500	LEN	F	09/12/2009	GJC						D		SS	A		G	FM				S2	H3							FR										A	CA	VN		
0.260	354.760	LEN	F	09/12/2009	GJC						D		SL	D		G		LM			S1	H3							FR														
0.270	355.030	LEN	F	09/12/2009	GJC						D		SS	B		G	FM				S1	H3							FR														
0.640	355.670	LEN	F	09/12/2009	GJC						D		SL	D	N	G		WI	SS	BN	S3	H2							FR										C	CA	VN		
		LEN	F	09/12/2009	GJC						D																			FR														
0.930	356.600	LEN	F	09/12/2009	GJC						D		SS	A		G	FM	CM	LM		S2	H3							FR										M	CA	VN		
0.170	356.770	LEN	F	09/12/2009	GJC						D		SS	A		G	FM	SL	LM	TU	S1	H3							FR														
									fining upwards																																			
0.170	356.940	LEN	F	09/12/2009	GJC						D		SS	B		G	FN	CM	SS	LM	S2	H3							FR														
1.860	358.800	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	OC	SL	PO	S1	H4							FR										M	CA	VN		
									with carbonaceous laminations																																			
0.170	358.970	LEN	F	09/12/2009	GJC						D		SL	D		G		SS	BN	TO	S1	H3							FR														
0.140	359.110	LEN	F	09/12/2009	GJC						D		SS	B		G	MC	LT	CA	CE	S1	H4							FR														
0.250	359.360	LEN	F	09/12/2009	GJC						D		SL	D		G		CM	SZ	BN	S1	H3							FR										M	CA	BU		
									with carbonaceous laminations																																			
0.270	359.630	LEN	F	09/12/2009	GJC						D		SS	B		G	FN	AB	CS	LM	S2	H3							FR														
1.490	361.120	LEN	F	09/12/2009	GJC						D		SL	V		G		CS	IP		S2	H2							FR										M	CA	IF		
0.550	361.670	LEN	F	09/12/2009	GJC						D		SL	B	N	G		RA	SD	ND	S1	H3							FR														
									recovered																																			

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.040	361.710	LEN	F	09/12/2009	GJC						D		SL	B		G					S1	H3							FR														
0.360	362.070	LEN	F	09/12/2009	GJC						D		SS	B		G	FM	SX	BN	TO	S2	H3							FR														
0.270	362.340	LEN	F	09/12/2009	GJC						D		SL	D		G		LM	TU		S1	H3							FR											CA	VN		
1.170	363.510	LEN	F	09/12/2009	GJC						D		SS	A		G	MC	LT	SL	PO	S1	H4							FR														
									calcareous cement																																		
0.070	363.580	LEN	F	09/12/2009	GJC						D		SH	V	K	G		CS	LM		S2	H3							FR														
1.090	364.670	LEN	F	09/12/2009	GJC						D		SS	A		G	MC	LT	MN	LM	S2	H4							FR														
2.970	367.640	LEN	F	09/12/2009	GJC						D		SS	A		G	MC	LT	SP	SX	S1	H4							FR		F												
									silty at base of unit																																		
2.320	369.960	LEN	F	09/12/2009	GJC						D		SL	D		G		MD	MU		S2	H3							FR										M	CA	VN		
									with fractures																																		
0.710	370.670	LEN	F	09/12/2009	GJC						D		SS	A		G	FM	SX	BN	TU	S1	H4							FR														
									graded bedding, fining upwards																																		
4.740	375.410	LEN	F	09/12/2009	GJC						D		SS	A		G	MC	LT	CA	CE	S1	H4							FR														
									sporadic silty lenses and bands of silty pods																																		
0.740	376.150	LEN	F	09/12/2009	GJC						D		SS	A		G	MC	CM	SL	LM	S1	H3							FR														
									lithic																																		
0.520	376.670	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	MN	SL	LM	S1	H3							FR														
0.140	376.810	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	CO	LN	BU	S1	H4							FR														
									Rare large silty pods >10mm																																		
0.080	376.890	LEN	F	09/12/2009	GJC						D		SL	D		G		TH	SZ	MU	S1	H3							FR														
									sharp base ~ 25degree angle																																		
0.040	376.930	LEN	F	09/12/2009	GJC						D		SS	A		G	FM				S1	H4							FR														
									irregular basal contact																																		
0.160	377.090	LEN	F	09/12/2009	GJC						D		SL	D		G					S2	H3							FR														
									calcite band middle of unit																																		
0.120	377.210	LEN	F	09/12/2009	GJC						D		SS	B		G	FV	SL	LM	TO	S1	H3							FR														

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													Rock Descriptor								Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.120	377.330	LEN	F	09/12/2009	GJC						D		SS	A		G	MD				S1	H4							FR														
0.180	377.510	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	SL	TU		S1	H4							FR														
									graded bedding, fining upwards, with silty lag bands at base of unit																																		
0.150	377.660	LEN	F	09/12/2009	GJC						D		SL	D		G		CM	SS	LM	S1	H3							FR				WB										
0.070	377.730	LEN	F	09/12/2009	GJC						D		SS	B		G	FV	SL	TO		S1	H2							FR														
									with carbonaceous stringers																																		
0.080	377.810	LEN	F	09/12/2009	GJC						D		SL	D		G		SS	IP		S1	H3							FR														
0.250	378.060	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	SL	PO	TU	S1	H4							FR														
									Lag band																																		
0.340	378.400	LEN	F	09/12/2009	GJC						D		SL	B	N	G		CS	WP		S2	H3							FR														
									Gradational lower contact																																		
0.870	379.270	LEN	F	09/12/2009	GJC						D		SS	A		G	MD				S1	H4							FR														
0.320	379.590	LEN	F	09/12/2009	GJC						D		SS	B		G	FM	SL	BN	TO	S1	H3							FR										R	CA	BN		
0.190	379.780	LEN	F	09/12/2009	GJC						D		SH	V	K	G		AB	LM		S2	H3							FR														
2.880	382.660	LEN	F	09/12/2009	GJC						D		SS	A		G	MC	SL	PO	MU	S1	H4							FR														
									lithic																																		
0.010	382.670	LEN	F	09/12/2009	GJC						D		KL																FR														
0.320	382.990	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	SL	PO	BU	S1	H4							FR														
0.160	383.150	LEN	F	09/12/2009	GJC						D		SL	D		G		SS	IP		S1	H3							FR														
									common laminations																																		
0.140	383.290	LEN	F	09/12/2009	GJC						D		SS	A		G	FN	CM	LM		S1	H3							FR														
0.400	383.690	LEN	F	09/12/2009	GJC						D		SL	D		G		SS	LM		S1	H3							FR														
									with cross bedding																																		
0.200	383.890	LEN	F	09/12/2009	GJC						D		SS	B		G	FN	AB	SL	LM	S1	H3							FR														
0.770	384.660	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	TK	SL	PO	S1	H3							FR														
									blebs																																		
2.110	386.770	LEN	F	09/12/2009	GJC						D		SS	A		G	MD	OC	SL	BZ	S1	H4							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.500	387.270	LEN	F	09/12/2009	GJC						D		SS	B		G	FN				S1	H3							FR														
0.450	387.720	LEN	F	09/12/2009	GJC						D		SL	D		G		SS	BN	BU	S1	H3							FR														
0.220	387.940	LEN	F	09/12/2009	GJC						D		SS	A		G	FN	CS	LM	BU	S2	H3							FR														
0.150	388.090	LEN	F	09/12/2009	GJC						D		SL	B		G		CS	IP		S1	H3							FR														
									common laminations																																		
0.060	388.150	LEN	F	09/12/2009	GJC						D		SS	A		G	MD				S1	H3							FR														
0.100	388.250	LEN	F	09/12/2009	GJC						D		SL	B	N	G		CS	PT		S1	H2							FR														
0.420	388.670	LEN	F	09/12/2009	GJC						D		SL	B		G					S1	H3							FR														
0.540	389.210	LEN	F	09/12/2009	GJC						D		SS	A		G	FN	SL	TU		S1	H4							FR														
0.560	389.770	LEN	F	09/12/2009	GJC						D		SL	B	E	G		CS	ST	FR	S1	H3							FR														
									limonitic fragments																																		
0.400	390.170	LEN	F	09/12/2009	GJC						D		SS	B	N	G	FM	RA	SD	ND	S1	H4							FR														
2.040	392.210	LEN	F	09/12/2009	GJC						D		SL	V		G		TH	CY	MU	S2	H3							FR														
									thin band with pellety texture																																		
0.450	392.660	LEN	F	09/12/2009	GJC						D		SL	B		G		OC	SS	BN	S1	H3							FR														
									fining upwards, sandy base																																		
0.380	393.040	LEN	F	09/12/2009	GJC						D		SS	B		G	FM	CM	SX	BN	S1	H3							FR														
0.780	393.820	LEN	F	09/12/2009	GJC						D		SS	B		G	FN	SH	SX	LM	S1	H3							FR														
0.190	394.010	LEN	F	09/12/2009	GJC						D		SL	D		G		MN	SZ	BN	S1	H3							FR														
0.500	394.510	LEN	F	09/12/2009	GJC						D		SS	B		G	FN	CM	SX	BN	S1	H4							FR														
0.130	394.640	LEN	F	09/12/2009	GJC						D		SL	D	K	G		CS			S1	H2							FR														
0.030	394.670	LEN	F	09/12/2009	GJC						D		KL																FR														
0.690	395.360	LEN	F	09/12/2009	GJC						D		XT	V	K	G		SH			S1	H2							FR														
0.080	395.440	LEN	F	09/12/2009	GJC						D		CS	D	N	G		CS	IP		PU	H2							FR														
									expansion																																		
0.240	395.680	LEN	F	09/12/2009	GJC						D		XT	V	K	G		SH	IP		S1	H3							FR														
0.350	396.030	LEN	F	09/12/2009	GJC						D		SS	B	N	G	FV				S1	H3							FR														

												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossil/Minerals Abundance	Fossil/Minerals Type	Fossil/Mineral Association	Sedimentary Relationship	Coal Type
0.290	396.320	LEN	F	09/12/2009	GJC						D		SS	A		G	FM	OC	SL	LM	S1	H4							FR														
0.400	396.720	LEN	F	09/12/2009	GJC						D		SL	D	K	G		CS	BU		S1	H3							FR														
0.220	396.940	LEN	F	09/12/2009	GJC						D		CS	D	N	G					PU	H2							FR														
									expansion																																		
0.580	397.520	LEN	F	09/12/2009	GJC						D		SL	V	N	G					S2	H3							FR														
1.150	398.670	LEN	F	09/12/2009	GJC						D		XT	V	K	G		AB	CS		PU	H2							FR														
									expansion																																		
1.740	400.410	LEN	F	09/12/2009	GJC						D		XT	V	K	G		SS	BN	TO	S2	H2							FR														
0.290	400.700	LEN	F	09/12/2009	GJC	16001					D		SS	B		G	MD	BN	CS	IP	S2	H3							FR														
0.040	400.740	LEN	F	09/12/2009	GJC	16001					D		XC	D	B	K		TF			S1	H2							FR														
0.310	401.050	LEN	F	09/12/2009	GJC	16002	BR				D		C6			K					S1	H2							FR										A	CA	VN		
0.120	401.170	LEN	F	09/12/2009	GJC	16002	BR				D		C5			K					S1	H1							FR										A	CA	VN		
									minor cleating																																		
0.130	401.300	LEN	F	09/12/2009	GJC	16002	BR				D		C4			K					S1	H1							FR														
									common cleats																																		
0.130	401.430	LEN	F	09/12/2009	GJC	16002	BR				D		C3			K					S1	H1							FR										M	CA	VN		
									common cleats																																		
0.080	401.510	LEN	F	09/12/2009	GJC	16002	BR				D		C5			K					S1	H1							FR										M	CA	VN		
0.010	401.520	LEN	F	09/12/2009	GJC	16002	BR				D		C2			K					S2	H1							FR														
0.210	401.730	LEN	F	09/12/2009	GJC	16002	BR				D		C5			K		CY	BP	MU	S2	H1							FR														
									399.50m Clay penny band																																		
0.070	401.800	LEN	F	09/12/2009	GJC	16002	BR				D		C3			K					S1	H1							FR														
0.020	401.820	LEN	F	09/12/2009	GJC	16002	BR				D		C5			K					S1	H1							FR														
0.010	401.830	LEN	F	09/12/2009	GJC	16002	BR				D		CS		N	G		CO	LN		S1	H1							FR														
0.250	402.080	LEN	F	09/12/2009	GJC	16002	BR				D		C4			K					S1	H1							FR										C	CA	CL		
0.010	402.090	LEN	F	09/12/2009	GJC	16002	BR				D		C2			K					S1	H1							FR										M	CA	CL		
0.240	402.330	LEN	F	09/12/2009	GJC	16002	BR				D		C5			K					S2	H1							FR										C	CA	CL		

												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.220	402.550	LEN	F	09/12/2009	GJC	16003					D		SL	V	K	G		CS	LM	LN	S1	H2							FR										C	CA	VN		
0.490	403.040	LEN	F	09/12/2009	GJC						D		SS	B		G	FN	AB	SL	LM	S2	H3							FR														
									carbonaceous inpart																																		
0.100	403.140	LEN	F	09/12/2009	GJC						D		SL	D		G		MN	SS	LM	S1	H3							FR										M	CA	IF		
0.060	403.200	LEN	F	09/12/2009	GJC						D		C6			K					S2	H1							FR														
0.040	403.240	LEN	F	09/12/2009	GJC						D		CZ	V		K					S1	H1							FR										M	CA			
1.050	404.290	LEN	F	09/12/2009	GJC						D		SL	V		G		BN	SZ		S2	H3							FR										M	CA	BN		
0.340	404.630	LEN	F	09/12/2009	GJC						D		SS	B		G	FN	SL	TO		S1	H3							FR														
0.280	404.910	LEN	F	09/12/2009	GJC						D		SS	A		G	MD				S1	H4							FR														
0.240	405.150	LEN	F	09/12/2009	GJC						D		XT	D	K	G		LM			S2	H2							FR										M	CA	IF		
									with faulting																																		
0.180	405.330	LEN	F	09/12/2009	GJC						D		SS	B		G	FM	SL	LM	TU	S1	H3							FR														
0.040	405.370	LEN	F	09/12/2009	GJC						D		SL	D		G		CS	LM		S1	H2							FR														
0.040	405.410	LEN	F	09/12/2009	GJC						D		SS	B		G	FN	CS	LM	MU	S1	H3							FR														
0.250	405.660	LEN	F	09/12/2009	GJC						D		SL	D		G		CO	IP		S1	H3							FR														
									Faulted Base																																		
0.200	405.860	LEN	F	09/12/2009	GJC						D		SL	B		G					S1	H3							FR														
0.190	406.050	LEN	F	09/12/2009	GJC						D		SL	B		G		SZ	BN	TO	S1	H3							FR														
0.320	406.370	LEN	F	09/12/2009	GJC						D		SS	B		G	FN	SL	LM	TO	S1	H3							FR														
0.160	406.530	LEN	F	09/12/2009	GJC						D		SL	D		G		CS	IP		S1	H3							FR														
0.070	406.600	LEN	F	09/12/2009	GJC						D		SS	B		G		CS	LN	LM	S1	H3							FR														
0.330	406.930	LEN	F	09/12/2009	GJC						D		SS	A		G	FM	SL	LM	TU	S2	H3							FR														
1.350	408.280	LEN	F	09/12/2009	GJC						D		SL	D		G		OC	SZ	LM	S1	H3							FR										M	CA	VN		
									contains faulting																																		
0.120	408.400	LEN	F	09/12/2009	GJC						D		SS	A		G	FM	MN	SL	LM	S1	H4							FR														
0.600	409.000	LEN	F	09/12/2009	GJC						D		SL	D		G		CM	SZ	TO	S1	H3							FR														
0.190	409.190	LEN	F	09/12/2009	GJC						D		SS	B		G	FM	SL	LM	WP	S1	H4							FR														

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											Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossil/Minerals Abundance	Fossil/Minerals Type	Fossil/Minerals Association	Sedimentary Relationship	Coal Type
0.250	409.440	LEN	F	09/12/2009	GJC						D		SL	D		G		SZ	LM	MU	S1	H3							FR														
0.140	409.580	LEN	F	09/12/2009	GJC						D		SS	B		G	FN	CS	LN	WP	S1	H4							FR														
0.110	409.690	LEN	F	09/12/2009	GJC						D		SL	D		G					S1	H3							FR											CA	TU		
0.110	409.800	LEN	F	09/12/2009	GJC						D		SS	B		G	FN	SL	IP		S1	H4							FR														
0.130	409.930	LEN	F	09/12/2009	GJC						D		SL	D		G		SZ	BN	BU	S2	H3							FR														
0.070	410.000	LEN	F	09/12/2009	GJC						D		SS	A		G	FM				S1	H3							FR														
0.780	410.780	LEN	F	09/12/2009	GJC						D		SL	D		G		SH	TU		S1	H3							FR														
									sandy inpart																																		
0.180	410.960	LEN	F	09/12/2009	GJC						D		SS	B		G	FM	CS	WP	TU	S1	H4							FR														
0.110	411.070	LEN	F	09/12/2009	GJC						D		SL	D		G		CM	LM		S1	H3							FR														
0.120	411.190	LEN	F	09/12/2009	GJC						D		SS	A		G	FM	CO	WP	TU	S1	H3							FR														
0.190	411.380	LEN	F	09/12/2009	GJC						D		SL	V		G		SZ	BU		S1	H3							FR														
0.160	411.540	LEN	F	09/12/2009	GJC						D		SS	A		G	FM	SL	TU	BU	S1	H4							FR														
1.020	412.560	LEN	F	09/12/2009	GJC						D		SL	V		G		CM	SH	LM	S1	H3							FR														
0.080	412.640	LEN	F	09/12/2009	GJC						D		SS	A		G	FM	LM			S1	H3							FR														
0.030	412.670	LEN	F	09/12/2009	GJC						D		SL	D		G					S1	H3							FR														
0.100	412.770	LEN	F	09/12/2009	GJC						D		SL	D		G		CM	SL	LM	S1	H3							FR														
									cross bedding																																		
0.090	412.860	LEN	F	09/12/2009	GJC						D		SS	A		G	FM	CS	LM		S1	H3							FR														
									cross bedding, sharp basal contact																																		
0.300	413.160	LEN	F	09/12/2009	GJC						D		SL	V		G		SH	SZ	BN	S2	H3							FR										M	CA	BN		
									minor cross bedding																																		
0.510	413.670	LEN	F	09/12/2009	GJC						D		SS	A		G	CS	MN	CS	BN	S1	H4							FR														
0.410	414.080	LEN	F	09/12/2009	GJC						D		SS	A		G	MD				S1	H4							FR										C	CA	VN		
0.280	414.360	LEN	F	09/12/2009	GJC						D		SS	M		G	CS	CS	BN	MU	S2	H3							FR											CA	VN		
0.210	414.570	LEN	F	09/12/2009	GJC						D		SL	D		G		SH	SZ	LM	S1	H3							FR														
3.190	417.760	LEN	F	09/12/2009	GJC						D		SS	A		G	MC	OC	CS	BN	S2	H4							FR														

												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossil/Minerals Abundance	Fossil/Minerals Type	Fossil/Minerals Association	Sedimentary Relationship	Coal Type
0.160	417.920	LEN	F	09/12/2009	GJC						D		SL	D		G		RA	CS	WP	S1	H3							FR														
0.830	418.750	LEN	F	09/12/2009	GJC						D		SL	A		G		CM	SZ	LM	S1	H3							FR										R	CA	BN		
1.360	420.110	LEN	F	09/12/2009	GJC						D		SL	V		G		SH	SZ	BN	S1	H3							FR														
									minor sideritic nodules																																		
0.230	420.340	LEN	F	09/12/2009	GJC						D		SS	A		G	FM	CS	SX	LM	S1	H4							FR										R	CA	BN		
									convoluted bedding																																		
0.040	420.380	LEN	F	09/12/2009	GJC						D		SH	V	N	G					S1	H3							FR														
0.030	420.410	LEN	F	09/12/2009	GJC						D		SS	A		G	FN				S1	H4							FR														
0.200	420.610	LEN	F	09/12/2009	GJC						D		SL	B		G		SS	BN		S1	H3							FR														
0.230	420.840	LEN	F	09/12/2009	GJC						D		SS	B		G	FN	SL	BN	LM	S1	H4							FR														
0.080	420.920	LEN	F	09/12/2009	GJC						D		SS	A		G	FM	CS	LM		S2	H4							FR														
1.570	422.490	LEN	F	09/12/2009	GJC						D		SS	A		G	MC				S1	H4							FR														
0.130	422.620	LEN	F	09/12/2009	GJC						D		SS	V		G	MC	CS	SX	LM	S2	H3							FR														
0.870	423.490	LEN	F	09/12/2009	GJC						D		SS	A		G	MC	CS	BN	MU	S1	H4							FR										R	CA	VN		
1.260	424.750	LEN	F	09/12/2009	GJC						D		SL	D		G		OC	SD	BN	S2	H3							FR										M	CA	VN		
2.030	426.780	LEN	F	09/12/2009	GJC						D		SH	V	K	G		CS	IP		S2	H2							FR														
0.350	427.130	LEN	F	09/12/2009	GJC	16004					D		SH	V	K	G		CS	IP		S2	H2							FR											CA	BU		
0.030	427.160	LEN	F	09/12/2009	GJC	16005	BLU				D		CZ			K					S2	H1							FR										A	CA	VN		
									throughout																																		
0.020	427.180	LEN	F	09/12/2009	GJC	16005	BLU				D		C5			K					S1	H1							FR														
0.150	427.330	LEN	F	09/12/2009	GJC	16005	BLU				D		C6			K		SN	IP		S2	H1							FR														
									gradational contact																																		
0.050	427.380	LEN	F	09/12/2009	GJC	16005	BLU				D		SL		K	G					S1	H1							FR														
0.340	427.720	LEN	F	09/12/2009	GJC	16006	BLU				D		C6			K					S2	H1							FR														
0.050	427.770	LEN	F	09/12/2009	GJC	16006	BLU				D		CS		N	K					S1	H2							FR														
									pellety																																		
0.710	428.480	LEN	F	09/12/2009	GJC	16007	BLU				D		C6			K					S2	H1							FR										C	CA	VN		

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											Rock Descriptor										Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc	Tectonic Structure Dip	Fossil/Minerals Abundance	Fossil/Minerals Type	Fossil/Minerals Association	Sedimentary Relationship	Coal Type
0.020	428.500	LEN	F	09/12/2009	GJC	16007	BLU				D		C6			K		CY	BP	WP	S1	H1							FR														
0.370	428.870	LEN	F	09/12/2009	GJC	16007	BLU				D		C6			K					S1	H1							FR														
0.070	428.940	LEN	F	09/12/2009	GJC	16008	BLU				D		XM		B	K					S1	H1							FR														
0.120	429.060	LEN	F	09/12/2009	GJC	16009	BLU				D		C6			K					S1	H1							FR														
0.050	429.110	LEN	F	09/12/2009	GJC	16009	BLU				D		C5			K					S1	H1							FR										A	CA	CL		
0.270	429.380	LEN	F	09/12/2009	GJC	16009	BLU				D		C6			K					S1	H1							FR														
0.030	429.410	LEN	F	09/12/2009	GJC	16010	BL				D		C5			K					S1	H1							FR										A	CA	CL		
0.080	429.490	LEN	F	09/12/2009	GJC	16010	BL				D		C5			K					S1	H1							FR										M	CA	CL		
0.210	429.700	LEN	F	09/12/2009	GJC	16010	BL				D		C3			K					S1	H1							FR										C	CA	CL		
0.080	429.780	LEN	F	09/12/2009	GJC	16010	BL				D		C6			K		CY	LN		S1	H1							FR														
0.110	429.890	LEN	F	09/12/2009	GJC	16011	BV2				D		CS	B	C	B					S1	H2							FR														
0.180	430.070	LEN	F	09/12/2009	GJC	16011	BV2				D		C6			K					S1	H1							FR											CA	TU		
0.020	430.090	LEN	F	09/12/2009	GJC	16011	BV2				D		CS	A	C	B		CS	CO	TO	S1	H2							FR														
0.070	430.160	LEN	F	09/12/2009	GJC	16011	BV2				D		CN			K		SL	BU		S2	H1							FR														
0.090	430.250	LEN	F	09/12/2009	GJC	16011	BV2				D		SS	B	C	G	FN				S1	H2							FR														
0.200	430.450	LEN	F	09/12/2009	GJC	16012	VU				D		C6			K					S1	H1							FR														
0.050	430.500	LEN	F	09/12/2009	GJC	16013	VU				D		CZ			K		AB	SL	LN	S1	H1							FR														
0.070	430.570	LEN	F	09/12/2009	GJC	16014	VU				D		C4			K					S1	H1							FR										M	CA	CL		
									with bright coal bands																																		
0.170	430.740	LEN	F	09/12/2009	GJC	16014	VU				D		C5			K					S1	H1							FR														
0.070	430.810	LEN	F	09/12/2009	GJC	16015	VU				D		C5			K		BP			S1	H1							FR														
0.060	430.870	LEN	F	09/12/2009	GJC	16015	VU				D		C4			K					S1	H1							FR														
0.200	431.070	LEN	F	09/12/2009	GJC	16015	VU				D		C6			K					S2	H1							FR										C	CA	IF		
									Appears to be Faulted																																		
0.040	431.110	LEN	F	09/12/2009	GJC	16015	VU				D		C5			K		CY	BZ		S1	H1							FR														
									irregular																																		
0.110	431.220	LEN	F	09/12/2009	GJC	16015	VU				D		C4			K					S1	H1							FR														

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
									Abundant Cleats																																		
0.050	431.270	LEN	F	09/12/2009	GJC	16015	VU				D		C6			K		SN	CS	PT	S1	H1							FR														
0.050	431.320	LEN	F	09/12/2009	GJC	16016	YARR				D		SS		N	G	FN				S1	H2							FR														
0.080	431.400	LEN	F	09/12/2009	GJC	16017	VL				D		C6			K		CS	BP		S1	H1							FR														
0.530	431.930	LEN	F	09/12/2009	GJC	16017	VL				D		C5			K					S1	H1							FR										M	CA	IF		
									with dickite infill																																		
0.180	432.110	LEN	F	09/12/2009	GJC	16017	VL				D		C4			K					S1	H1							FR										M	CA	IF		
									with dickite infill																																		
0.110	432.220	LEN	F	09/12/2009	GJC	16017	VL				D		C5			K					S1	H1							FR										M	CA	IF		
									with dickite infill																																		
0.030	432.250	LEN	F	09/12/2009	GJC	16017	VL				D		XC	D	B	K		PT			S1	H2							FR														
0.030	432.280	LEN	F	09/12/2009	GJC	16018	VL				D		C4			K					S1	H1							FR										C	CA	IF		
									with dickite infill																																		
0.800	433.080	LEN	F	09/12/2009	GJC	16018	VL				D		C5			K					S1	H1							FR										C	CA	IF		
									with dickite infill																																		
0.040	433.120	LEN	F	09/12/2009	GJC	16018	VL				D		C4			K					S4	H1							FR														
									Dickite infilling cleats																																		
0.030	433.150	LEN	F	09/12/2009	GJC	16018	VL				D		C6			K					S1	H1							FR														
									graded into unit below																																		
0.020	433.170	LEN	F	09/12/2009	GJC	16018	VL				D		CS	D	G	C					S1	H2							FR														
0.370	433.540	LEN	F	09/12/2009	GJC	16019	VL				D		C4			K					S1	H1							FR										C	CA	IF		
									with dickite infill																																		
0.300	433.840	LEN	F	09/12/2009	GJC	16019	VL				D		C3			K					S1	H1							FR										C	CA	IF		
									with dickite infill																																		
0.140	433.980	LEN	F	09/12/2009	GJC	16019	VL				D		C5			K					S3	H1							FR										M	CA	IF		
									with dickite infill																																		
0.330	434.310	LEN	F	09/12/2009	GJC	16019	VL				D		C4			K					S1	H1							FR										M	CA	IF		

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
0.220	434.530	LEN	F	09/12/2009	GJC	16019	VL				D		C5			K		MN	PY	LN	S1	H1							FR														
0.550	435.080	LEN	F	09/12/2009	GJC	16019	VL				D		C4			K					S1	H1							FR														
0.070	435.150	LEN	F	09/12/2009	GJC	16019	VL				D		C5			K		MD	IP		S1	H1							FR														
0.020	435.170	LEN	F	09/12/2009	GJC	16020					D		XM			K		CO			S3	H1							FR														
0.270	435.440	LEN	F	09/12/2009	GJC	16020					D		XH	V	K	G		CO	LN	BN	S2	H2							FR														
0.220	435.660	LEN	F	09/12/2009	GJC						D		XT	V	G	K		MN	LM		S1	H2							FR														
0.150	435.810	LEN	F	09/12/2009	GJC						D		CZ		G	K					S2	H1							FR														
									rare bright band																																		
0.930	436.740	LEN	F	09/12/2009	GJC						D		XT	V	K	G		CO	LN		S2	H2							FR														
3.920	440.660	LEN	F	09/12/2009	GJC						D		SL	D	K	G		OC	CS	LM	S2	H2							FR										R	CA	VN		
0.050	440.710	LEN	F	09/12/2009	GJC	16021	BL				D		C5			K					S1	H1							FR										A	CA	VN		
0.100	440.810	LEN	F	09/12/2009	GJC	16021	BL				D		C6			K					S1	H1							FR										M	CA	IF		
									common dickite infill																																		
0.120	440.930	LEN	F	09/12/2009	GJC	16021	BL				D		C4			K					S1	H1							FR										M	CA	IF		
									common dickite infill																																		
0.070	441.000	LEN	F	09/12/2009	GJC	16021	BL				D		C4			K					S4	H1							FR														
0.030	441.030	LEN	F	09/12/2009	GJC	16021	BL				D		C6			K		MD	IP		S1	H1							FR														
0.120	441.150	LEN	F	09/12/2009	GJC						D		XT		K	G		CO	BP	TU	S2	H2							FR														
0.310	441.460	LEN	F	09/12/2009	GJC						D		SS	B	N	G	FN	SL	TU		S2	H2							FR														
									faulted middle of unit, with distinct basal contact																																		
1.260	442.720	LEN	F	09/12/2009	GJC						D		SS	A		G	MC	RA	SL	BN	S2	H4							FR														
0.020	442.740	LEN	F	09/12/2009	GJC						D		KL																FR														
3.030	445.770	LEN	F	09/12/2009	GJC						D		SS	A		G	CS	RA	SL	LM	S2	H4							FR										R	CA	BN		
0.230	446.000	LEN	F	09/12/2009	GJC						D		SS	B		G	FM	CM	CS	LN	S1	H3							FR														
1.070	447.070	LEN	F	09/12/2009	GJC						D		SS	A		G	CS	OC	SL	BN	S2	H4							FR														
									carbonaceous laminations																																		
1.720	448.790	LEN	F	09/12/2009	GJC						D		SS	A		G	CS	RA	SL	PO	S2	H3							FR														

LENTON
Lithology Log

Hole LEN241PC

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												Rock Descriptor									Geotech		Sedimentology							Bedding			Structure						Fossil/Mineral				
Calculated Thickness	Interval Base Depth	Project Code	Log Status	Date Logged	Logger's Initials	Sample Number	Horizon/Seam Name	Ply	% Core Recovery	Hole Condition	Bit Type	% Lithotype	Lithotype	Shade	Hue	Colour	Grain Size	Qualifier #1	Qualifier #2	Qualifier #3	Mechanical State	Strength	Roundness	Sorting	Grain Description	Matrix Description	Porosity	Permeability	Weathering	Bedding Spacing	Bedding Surface Separation	Bedding Dip	Sedimentary Structure Desc.	Sedimentary Structure Dip	Tectonic Structure Type	Tectonic Structure Spacing	Tectonic Structure Desc.	Tectonic Structure Dip	Fossils/Minerals Abundance	Fossils/Minerals Type	Fossils/Minerals Association	Sedimentary Relationship	Coal Type
									faulting base of unit																																		
1.610	450.400	LEN	F	09/12/2009	GJC						D		SS	A		G	CS	SP	CS	LM	S1	H4							FR														
									calcareous cement, lithic																																		
0.220	450.620	LEN	F	09/12/2009	GJC						D		SS	A		G	FM	LT			S1	H4							FR														
0.680	451.300	LEN	F	09/12/2009	GJC						D		SS	A		G	CS	CS	BP		S2	H3							FR														
3.200	454.500	LEN	F	09/12/2009	GJC						D		SS	A		G	CS	RA	SL	PO	S1	H4							FR														

APPENDIX 2: DEFECT LOGS

The following appendix contains the defect log produced during stratigraphic logging of the LEN240PC hole in the Lenton deposit area. A defect log records the number, width, type, dip, shape and roughness of structural defects located within the core. Defects are fractures (natural or drilling induced), joints, cleats, faults and structural zones (shear, broken, infilled, etc.) that profoundly influence the geotechnical character of the strata, and therefore whose occurrence must be incorporated into any mine development plan. All holes were logged in the field using codes described in the defect dictionary (next page) and input digitally into a geodatabase.

Lenton Defects Dictionary

Header Codes

PROJECT

LEN	Lenton

HOLE NUMBER

The same number used for the lithology log

SITE NUMBER

The same number used for the lithology log

LEASE

0337	ML70337 - Lenton
E766	EPC766 - Lenton
E865	EPC865 - Lenton North

AMG EASTING

Put Predicted/GPS coordinate in field until Surveying is complete, then update the field with correct coordinate

AMG NORTHING

Put Predicted/GPS coordinate in field until Surveying is complete, then update the field with correct coordinate

COLLAR

Leave this field blank until surveying is

MAP ZONE

A8456J	AGD84 - Zone 56J
G9456J	GDA94 - Zone 56J

GEOLOGIST

That would be you!

DRILLER

Initials please!

DRILL RIG

CS	CSG Drilling Rig
N2	New Hope Rig 2
N3	New Hope Rig 3
N4	New Hope Rig 4

DATE STARTED

Date in which drilling started

DATE COMPLETE

Date in which drilling was completed

Defect Codes

ROCK MASS UNIT DESCRIPTION CODES

Base of Rock Mass

The base depth of the rock mass unit, as defined by the rock mass unit type, or alternatively, the bedding spacing

Rock Mass Unit Type

B	BROKEN ZONE
C	COAL
D	DEFECTS
F	FAULT
L	CORE LOSS
N	NORMAL FAULT
O	NO CORE
S	SHEAR ZONE
T	THRUST FAULT
U	UNBROKEN CORE

Estimated Strength

R1	very weak rock
R2	weak rock
R3	moderately weak
R4	moderately strong rock
R5	strong rock
S4	soft
S5	firm

Bedding Spacing

MB	medium bedded 0.2 - 0.6m
TB	thinly bedded 0.06 - 0.2m
UB	very thinly bedded 0.02 - 0.06m
VB	very thickly bedded > 2m

DEFECT TYPE DESCRIPTION CODES

Base of Rock Mass

The depth of the centre point of the defect. This cannot be the same as the base of the rock mass unit

Defect Width

The width (in mm) of the defect being described

Defect Type

BG	bedding
BP	parted bedding plane
CL	clay band
CR	crushed seam
CT	cleat
FR	fracture
FT	fault
FZ	fault zone
IN	infilled zone
JT	joint
SH	shear zone

Dip Angle

The angle of dip of the defect

Infill Type

CA	calcite
CB	carbonate
CH	chlorite
CL	clay
CO	coaly
CR	crushed rock
DI	dickite
FE	iron oxide
IL	illite
KA	kaolin
KL	clean
MN	manganese
PY	pyrite
QZ	quartz
SA	sand
SD	siderite
SL	silt
TF	tuffaceous
XH	carbonaceous shale
XM	carbonaceous mudstone

Surface Shape

IR	irregular
PL	planar
ST	stepped
UN	undulose

Surface Roughness

CU	curved
PO	polished
RO	rough
SK	slickensided

If you require another code, please consult the person in charge of the dictionary within New Hope Coal

Hole	From	Depth	RT	St	BS	RNotes	Defect	DefThk	DT	I	An	IT	Sh	Ro	DNotes
LEN240PC	0	1	L												
LEN240PC	1	6.3	B	S4											
LEN240PC	6.3	9.3	U	R1											
LEN240PC	9.3	11.8	U	R1											
LEN240PC	11.8	12.3	B	S4											
LEN240PC	12.3	13.23	U												
LEN240PC							13.23	2	BG		5		PL	RO	
LEN240PC							14.11	1	BG		5		PL	RO	
LEN240PC							14.31	1	BG		5		PL	RO	
LEN240PC	13.23	14.31	D												
LEN240PC	14.31	14.41	B												
LEN240PC	14.41	14.6	U												
LEN240PC	14.6	14.8	B												
LEN240PC							14.93	1	BG		2		PL	RO	
LEN240PC							14.97	1	FR		20		PL	RO	
LEN240PC							15.58	1	FR		5		PL	RO	
LEN240PC							15.77	1	BG		2	CL	IR	RO	
LEN240PC	14.8	15.77	D												
LEN240PC	15.77	16.81	U												
LEN240PC							16.83	2	FR		5		PL	RO	
LEN240PC	16.81	16.83	D												
LEN240PC	16.83	17.67	U												
LEN240PC							17.68	2	BG		0		IR	RO	
LEN240PC	17.67	17.75	D												
LEN240PC	17.75	17.8	B												
LEN240PC	17.8	18.67	U												
LEN240PC							18.67	1	BG		0		PL	RO	
LEN240PC							19.29	1	BG		0		PL	RO	
LEN240PC							19.31	1	BG		2		IR	RO	
LEN240PC							20.18	1	BG		2		IR	RO	
LEN240PC							20.29	2	BG		0		IR	RO	
LEN240PC							20.5	1	BG		0		IR	RO	
LEN240PC	18.67	20.8	D												

Hole	From	Depth	RT	St	BS	RNotes	Defect	DefThk	DT	I	An	IT	Sh	Ro	DNotes
LEN240PC							21.29	1	BG		0		PL	RO	
LEN240PC							22.1	2	BG		0		PL	RO	
LEN240PC	20.8	22.61	D												
LEN240PC	22.61	22.7	B												
LEN240PC							23.3	2	BG		0		PL	RO	
LEN240PC							23.47	2	BG		0		IR	RO	
LEN240PC	22.7	23.8	D												
LEN240PC	23.8	25.7	U												
LEN240PC							26.35	2	FR		5		IR	RO	
LEN240PC							26.77	2	FR		2		IR	RO	
LEN240PC							27	2	BG		2		IR	RO	
LEN240PC	25.7	27.3	D												
LEN240PC							28.02	2	BG		0		IR	RO	
LEN240PC							28.39	1	BG		0		IR	RO	
LEN240PC							28.55	2	BG		0		PL	RO	
LEN240PC	27.3	30.3	D												
LEN240PC	30.3	32.86	U												DRILLING INDUCED
LEN240PC	32.86	33.2	B												
LEN240PC							33.88	5	BG		0		IR	RO	
LEN240PC							35.22	2	FR		0		IR	RO	
LEN240PC							35.63	2	FR		0		IR	RO	
LEN240PC	33.2	36.1	D												
LEN240PC	36.1	36.3	L												
LEN240PC							36.91	1	BG		0		PL	RO	
LEN240PC							37.37	1	BG		0		PL	RO	
LEN240PC							37.45	3	FR		5		IR	RO	
LEN240PC							37.48	3	FR		0		IR	RO	
LEN240PC							37.59	3	FR		0		IR	RO	
LEN240PC	36.3	39.1	D												
LEN240PC							39.7	1	BG		0		PL	PO	
LEN240PC							40.63	1	BG		0		PL	PO	
LEN240PC							41.26	2	BG		0		IR	RO	
LEN240PC							41.39	2	BG		0		IR	RO	

Hole	From	Depth	RT	St	BS	RNotes	Defect	DefThk	DT	I	An	IT	Sh	Ro	DNotes
LEN240PC	39.1	42.1	D												
LEN240PC							43.24	1	BG		0		PL	RO	
LEN240PC							43.93	1	BG		0		PL	RO	
LEN240PC	42.1	45.1	D												
LEN240PC							46.15	1	FT		30		PL	SK	
LEN240PC							46.57	1	FT		25		PL	SK	
LEN240PC							47.22	2	BP		0		IR	RO	
LEN240PC	45.1	48.1	D												
LEN240PC							49.03	2	BP		2		IR	RO	
LEN240PC							50.22	2	BP		0		IR	RO	
LEN240PC	48.1	51	D												
LEN240PC							51.8	1	BG		0		PL	RO	
LEN240PC							52.1	2	BG		0		IR	RO	
LEN240PC							52.47	2	BG		0		IR	RO	
LEN240PC	51	54	D												
LEN240PC	54	54.18	U												
LEN240PC	54.18	55	U												
LEN240PC	55	55.7	U												
LEN240PC	55.7	56.5	U												
LEN240PC	56.5	57	U												
LEN240PC	57	59.08	U												
LEN240PC							59.09	1	BP				PL	RO	
LEN240PC	59.08	60.1	D												
LEN240PC	60.1	60.35	U												
LEN240PC	60.35	60.44	B												
LEN240PC	60.44	61.94	U												
LEN240PC							61.94	5	CR				IR	RO	
LEN240PC	61.94	68.44	D												
LEN240PC							68.45	1	FT		30		PL	SK	
LEN240PC	68.44	71.15	D												
LEN240PC							71.16	1	FT		30		PL	SK	
LEN240PC							71.35	1	FT		30		PL	SK	
LEN240PC	71.15	71.6	D												

Hole	From	Depth	RT	St	BS	RNotes	Defect	DefThk	DT	I	An	IT	Sh	Ro	DNotes
LEN240PC	71.6	71.65	L												
LEN240PC	71.65	71.95	U												
LEN240PC	71.95	75.05	B												
LEN240PC	75.05	76.78	U												
LEN240PC							76.8	1	BP		0		PL	PO	
LEN240PC							76.91	1	FT		30		PL	SK	
LEN240PC							76.97	1	FT		30		PL	SK	
LEN240PC							77.12	1	FT		20		PL	SK	
LEN240PC							77.27	1	FT		20		PL	SK	
LEN240PC	76.78	78	D												
LEN240PC	78	81.05	U												DRILLING INDUCED
LEN240PC							81.19	1	FR		45	CA	IR	RO	
LEN240PC							81.31		FR		45	CA	IR	RO	
LEN240PC	81.05	81.32	D												
LEN240PC	81.32	84.05	U												
LEN240PC							84.38		FT		45	CL	PL	SK	
LEN240PC							84.99		FT		45		PL	SK	
LEN240PC							85.34		FT		30		PL	SK	
LEN240PC							85.47		FT		5		PL	SK	
LEN240PC	84.05	87	D												
LEN240PC							87.81		FT		30		PL	SK	
LEN240PC							87.87		FR		20		IR	RO	
LEN240PC							88.44		FR		0		IR	RO	
LEN240PC							89.48		FT		30		PL	RO	
LEN240PC	87	90	D												
LEN240PC	90	90.45	U												
LEN240PC							90.5		FT		60	CA	IR	RO	
LEN240PC							90.97		FR		10		IR	RO	
LEN240PC							91		FT		10	CA	IR	RO	
LEN240PC							91.05		FT		45	CA	IR	RO	
LEN240PC							91.58		FT		70	CA	IR	RO	
LEN240PC							91.95		FR		0		IR	RO	
LEN240PC	90.45	93	D												

Hole	From	Depth	RT	St	BS	RNotes	Defect	DefThk	DT	I	An	IT	Sh	Ro	DNotes
LEN240PC							93.69		FR		5		PL	RO	
LEN240PC							94.94		FR		10		PL	RO	
LEN240PC	93	96	D												
LEN240PC							96.55		FR		5	CA	PL	RO	
LEN240PC							96.61		FR		5	CA	IR	RO	
LEN240PC							97.43		FT		70		PL	RO	
LEN240PC	96	99	D												
LEN240PC							99.68		BP		0		PL	RO	
LEN240PC							99.83		BP		0		PL	RO	
LEN240PC							99.92		FR				IR	PO	
LEN240PC							100.1	1	FT		5		PL	RO	
LEN240PC							100.21	1	FT		5		PL	SK	
LEN240PC	99	102	D												
LEN240PC							103.31		FR		75	CA	PL	CU	
LEN240PC							103.48		FR		45		PL	CU	
LEN240PC							104.79		FR		5		PL	RO	
LEN240PC	102	104.88	D												
LEN240PC							104.98		FT		10		PL	RO	
LEN240PC							105.04		FT		20		UN	SK	
LEN240PC							105.09		FT		20		IR	SK	
LEN240PC							105.18		FT		25		UN	SK	
LEN240PC							105.36		FT		20		UN	SK	
LEN240PC							105.46		FR		0		PL	SK	
LEN240PC							107.22		FR		10		UN	RO	
LEN240PC	104.88	108	D												
LEN240PC	108	108.8	U												
LEN240PC							109.23		FR		0		PL	PO	
LEN240PC							109.31		FR		10		PL	PO	
LEN240PC							112.92		FR		5		ST	RO	
LEN240PC							113.38		FR		0	CO	PL	RO	
LEN240PC	108.8	114	D												
LEN240PC							115.43		FT		45		UN	SK	
LEN240PC							115.49		FR		10		ST	RO	

Hole	From	Depth	RT	St	BS	RNotes	Defect	DefThk	DT	I	An	IT	Sh	Ro	DNotes
LEN240PC	114	115.63	D												
LEN240PC							116.37		FR		5		ST	RO	
LEN240PC	115.63	117	D												
LEN240PC	117	120	U												
LEN240PC							120.85		BG		0		PL	PO	
LEN240PC							121.87		FR		70	CA	PL		
LEN240PC							122.88		FR		70	CA	PL		
LEN240PC	120	123	D												
LEN240PC							123.91		FT		45		UN	RO	
LEN240PC							124.96		FT		45		ST	RO	Drillers predicted width 13cm
LEN240PC	123	126	D												
LEN240PC	126	127.06	U												
LEN240PC							127.06		FR						DRILLING INDUCED
LEN240PC							127.12		FR						DRILLING INDUCED
LEN240PC	127.06	128.48	D												
LEN240PC	128.48	129	U												
LEN240PC	129	131.5	U												
LEN240PC	131.5	132	U												
LEN240PC							132.25	1	FT		45		PL	PO	
LEN240PC							133.96		FR		5		IR	RO	
LEN240PC							134.57		FR		5		PL	RO	
LEN240PC	132	135	D												
LEN240PC							136		FT		60		ST	RO	
LEN240PC							136.29		FR		5		IR	RO	
LEN240PC							136.59		FT		45		PL	RO	
LEN240PC							136.73		FT		15		PL	RO	
LEN240PC							136.77		FT		45		PL	RO	
LEN240PC							137.02		FR		10		PL	PO	
LEN240PC	135	138	D												
LEN240PC							139.85		FR		5		PL	RO	
LEN240PC							140.24		FT		10		PL	PO	
LEN240PC	138	140.48	D												
LEN240PC							141.75		FT		30		PL	RO	

Hole	From	Depth	RT	St	BS	RNotes	Defect	DefThk	DT	I	An	IT	Sh	Ro	DNotes
LEN240PC							141.78		FT		30		PL	RO	
LEN240PC	140.48	141.8	D												
LEN240PC							142.53		BG		0		PL	RO	
LEN240PC							142.84		BG		0		PL	RO	
LEN240PC							143.29		FT		10		UN	RO	
LEN240PC							143.49		FT		10		PL	PO	
LEN240PC	141.8	144	D												
LEN240PC							144.93		FT		30		ST	RO	
LEN240PC							145.82		BG		10	CO	PL	RO	
LEN240PC	144	147	D												
LEN240PC							148.46		BG		0		PL	PO	
LEN240PC							148.57		FR		0		IR	RO	DRILLING INDUCED
LEN240PC							148.94		BG		0		PL	PO	
LEN240PC							149.26		BG		0		PL	PO	
LEN240PC	147	150	D												
LEN240PC	150	150.25	U												
LEN240PC							151.19		FR		0		PL	PO	
LEN240PC							151.75		FR		10		PL	PO	
LEN240PC	150.25	152.65	D												
LEN240PC	152.65	153.05	B					0							
LEN240PC	153.05	154.16	D				154.16		FR		0		PL	SM	
LEN240PC							154.22	30	CR						
LEN240PC							154.51		FR				ST	RO	
LEN240PC	154.16	155.9	D												
LEN240PC							156.13		FR		10		PL	SM	
LEN240PC							156.95		FR		0		PL	SM	
LEN240PC	155.9	158.9	D												
LEN240PC							160.61		FR		10		PL	SM	
LEN240PC							161.07		FR		15		PL	SM	
LEN240PC	158.9	162	D												
LEN240PC							164.2		BG		0		IR	RO	
LEN240PC							164.5		BG		5		IR	RO	
LEN240PC							165.91		FR		0		PL	PO	

Hole	From	Depth	RT	St	BS	RNotes	Defect	DefThk	DT	I	An	IT	Sh	Ro	DNotes
LEN240PC							167.99		FR		0		PL	SM	
LEN240PC	162	169.33	D												
LEN240PC							170.02		FR		15		ST	RO	
LEN240PC							170.41		FR		10		IR	RO	
LEN240PC	169.33	171	D												
LEN240PC							171.66		FT		15	CA	UN	RO	
LEN240PC							172.81		FR		10		ST	RO	
LEN240PC							173.2		FR		0		PL	RO	
LEN240PC	171	174	D												
LEN240PC							174.79		FR		5		IR	RO	
LEN240PC							175.37		FR		5		IR	RO	
LEN240PC	174	175.37	D												
LEN240PC							175.63		FR		0	CA	IR	RO	
LEN240PC	175.37	178	D												
LEN240PC	178	181	U												
LEN240PC							181.41		FT		45		IR	RO	
LEN240PC							181.47		FT		15		PL	PO	
LEN240PC							181.84		FR		0		PL	SM	DRILLING INDUCED
LEN240PC							181.94		FT		0		ST	RO	
LEN240PC							182		FR		0		PL	PO	
LEN240PC							182.45		FR		0		PL	PO	
LEN240PC							182.85		FR		10	CO	IR	RO	
LEN240PC							182.92		FR		0	CO	PL	PO	
LEN240PC							183.34		FR		10	CA	PL	SM	
LEN240PC							183.46		FR		0		IR	RO	
LEN240PC							183.59		FT		45	CA	UN	SM	
LEN240PC	181	184	D												
LEN240PC							184.29		FT		30		IR	RO	
LEN240PC							184.88		FR		10		IR	RO	
LEN240PC							186.14		FR		5		IR	RO	
LEN240PC							186.47		BG		5	CO	IR	RO	
LEN240PC	184	187	D												
LEN240PC							187.7		BG		5	CO	PL	SM	

Hole	From	Depth	RT	St	BS	RNotes	Defect	DefThk	DT	I	An	IT	Sh	Ro	DNotes
LEN240PC							187.85		BG		5	CO	PL	SM	
LEN240PC							188.37		FR		10	CO	ST	RO	
LEN240PC							188.89		FR		0		IR	RO	
LEN240PC							189.15		FR		0		PL	SM	
LEN240PC	187	189.29	D												
LEN240PC							190		FR		0		PL	SM	DRILLING INDUCED
LEN240PC							191.18		FR		10	CO	IR	RO	
LEN240PC							191.71		FR		0		ST	RO	
LEN240PC							192.66		FR		0		IR	RO	DRILLING INDUCED
LEN240PC	189.29	193	D												
LEN240PC							193.66		FR		5		IR	RO	
LEN240PC							194.01		FR		5		IR	SM	
LEN240PC							194.51		FR		0		IR	RO	
LEN240PC							194.92		BG		0	CO	PL	SM	
LEN240PC	193	196	D												
LEN240PC							196.27		FT		45		PL	SK	
LEN240PC							196.3		FR		0		PL	SM	
LEN240PC							196.86		FR		5		IR	RO	
LEN240PC							197.16		FR		5	CO	IR	RO	
LEN240PC							197.31		FT		30		ST	SM	
LEN240PC							197.5		FR		10	CO	PL	SM	
LEN240PC							197.56		FT		45	CO	UN	SM	
LEN240PC							197.64		FT		45		IR	SM	
LEN240PC							197.78		FT		20	CO	ST	SM	
LEN240PC							197.85		FT		30		ST	SM	
LEN240PC							198.29		FT		20		PL	RO	
LEN240PC							198.38		FT		30		ST	SM	
LEN240PC	196	199	D												
LEN240PC							199.76		FR		5		ST	SM	
LEN240PC							199.9		FR		5		PL	SM	
LEN240PC							200.35		BG		0		PL	SM	
LEN240PC							200.48		FT		30		UN	SM	
LEN240PC							200.74		FR		10		UN	SM	

Hole	From	Depth	RT	St	BS	RNotes	Defect	DefThk	DT	I	An	IT	Sh	Ro	DNotes
LEN240PC							201.23		FR		0		PL	PO	
LEN240PC							201.53		FR		0		IR	RO	
LEN240PC	199	202	D												
LEN240PC							202.8		BG		0		PL	PO	
LEN240PC							203.12		BG		0		PL	PO	
LEN240PC							203.28		BG		0		PL	SM	
LEN240PC							203.41		FR		5	CO	UN	SM	
LEN240PC							203.46		FT		45	CO	PL	RO	
LEN240PC							203.59		BG		0		PL	PO	
LEN240PC							204.09		BG		0		PL	SM	
LEN240PC							204.7		BG		0		PL	SM	
LEN240PC	202	205	D												
LEN240PC	205	208	U												
LEN240PC	208	211	U												
LEN240PC	211	214	U												
LEN240PC							214.16		FR		0		ST	RO	
LEN240PC							215.37		FR		0		ST	RO	
LEN240PC	214	216	D												
LEN240PC							218		BG		5	CO	PL	RO	
LEN240PC	216	219	D												
LEN240PC							220.38		FR		10	CO	IR	RO	
LEN240PC							221.19		FT		30	CO	IR	RO	
LEN240PC							221.24		FR		15	CO	UN	RO	
LEN240PC	219	222	D												
LEN240PC							222.86		FT		20	CO	IR	RO	
LEN240PC							224.05		FT		15		PL	SM	
LEN240PC							224.55		FR		0	CO	IR	RO	
LEN240PC	222	225	D												
LEN240PC							226.69		FT		30		PL	RO	
LEN240PC	225	227.64	D												
LEN240PC							228.25		FR		10		PL	RO	
LEN240PC							228.93		FT		20		PL	RO	
LEN240PC							229.22	40	CR						

APPENDIX 3: XRF DATA

The following appendix contains major, minor and trace element geochemical data obtained using X-Ray Fluorescence (XRF) for thirteen fine-grained samples collected from the Lenton deposit area. This data was obtained from the XRF located at the University of Ottawa in July 2011. All major elements are reported in weight oxide percent (wt %) where minor and trace elements are reported in parts per million (ppm).

Sample Name	L.O.I. (%)	Sum (%)	Sum + L.O.I. (%)	SiO2 (%)	Al2O3 (%)	CaO (%)	K2O (%)	MgO (%)	MnO (%)	Na2O (%)	P2O5 (%)	Fe2O3(T) (%)	TiO2 (%)
LEN001	6.24	93.829	**100.07**	56.98	19.97	0.81	3.319	1.59	0.061	0.87	0.123	9.187	0.745
LEN002	5.31	95.219	**100.53**	58.70	19.57	0.79	3.354	1.64	0.076	0.84	0.107	9.199	0.755
LEN003	12.98	88.025	**101.01**	50.98	30.25	0.48	1.142	0.55	0.050	0.36	0.125	2.444	1.446
LEN004	6.05	95.25	**101.30**	56.98	21.36	0.55	3.667	1.59	0.176	0.68	0.103	9.192	0.776
LEN005	5.45	95.387	**100.84**	58.83	19.78	0.66	3.188	1.69	0.060	0.94	0.064	9.192	0.830
LEN006	5.62	96.673	**102.29**	62.27	19.35	0.65	3.592	1.37	0.062	0.68	0.097	7.562	0.852
LEN007	15.65	87.13	**102.78**	51.17	29.98	0.48	0.876	0.53	0.031	0.39	0.104	1.966	1.419
LEN008	7.09	94.041	**101.13**	57.03	20.48	0.97	2.328	1.59	0.086	0.94	0.128	9.466	0.868
LEN009	6.17	95.533	**101.70**	57.99	19.51	0.71	3.559	1.43	0.066	0.56	0.096	10.647	0.774
LEN010	16.10	86.48	**102.58**	54.03	17.66	1.31	2.252	1.34	0.162	0.63	0.184	8.012	0.746
LEN011	11.05	90.379	**101.43**	54.46	28.53	0.40	1.703	0.77	0.009	0.48	0.094	2.518	1.260
LEN012	6.61	93.48	**100.09**	55.59	19.91	0.77	3.172	1.53	0.073	0.80	0.093	10.560	0.786
LEN013	6.18	95.421	**101.60**	60.44	19.49	1.01	3.687	1.33	0.085	0.69	0.072	7.578	0.837
LEN014	8.21	92.253	**100.46**	59.45	19.42	1.18	1.577	1.39	0.058	0.94	0.112	7.015	0.979

Sample Name	Ba (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)	Ga (ppm)	La (ppm)	Nb (ppm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Rb (ppm)	Sr (ppm)	Th (ppm)
LEN001	632	68	27	73	15	33	11	24	79	43	169	217	26
LEN002	632	83	25	79	16	37	12	41	48	31	165	202	19
LEN003	371	169	10	112	25	45	16	70	16	67	61	230	47
LEN004	499	71	27	105	22	39	11	24	51	39	172	117	23
LEN005	306	45	29	80	16	56	12	19	49	36	155	155	26
LEN006	691	77	20	66	14	49	11	30	14	20	185	220	25
LEN007	336	158	27	115	19	51	14	56	1	50	47	211	49
LEN008	471	56	31	81	11	18	10	22	34	61	120	204	31
LEN009	697	84	24	63	17	49	10	29	28	34	181	211	20
LEN010	473	64	23	61	13	14	9	27	9	40	96	275	30
LEN011	379	111	16	77	18	66	15	41	12	34	83	224	38
LEN012	645	72	26	70	21	55	11	36	27	50	160	221	26
LEN013	701	99	19	76	12	36	12	38	26	50	188	211	35
LEN014	259	107	26	76	16	34	9	34	3	31	76	154	27

Sample Name	U (ppm)	V (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)
LEN001	11	109	29	103	146
LEN002	7	105	28	159	149
LEN003	21	169	54	195	358
LEN004	8	111	26	101	149
LEN005	10	135	28	97	168
LEN006	11	103	29	127	171
LEN007	19	152	50	85	353
LEN008	14	99	29	114	154
LEN009	5	123	28	145	160
LEN010	12	121	28	69	148
LEN011	16	144	33	53	230
LEN012	10	105	27	145	156
LEN013	17	110	33	86	170
LEN014	11	125	23	101	184

APPENDIX 4: MACERAL ANALYSIS DATA

This appendix contains data obtained from the maceral analysis of 72 coal samples from the Lenton deposit by Australian Coal Industries Research Laboratories (ACIRL) in Queensland, Australia. All samples were analyzed in accordance with Australian Standard 2856.2.

HOLENAME	FROM (m)	TO (m)	Thickness	SEAM	Total Vitrinite (%)	Vitrinite			Total Liptinite (%)	Liptinite			
						Telovitrinite (%)	Detrovitrinite (%)	Gelovitrinite (%)		Sporinite (%)	Cutinite (%)	Resinite (%)	Alginite (%)
LEN003C	40.90	41.93	1.03	BL	60.80	40.10	20.70	0.00	1.00	0.60	0.40	0.00	0.00
LEN030C2	53.07	53.60	0.53	BL	57.10	31.00	26.10	0.00	1.80	1.80	0.00	0.00	0.00
LEN030C2	53.07	53.60	0.53	BL	53.60	27.70	25.90	0.00	1.80	1.60	0.20	0.00	0.00
LEN121C1	67.45	68.17	0.72	BLL	51.10	29.20	21.90	0.00	2.70	2.30	0.40	0.00	0.00
LEN121C1	67.45	68.17	0.72	BLL	42.40	19.80	22.60	0.00	3.40	3.00	0.40	0.00	0.00
LEN158C1	69.38	69.95	0.57	BLL	69.10	39.60	29.50	0.00	2.20	1.80	0.40	0.00	0.00
LEN158C1	69.38	69.95	0.57	BLL	55.90	23.40	32.50	0.00	3.20	3.00	0.20	0.00	0.00
LEN184LC	133.04	133.42	0.38	BLL	61.00	44.90	16.10	0.00	1.80	1.60	0.20	0.00	0.00
LEN184LC	133.04	133.42	0.38	BLL	48.40	27.50	20.70	0.20	1.40	1.40	0.00	0.00	0.00
LEN004C	35.20	36.38	1.18	BR	63.60	48.10	15.50	0.00	1.30	0.90	0.40	0.00	0.00
LEN018C	30.23	31.45	1.22	BR	61.60	50.10	11.50	0.00	1.10	0.80	0.30	0.00	0.00
LEN030C	33.20	33.71	0.51	BR	57.00	45.50	11.50	0.00	2.60	1.80	0.80	0.00	0.00
LEN030C2	32.72	34.10	1.38	BR	39.20	19.40	19.80	0.00	2.60	2.40	0.20	0.00	0.00
LEN031C1	19.59	20.71	1.12	BR	50.80	30.30	20.50	0.00	0.60	0.60	0.00	0.00	0.00
LEN031C1	19.59	20.71	1.12	BR	30.90	13.30	17.60	0.00	0.80	0.80	0.00	0.00	0.00
LEN042C1	37.49	38.78	1.29	BR	53.90	29.10	24.80	0.00	1.40	1.20	0.00	0.20	0.00
LEN042C1	37.49	38.78	1.29	BR	30.40	7.00	23.40	0.00	2.70	2.10	0.40	0.20	0.00
LEN044XC	56.63	57.96	1.33	BR	68.90	43.70	25.20	0.00	0.80	0.80	0.00	0.00	0.00
LEN044XC	56.63	57.96	1.33	BR	35.80	13.10	22.70	0.00	0.80	0.60	0.20	0.00	0.00
LEN046XC	42.02	43.26	1.24	BR	66.30	43.40	22.90	0.00	0.60	0.60	0.00	0.00	0.00
LEN046XC	42.02	43.26	1.24	BR	33.50	12.90	20.60	0.00	1.00	1.00	0.00	0.00	0.00
LEN048XC	43.66	44.90	1.24	BR	64.60	43.40	21.20	0.00	1.00	1.00	0.00	0.00	0.00
LEN048XC	43.66	44.90	1.24	BR	37.00	11.50	25.50	0.00	0.90	0.90	0.00	0.00	0.00
LEN076C1	20.42	21.88	1.46	BR	53.10	30.80	22.30	0.00	1.20	0.80	0.20	0.20	0.00
LEN076C1	20.42	21.88	1.46	BR	28.70	10.70	18.00	0.00	2.40	1.20	0.60	0.60	0.00
LEN076C4	22.14	23.62	1.48	BR	54.20	32.40	21.80	0.00	1.00	0.60	0.40	0.00	0.00
LEN076C4	22.14	23.62	1.48	BR	58.60	35.40	23.20	0.00	1.30	1.10	0.20	0.00	0.00
LEN121C1	40.46	41.84	1.38	BR	47.00	25.60	21.40	0.00	2.80	2.80	0.00	0.00	0.00
LEN158C1	44.44	45.74	1.30	BR	51.90	28.20	23.70	0.00	1.90	1.70	0.20	0.00	0.00
LEN158C1	44.44	45.74	1.30	BR	45.00	26.50	18.50	0.00	2.70	2.30	0.40	0.00	0.00
LEN158C1	44.44	45.74	1.30	BR	34.50	11.80	22.70	0.00	2.80	2.60	0.20	0.00	0.00
LEN184LC	110.92	112.26	1.34	BR	50.60	34.10	16.30	0.20	1.80	1.60	0.20	0.00	0.00
LEN185LC	18.99	20.11	1.12	BR	57.90	37.10	20.80	0.00	1.00	1.00	0.00	0.00	0.00
LEN186LC	21.94	23.32	1.38	BR	48.40	35.30	12.90	0.20	2.20	1.60	0.60	0.00	0.00
LEN076C4	49.38	53.80	4.42	BV3	62.80	31.00	31.80	0.00	0.80	0.60	0.20	0.00	0.00
LEN076C4	49.38	53.80	4.42	BV3	58.90	27.70	31.20	0.00	0.80	0.60	0.20	0.00	0.00
LEN018C	58.89	61.87	2.98	VL	57.00	44.00	13.00	0.00	0.90	0.40	0.50	0.00	0.00

HOLENAME	FROM (m)	TO (m)	Thickness	SEAM	Total Vitrinite (%)	Vitrinite			Total Liptinite (%)	Liptinite			
						Telovitrinite (%)	Detrovitrinite (%)	Gelovitrinite (%)		Sporinite (%)	Cutinite (%)	Resinite (%)	Alginite (%)
LEN030C	55.00	58.36	3.36	VL	52.80	39.60	13.20	0.00	1.40	0.90	0.50	0.00	0.00
LEN030C2	56.26	59.32	3.06	VL	48.80	25.00	23.80	0.00	1.00	1.00	0.00	0.00	0.00
LEN030C2	56.26	59.32	3.06	VL	28.30	6.90	21.40	0.00	1.00	1.00	0.00	0.00	0.00
LEN031C1	44.64	46.98	2.34	VL	64.60	38.30	26.30	0.00	0.80	0.80	0.00	0.00	0.00
LEN031C1	44.64	46.98	2.34	VL	36.60	12.00	24.60	0.00	0.40	0.40	0.00	0.00	0.00
LEN042C1	80.14	81.70	1.56	VL	63.80	36.90	26.90	0.00	0.40	0.20	0.20	0.00	0.00
LEN042C1	80.14	81.70	1.56	VL	41.00	18.60	22.40	0.00	0.40	0.40	0.00	0.00	0.00
LEN045C2	90.89	94.42	3.53	VL	56.10	33.40	22.70	0.00	0.60	0.60	0.00	0.00	0.00
LEN045C2	90.89	94.42	3.53	VL	35.60	14.00	21.60	0.00	1.40	1.20	0.20	0.00	0.00
LEN046C2	72.05	75.15	3.10	VL	62.50	35.90	26.60	0.00	1.20	1.00	0.20	0.00	0.00
LEN046C2	72.05	75.15	3.10	VL	34.10	14.80	19.30	0.00	1.40	1.40	0.00	0.00	0.00
LEN046XC	71.75	75.24	3.49	VL	62.20	40.00	22.20	0.00	0.40	0.40	0.00	0.00	0.00
LEN046XC	71.75	75.24	3.49	VL	37.40	14.70	22.70	0.00	0.40	0.40	0.00	0.00	0.00
LEN048XC	73.24	76.00	2.76	VL	67.20	43.10	24.10	0.00	0.60	0.60	0.00	0.00	0.00
LEN048XC	73.24	76.00	2.76	VL	32.40	8.80	23.60	0.00	0.20	0.20	0.00	0.00	0.00
LEN050C1	43.68	46.49	2.81	VL	60.70	32.30	28.40	0.00	0.60	0.60	0.00	0.00	0.00
LEN050C1	43.68	46.49	2.81	VL	37.10	14.90	22.20	0.00	0.40	0.40	0.00	0.00	0.00
LEN121C1	70.39	73.90	3.51	VL	55.80	33.20	22.60	0.00	1.60	1.40	0.20	0.00	0.00
LEN121C1	70.39	73.90	3.51	VL	26.40	7.70	18.70	0.00	1.60	1.40	0.20	0.00	0.00
LEN146XC	267.77	271.05	3.28	VL	32.30	10.50	21.80	0.00	1.30	1.30	0.00	0.00	0.00
LEN146XC	267.77	271.05	3.28	VL	64.90	40.20	24.70	0.00	0.60	0.60	0.00	0.00	0.00
LEN158C1	72.53	76.12	3.59	VL	59.80	34.70	25.10	0.00	1.20	1.20	0.00	0.00	0.00
LEN158C1	72.53	76.12	3.59	VL	26.20	8.80	17.40	0.00	1.30	1.30	0.00	0.00	0.00
LEN185LC	48.90	51.21	2.31	VL	68.30	---	---	---	0.60	---	---	---	---
LEN185LC	48.90	51.21	2.31	VL	33.60	18.10	15.50	0.00	0.80	0.80	0.00	0.00	0.00
LEN186LC	60.03	62.41	2.38	VL	89.00	---	---	---	0.80	---	---	---	---
LEN186LC	60.03	62.41	2.38	VL	36.80	18.70	18.10	0.00	0.20	0.20	0.00	0.00	0.00
LEN076C1	47.80	51.00	3.20	VL1	61.70	29.50	32.20	0.00	1.20	0.80	0.20	0.20	0.00
LEN076C1	47.80	51.00	3.20	VL1	34.90	11.70	23.20	0.00	0.60	0.60	0.00	0.00	0.00
LEN018C	57.65	58.89	1.24	VU	55.70	43.40	12.30	0.00	1.60	1.20	0.40	0.00	0.00
LEN031C1	42.50	43.76	1.26	VU	25.10	11.10	14.00	0.00	0.80	0.40	0.20	0.20	0.00
LEN042C1	78.10	80.14	2.04	VU	20.00	10.20	9.80	0.00	1.20	0.80	0.20	0.20	0.00
LEN044XC	90.70	96.02	5.32	VU	55.50	33.70	21.80	0.00	0.40	0.20	0.20	0.00	0.00
LEN044XC	90.70	96.02	5.32	VU	26.00	9.40	16.60	0.00	0.40	0.40	0.00	0.00	0.00
LEN050C1	41.85	43.68	1.83	VU	21.90	9.20	12.70	0.00	1.60	1.00	0.20	0.40	0.00

HOLENAME	FROM (m)	TO (m)	Thickness	SEAM	Total Inertinite (%)	Inertinite							Vitrinite Reflectance
						Fusinite (%)	Semifusinite (%)	Detrinite (%)	Macrinite (%)	Micronite (%)	Total Minerals (%)	Seminertinite (%)	
LEN003C	40.90	41.93	1.03	BL	36.60	12.70	19.80	3.90	0.20	0.00	1.70	23.90	1.06
LEN030C2	53.07	53.60	0.53	BL	36.00	2.40	24.50	9.10	0.00	0.00	5.10	33.60	1.14
LEN030C2	53.07	53.60	0.53	BL	38.60	2.00	29.10	7.50	0.00	0.00	6.10	36.60	1.14
LEN121C1	67.45	68.17	0.72	BLL	41.50	1.60	30.10	9.80	0.00	0.00	4.70	39.90	1.14
LEN121C1	67.45	68.17	0.72	BLL	49.90	1.60	38.70	9.60	0.00	0.00	4.40	48.30	1.14
LEN158C1	69.38	69.95	0.57	BLL	25.10	1.00	17.60	6.50	0.00	0.00	3.60	24.20	1.13
LEN158C1	69.38	69.95	0.57	BLL	37.90	1.60	27.70	8.60	0.00	0.00	3.00	36.30	1.14
LEN184LC	133.04	133.42	0.38	BLL	34.20	2.40	28.60	3.20	0.00	0.00	3.00	---	1.13
LEN184LC	133.04	133.42	0.38	BLL	42.10	2.80	34.70	4.40	0.00	0.20	8.20	---	1.11
LEN004C	35.20	36.38	1.18	BR	32.00	5.70	20.60	5.30	0.20	0.20	3.10	26.10	1.05
LEN018C	30.23	31.45	1.22	BR	34.10	12.20	15.00	5.80	0.90	0.20	3.30	21.70	1.09
LEN030C	33.20	33.71	0.51	BR	37.30	11.70	15.90	8.70	1.00	0.01	3.20	25.60	1.09
LEN030C2	32.72	34.10	1.38	BR	52.80	1.40	40.60	10.80	0.00	0.00	5.40	51.40	1.12
LEN031C1	19.59	20.71	1.12	BR	44.40	4.30	30.30	9.60	0.20	0.00	4.10	40.10	1.09
LEN031C1	19.59	20.71	1.12	BR	63.60	5.10	47.50	11.00	0.00	0.00	4.70	58.50	1.08
LEN042C1	37.49	38.78	1.29	BR	42.20	4.50	30.10	7.40	0.20	0.00	2.50	37.70	1.11
LEN042C1	37.49	38.78	1.29	BR	62.40	3.80	48.50	10.10	0.00	0.00	4.60	58.60	1.09
LEN044XC	56.63	57.96	1.33	BR	26.60	2.10	18.10	6.40	0.00	0.00	3.70	24.50	1.10
LEN044XC	56.63	57.96	1.33	BR	59.80	3.20	46.30	10.30	0.00	0.00	3.60	56.60	1.08
LEN046XC	42.02	43.26	1.24	BR	30.20	2.60	22.10	5.50	0.00	0.00	3.00	27.60	1.07
LEN046XC	42.02	43.26	1.24	BR	61.80	2.20	48.20	11.40	0.00	0.00	3.70	59.60	1.06
LEN048XC	43.66	44.90	1.24	BR	30.70	2.30	22.40	6.00	0.00	0.00	3.70	28.40	1.04
LEN048XC	43.66	44.90	1.24	BR	59.00	3.70	44.90	10.20	0.20	0.00	3.00	55.30	1.03
LEN076C1	20.42	21.88	1.46	BR	43.30	3.60	34.00	5.70	0.00	0.00	2.40	39.70	1.09
LEN076C1	20.42	21.88	1.46	BR	64.40	2.50	51.00	10.90	0.00	0.00	4.50	61.90	1.08
LEN076C4	22.14	23.62	1.48	BR	40.30	1.40	30.80	8.10	0.00	0.00	4.50	38.90	1.06
LEN076C4	22.14	23.62	1.48	BR	35.40	1.50	25.80	8.10	0.00	0.00	4.70	33.90	1.07
LEN121C1	40.46	41.84	1.38	BR	46.00	1.20	35.20	9.20	0.40	0.00	4.20	44.80	1.13
LEN158C1	44.44	45.74	1.30	BR	43.10	1.20	33.40	8.50	0.00	0.00	3.10	41.90	1.12
LEN158C1	44.44	45.74	1.30	BR	48.80	1.30	39.10	8.40	0.00	0.00	3.60	47.50	1.12
LEN158C1	44.44	45.74	1.30	BR	59.90	1.80	44.80	13.30	0.00	0.00	2.80	58.20	1.11
LEN184LC	110.92	112.26	1.34	BR	41.50	3.10	33.30	4.90	0.00	0.20	6.40	---	1.08
LEN185LC	18.99	20.11	1.12	BR	35.20	3.00	28.40	3.80	0.00	0.00	6.00	---	1.09
LEN186LC	21.94	23.32	1.38	BR	43.50	1.40	39.50	2.60	0.00	0.00	6.00	---	1.09
LEN076C4	49.38	53.80	4.42	BV3	33.40	1.60	25.30	6.50	0.00	0.00	3.10	31.80	1.11
LEN076C4	49.38	53.80	4.42	BV3	36.50	0.80	28.10	7.60	0.00	0.00	3.90	35.70	1.11
LEN018C	58.89	61.87	2.98	VL	38.70	10.60	17.70	9.40	0.50	0.50	3.40	27.60	1.13

HOLENAME	FROM (m)	TO (m)	Thickness	SEAM	Total Inertinite (%)	Inertinite							Vitrinite Reflectance
						Fusinite (%)	Semifusinite (%)	Detrinite (%)	Macrinite (%)	Micronite (%)	Total Minerals (%)	Seminertinite (%)	
LEN030C	55.00	58.36	3.36	VL	43.00	14.10	19.00	8.70	0.90	0.30	2.70	28.60	1.12
LEN030C2	56.26	59.32	3.06	VL	46.50	1.20	36.70	8.40	0.20	0.00	3.70	45.40	1.15
LEN030C2	56.26	59.32	3.06	VL	64.80	1.80	52.00	11.00	0.00	0.00	6.10	62.90	1.17
LEN031C1	44.64	46.98	2.34	VL	31.10	1.70	22.10	7.10	0.20	0.00	3.50	29.40	1.09
LEN031C1	44.64	46.98	2.34	VL	58.50	2.80	45.90	9.40	0.40	0.00	4.50	55.70	1.09
LEN042C1	80.14	81.70	1.56	VL	33.50	2.50	25.20	5.80	0.00	0.00	2.30	31.00	1.11
LEN042C1	80.14	81.70	1.56	VL	55.50	3.20	39.80	12.50	0.00	0.00	3.20	52.90	1.11
LEN045C2	90.89	94.42	3.53	VL	40.70	1.00	30.20	9.50	0.00	0.00	2.60	39.70	1.18
LEN045C2	90.89	94.42	3.53	VL	59.20	1.60	45.20	12.20	0.20	0.00	3.80	57.60	1.18
LEN046C2	72.05	75.15	3.10	VL	33.60	1.20	25.20	7.20	0.00	0.00	2.70	32.40	1.15
LEN046C2	72.05	75.15	3.10	VL	60.00	1.20	46.30	12.50	0.00	0.00	4.70	58.80	1.15
LEN046XC	71.75	75.24	3.49	VL	34.30	2.80	25.60	5.90	0.00	0.00	3.20	31.50	1.10
LEN046XC	71.75	75.24	3.49	VL	58.10	2.40	47.30	8.40	0.00	0.00	4.10	55.70	1.09
LEN048XC	73.24	76.00	2.76	VL	29.90	2.10	21.30	6.50	0.00	0.00	2.40	27.80	1.05
LEN048XC	73.24	76.00	2.76	VL	63.50	2.00	52.10	9.40	0.00	0.00	3.90	61.50	1.04
LEN050C1	43.68	46.49	2.81	VL	36.20	1.20	26.60	8.40	0.00	0.00	2.50	35.00	1.10
LEN050C1	43.68	46.49	2.81	VL	58.60	4.00	45.60	9.00	0.00	0.00	3.80	54.60	1.10
LEN121C1	70.39	73.90	3.51	VL	39.70	1.40	27.10	11.20	0.00	0.00	2.90	38.30	1.17
LEN121C1	70.39	73.90	3.51	VL	66.80	1.20	52.40	13.00	0.20	0.00	5.30	65.60	1.17
LEN146XC	267.77	271.05	3.28	VL	60.70	4.40	47.30	9.00	0.00	0.00	5.60	56.30	1.11
LEN146XC	267.77	271.05	3.28	VL	31.30	2.50	23.50	5.10	0.20	0.00	3.10	---	1.14
LEN158C1	72.53	76.12	3.59	VL	36.20	1.20	25.30	9.70	0.00	0.00	2.80	35.00	1.17
LEN158C1	72.53	76.12	3.59	VL	68.80	1.30	53.60	13.70	0.20	0.00	3.60	67.60	1.15
LEN185LC	48.90	51.21	2.31	VL	28.60	---	---	---	---	---	2.50	---	1.08
LEN185LC	48.90	51.21	2.31	VL	60.30	2.20	53.10	4.60	0.00	0.40	5.40	---	1.07
LEN186LC	60.03	62.41	2.38	VL	28.60	---	---	---	---	---	2.70	---	1.12
LEN186LC	60.03	62.41	2.38	VL	58.60	5.60	47.30	5.10	0.00	0.60	4.50	---	1.12
LEN076C1	47.80	51.00	3.20	VL1	34.70	4.60	23.40	6.70	0.00	0.00	2.50	30.10	1.14
LEN076C1	47.80	51.00	3.20	VL1	58.60	2.50	46.70	9.40	0.00	0.00	5.90	56.10	1.15
LEN018C	57.65	58.89	1.24	VU	40.90	10.30	20.50	8.80	0.60	0.70	1.80	29.90	1.10
LEN031C1	42.50	43.76	1.26	VU	69.70	2.50	57.60	9.60	0.00	0.00	4.60	67.20	1.14
LEN042C1	78.10	80.14	2.04	VU	75.40	2.60	64.20	8.60	0.00	0.00	3.30	72.80	1.14
LEN044XC	90.70	96.02	5.32	VU	41.50	1.40	34.10	6.00	0.00	0.00	2.50	40.10	1.14
LEN044XC	90.70	96.02	5.32	VU	71.10	3.10	60.10	7.90	0.00	0.00	2.50	68.00	1.14
LEN050C1	41.85	43.68	1.83	VU	73.40	2.30	61.10	9.80	0.20	0.00	3.10	71.10	1.17