Palaeontological Heritage component of FibreCo Telecommunications, basic assessment for the proposed fibre optic data cable project: Route 5: Port Elizabeth to Durban

DEA REFERENCE: 12/12/20/2161

Prepared for: **SRK Consulting**
SRK House
265 Oxford Road
Illovo 2196
South Africa

Compiled by: Robert Gess
Bernard Price Institute for Palaeontological Research
University of the Witwatersrand
(Honorary staff member of the Albany Museum)

c/o Box 40
Bathurst
6166
robg@imaginet.co.za

March 2011

Contents:

Background

SRK Consulting Pty (Ltd) ("SRK") has been appointed by FibreCo Telecommunications ("FibreCo"), to undertake a BAR in terms of the National Environmental Management Act (NEMA), (Act No. 107 of 1998) as amended in 2010 for the construction and operation of an optic fibre data cable and associated infrastructure linking certain cities and towns in South Africa. The authorisation of the BA study will be managed by the Department of Environmental Affairs (DEA).

This BA (DEA reference 12/12/20/2161) deals with the section of the route linking Port Elizabeth and Durban. Separate BA"s are being undertaken for other sections of the route in South Africa. The FibreCo data cable is anticipated to follow national/ provincial road servitudes. Exact details regarding road cutting and river crossings have not yet been finalized.

Rob Gess consulting was contracted on 17th March 2011 to conduct a phase one Palaeontological Impact Assessment for this and five other routes. The tight time constraints on this project only permitted a drive through examination of sensitive routes with very limited sampling, together with a basic desktop assessment.

Geology

The bedrock underlying this route is representative of much of the geological history of the Eastern Cape. It includes ancient basement comprising 1000 million year old granites and metamorphic rocks of the Natal Metamorphic suite; Ordivician quartzites of the Natal Group and Peninsular Formation (Table Mountain Group, Cape Supergroup); Late Devonian to Early Carboniferous quartzites and shales of the Witteberg Group; Late Carboniferous to mid Triassic rocks of the Karoo Supergroup (including the Dwyka, Ecca and Beaufort Groups); dolerites associated with the Jurassic eruptions of the Stormsberg Group; late Jurassic to Cretaceous sediments of the Sundays River and Kirkwood formations (Uitenhage Group); Triassic deposits of the Alexandria and Berea Formations; and Quaternary cover, including the Nanaga and Bluewaterbay Formations of the Algoa Group.

Natal Metamorphic suite gneiss and schists were transformed by compression during the assembly of the Supercontinent Rodinia from the continents Nena, Ur and Atlantica. They, together with other rocks of the Namaqualand Natal Metamorphic belt, originated as sediments deposited in the seaway between Ur and Nena. Closure of this Sea and compression of its floor during the prolonged collision of Ur and Nena resulted in the formation of enormous mountains the roots of which were intruded with granite forming magmas due to melting of subducted crust.

Quartzites of the **Natal Group** were formed following early rifting of the supercontinent Gondwana during the Ordivician. As a rift valley began to form, rivers diverted into it and deposited the coarse sands which produced the Natal Group.

This rift widened and accumulated sediments, at first largely fluvial and later marine, which today form the substance of the Cape Supergroup. The **Cape Supergroup** is subdivided into

three Groups: the lowermost Table Mountain Group, middle Bokkeveld Group and uppermost Witteberg Group.

The Peninsular Formation of the **Table Mountain Group**, partially underlying Port Elizabeth, belongs to the early (Ordivician) fluvial phase of this sequence.

The **Bokkeveld Group** is not represented along this route.

The route does however traverse much of the **Witteberg Group**. The Witteberg Group is subdivided into a lower Weltevrede Subgroup and an upper Lake Mentz Subgroup.

The Weltevrede Subgroup, in the Western Cape is subdivided into the Swartruggens, Blinkberg and Wagendrift Formations. The Swartruggens Formation consists of buff to crimson/purple shales, with thin interbedded sandstones. This is underlain by the far more massive quartzites of the Blinkberg Formation, and the shaly Wagendrift Formation.

Within the Eastern Cape the Weltevrede Subgroup is not as thick as in the west and is generally exposed along the coastal plain, where it is deeply weathered making it difficult to map. The sequence, as in the west, tends to be shaly at the bottom and top, with a distinctly coarser grained middle section, however differentiation of the individual units of the Weltevrede Formation has not generally been undertaken in mapping of the Eastern Cape.

The Weltevrede Subgroup consists of sediments deposited along the shoreline of the cold-water Agulhas Sea, by rivers disgorging into lobate delta systems.

The Lake Menz Subgroup consists of four subunits (the Witpoort, Kweekvlei, Floriskraal and Waaipoort formations.

The Witpoort Formation, the basal member, is characterised by thick light coloured quartzites, consolidated from mature quartz sand accumulated along a sandy shoreline, under linear barrier-island conditions. These form distinctive, resilient ridges that may be traced along the full length of the Cape Fold Belt. Thin black shale layers and lenses within this formation include deposits derived from muds carried by river systems into coastal estuarine lagoons.

A sudden rise in relative sea level, corresponding to the Tournasion transgression at the end of the Devonian Period, terminated the sandy shoreline deposition of the Witpoort Formation, which is overlain by fine muddy sediments of the lower Carboniferous Kweekvlei Formation. These shales generally weather to form lowered topography breaking away from the Witpoort Formation ridges.

As the basin gradually shallowed, delta front and shoreline sands of the Floriskraal Formation encroached on the underlying silts and muds of the Kweekvlei Formation.

Flouriskraal strata are in turn overlain by the Waaipoort mud and siltstone unit. This may represent a lagoonal environment behind and adjoining the prograding Floriskraal shoreline sands. It has been suggested that freshwater and lacustrine indicators, suggest that large lake-like

environments may have developed on the continental margin. Localised glacially related deposits including the Dirkskraal Formation, assigned to the Kommadagga Subgroup, are found overlying Lake Mentz subgroup in some parts of the Eastern Cape.

The Witteberg is terminated by an unconformity, or gap in the geological record, of possibly 30 million years, after which the massive diamictites of the Dwyka Formation were deposited, indicating that an ice age had passed.

This would be in keeping with palaeomagnetic interpretations which suggest that, at the time of deposition of the Witteberg Group, what is now South Africa was within the Antarctic circle.

The strata of the **Karoo Supergroup** were deposited within the Karoo sedimentary Basin, which resulted from shortening and thickening of the southern margin of Africa, with coeval folding and uplift of the Cape Supergroup strata along its southern margin. Lowermost Karoo strata of the Dwyka and lower Ecca Groups were affected by folding in the vicinity of the Cape Fold Belt. Deposition was shifted from the northern edge of the Agulhas Sea to the increasingly freshwater, inland Karoo Basin. The Karoo Supergroup strata are between 310 and 182 million years old and span the Upper Carboniferous to Middle Jurassic Periods. During this interval the basin evolved from an inland sea flooded by a melting ice cap, to a giant lake fed by seasonal meandering (and at times braided) rivers. This lake steadily shrank as it filled with sediment and the basin"s rate of subsidence stabilised. The land became increasingly arid and was covered with wind blown sand towards the end of its cycle. Finally the subcontinent was inundated with basaltic lava that issued from widespread linear cracks within the crust, to form the capping basalts of the Drakensberg Group.

The **Dwyka Group** (particularly here in the south of the basin) consists almost exclusively of diamictite known as the Dwyka tillite. This is a distinctive rock type which, when freshly exposed, consists of a hard fine-grained blueish-black matrix in which abundant roughly shaped clasts are embedded. These vary greatly in both lithology and size. During the formation of the Dwyka, beginning in the Late Carboniferous, southern Africa had drifted over the south pole, whilst simultaneously, the world was experiencing a cold episode. Glaciers flowing into the flooded Karoo basin broke up, melted and discharged a mixture of finely ground rock flour and rough chunks of rock. These formed the matrix and clasts of the Dwyka tillite.

Early in the Permian period the ice sheets retreated and fine muds were washed into the Karoo Basin, forming the Prince Alfred and Whitehill formations of the lower **Ecca Group**. These interfinger at first with the last tillites.

Subsequent deposition of the Collingham, Ripon and Fort Brown and Waterford formations of the Ecca Group resulted from sediment carried into the Ecca Lake by rivers draining the recently up thrust Cape Mountains. These rivers formed deltas where they flowed into the Ecca Lake. Proximally the deltas tended to be sandy. Mud accumulating on the more distal front of the deltas periodically slumped and cascaded down into deep water, spreading out and depositing large layered fan shaped turbidite deposits.

As the Ecca Lake silted up a sub aerial (exposed) shoreline began to develop, initially in the

south east of the basin. The lake steadily shrank towards the centre of the basin, leaving behind flat silty plains across which long rivers meandered from the Cape Mountains towards the much reduced lake. Sands were deposited along the river channels whereas periodic flooding deposited muds on the broad flood planes. These in time came to form the interbedded sandstones and mudstones of the Koonap, Middleton and Balfour formations of the Adelaide Subgroup, **Beaufort Group**.

In the Free State and Kwazulu-Natal the sequence differs due to far longer persistence of the Ecca Lake than in the Eastern Cape. The Volksrust Formation (Ecca Group), a lacustrine shaly unit initially co-eval with the Fort Brown Formation continued to accumulate throughout deposition of the lower two thirds of the Adelaide Subgroup, Beaufort Group, (including the Koonap and Middleton formations which are locally not expressed). The Volksrust Formation is directly overlain by the Normandien Formation, which is the local equivalent of the Balfour Formation (Adelaide Subgroup).

The beginning of the Triassic Period in South Africa was marked by a change in sedimentation, leading to the distinct sandstone dominated lithology of the Katberg Formation (lower Tarkastad Subgroup). Extensive sandy deposits resulted from multi channelled braided river systems that replaced the meandering rivers of the underlying Adelaide Subgroup. This change may have resulted from increased erosion of the landscape due to widespread extinction of plant groups during the end-Permian mass extinction.

A return to a meandering river system, possibly as a result of a recovery of vegetation cover is reflected in the mudstone dominated strata of the Burgersdorp Formation (Tarkastad Subgroup).

During the formation of the volcanic **Drakensberg Group**, during the Jurassic, crack like fissures in the earths crust became filled with molten lava that later cooled to form dolerite dykes. Other magma was injected under pressure between horizontal sedimentary strata and cooled to form extensive horizontal sills of dolerite.

Rocks of the **Uitenhage Group**, comprising the Enon Formation, Kirkwood Formation and Sundays River Formation, were deposited were deposited during the Cretaceous. Only the latter two are represented in this area.

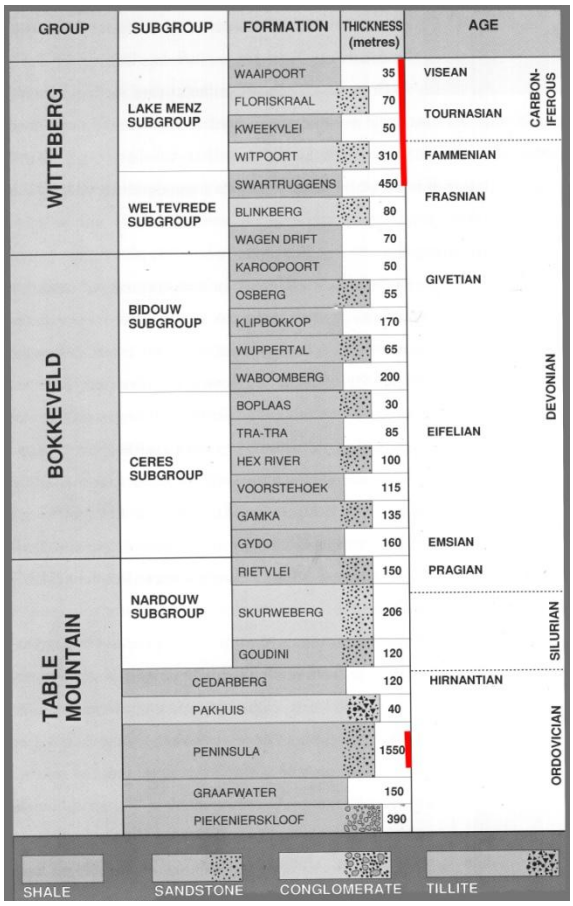
The Uitenhage Group sediments were laid down in one of a number of small coastal basins created by stretching and tearing of the crust during the final breakup of the supercontinent Gondwana during the early Cretaceous, 140 to 120 million years ago.

The **Enon Formation** consists of pebbly conglomerates, deposited where rivers ran down into this steep sided rift basin. More distally, sand and muddy material formed a narrow coastal plane deposited by braided rivers, which would ultimately become the **Kirkwood Formation** strata. Silt and mud washed out onto the marine coastal shelf formed the clays of the **Sundays River Formation**. Three marine transgressions (rises in sea level) during the Cretaceous resulted in interlayering of the Sundays River marine clay deposits and sandy, terrestrial, Kirkwood Formation deposits.

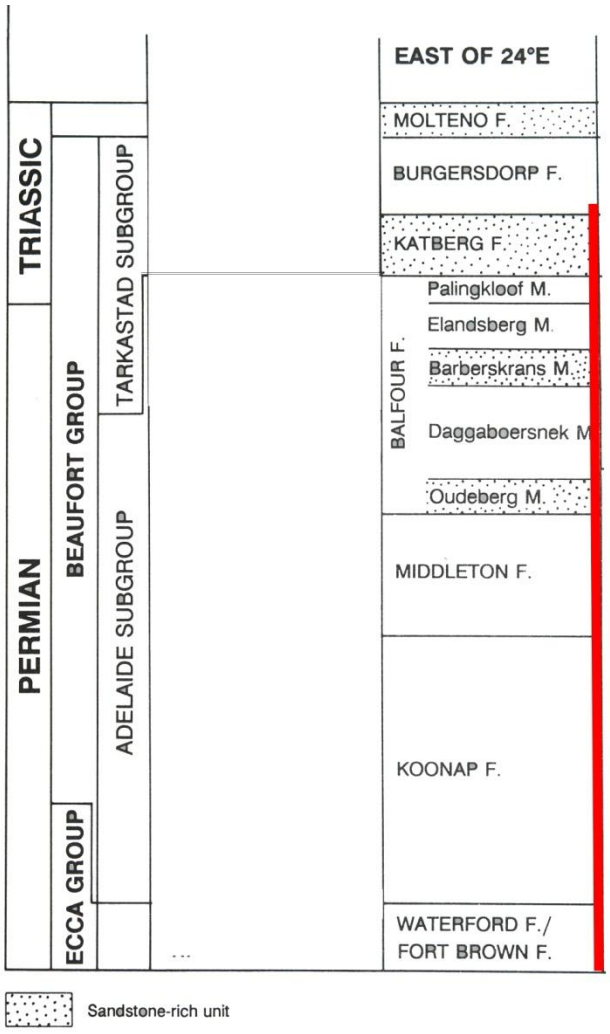
Strata of the Algoa Group were laid down in Tertiary to Quaternary times along the coastline of the Eastern Cape (in particular around the Algoa Bay), and have gradually been uplifted through time. The Miocene to Pliocene aged **Alexandria Formation** (**Algoa Group**) generally consists of alternating layers of calcareous sandstone, conglomerate and coquinite (shelly conglomerate), containing a rich assemblage of marine invertebrates. The Alexandria Formation appears to have been laid down in a full range of coastal depositional environments ranging from shoreface and foreshore to lagoonal and/or estuarine

More recent cover includes the lime-rich **Bluewaterbay Formation** (**Algoa Group**) and the sandy **Nanaga Formation** (**Algoa Group**) which consolidated from dunes of windblown sand.

Similar reddish Tertiary aeolianites comprise the **Berea Formation** of Natal.



Stratigraphy of Ordivician to Carboniferous rocks of the Cape Supergroup.
Red line represents strata affected by the proposed development



Stratigraphy of Permotriassic sedimentary rocks in the Eastern Cape. Red line represents strata affected by the proposed development. F. = Formation, M. = Member
(modified after Rubidge *et al*. In *Biostratigraphy of the Beaufort Group* (1995), Council for Geoscience)

Palaeontology

Most of South Africa‟s known Devonian plant fossils come from shales within the Upper Devonian age lower Witteberg Group (Cape Supergroup) in the Eastern Cape. Plant fossils within these shales were first noted by Bain in 1857, who came across various fossils during road building activities in the vicinity of Kowie River (Port Alfred), Woest‟s Hill and Howison‟s Poort. The first two of these localities would now be considered to be within the outcrop area of the Weltevrede Formation, and the latter within the Witpoort formation.

Bain‟s original material has been lost, however, with ongoing development at the Kowie River Mouth later in the eighteen hundreds, further **Weltevrede Subgroup (Witteberg Group, Cape**

Supergroup) plant fossils were uncovered. These were mainly discovered when the cliffs behind the hospital and the station were cut back, and provided the material for the definition of a few taxa, including lycopods. Associated with the plant fossils were chonchostracan arthropods and eurypterid fragments. Only very cursory collecting, however, is evidenced by the museum collection. Other Weltevrede Formation plant fossils were found on a farm (Sweetfountain) near Bathurst.

Marine invertebrate fossils including bivalves, brachiopods and trilobites have been recorded from the top of the Weltevrede Formation at Howisons Poort, and bivalves are also known from a second locality. "*Spirophyton*" is commonly encountered.

The Howison‟s Poort plant locality mentioned by Bain is located along the cable route, situated about fifteen metres above the bottom of the **Witpoort Formation (Lake Mentz Subgroup, Witteberg Group, Cape Supergroup)** sequence. It consists of a black shale, less than a metre thick, within a cliff of quartz rich sandstones. Various researchers have subsequently recovered plant fragments from pieces of shale that can, with difficulty, be winkled out of the cliff. A number of taxa have been described from this locality, making it significant type locality. Until the 1980s this remained essentially the only known fossil locality within the Witpoort Formation.

Interception of a relatively thick black shale near the top of the Witpoort Formation during roadworks at Waterloo Farm near Grahamstown in 1985 engendered the discovery of sub-Saharan Africa‟s most important Late Devonian fossil site. This site is also situated along the cable route. It is of particular international interest, not just due to its comprehensive preservation of a fauna and flora, but also because it belongs to the latest Famennian age, immediately preceding the world-changing second great extinction event. This was an important time period when enormous environmental upheavals were triggered by the emergence of the first forests, whole groups of organisms went entirely extinct and the earliest tetrapods emerged from the water to exploit the first widespread terrestrial environments.

Research on the Waterloo Farm fossils is ongoing. A fauna of about 20 species of fossil fish has been isolated, of which about a third have thus far been taxonomically defined. Some of these, such as the world‟s oldest fossil lamprey, *Priscomyzon riniensis,* have caused an international stir. *Priscomyzon* provides an example of the unusual type of preservation at Waterloo Farm, where impressions of soft tissues, rather than just bones, are recorded. The fauna also contains a range of armour plated (placoderm) fish, spine finned (acanthodian) fish, ancient sharks, early ray-finned fish, and lobe-finned fish including coelacanths, lungfish and osteolepiforms. These are accompanied by arthropods such as scorpions and giant euryperids („water- scorpions‟), in addition to one of the world‟s most significant records of algae and plants from the latest Devonian.

Plant fossils and various trace fossils are also known from thin reddish shale interbeds within the associated Witpoort Formation quartzites at Waterloo Farm. Three dimensionally preserved lycopod stems are preserved within the quartzites here and at other localities.

The remainder of the Lake Mentz Subgroup, the Kweekvlei Formation, Floriskraal Formation and Waaipoort Formation are all Early Carboniferous in age, the 360 myo Devonian-

Carboniferous boundary (and the Hangenberg Extinction event) having been passed at the top of the Witpoort Formation.

The fine muddy sediments of the **Kweekvlei Formation (Lake Mentz Subgroup, Witteberg Group)** are increasingly silty upwards but have, as yet, yielded only plant fragments and sparse ichnofossils. The overlying **Floriskraal Formation (Lake Mentz Subgroup, Witteberg Group)** is similarly characterised by sparse plant fossils and trace fossils, though acanthodian fish remains have been noted from its upper strata.

From near Port Elizabeth towards the Western Cape, thin carbon-rich lenses, as well as phosphatic and calcitic nodules within the **Waaipoort Formation (Lake Mentz Subgroup, Witteberg Group)** have yielded interesting, though scarce, plant fossils. More significantly, an extensive fish fauna has been described, consisting largely of primitive palaeoniscoids (ray finned fish) with, in addition, acanthodians and sharks. A eurypterid and bivalves have also been collected. Placoderm fish remains, which dominate Witpoort Formation faunal remains are entirely absent from these strata, reflecting their world wide extinction during the Hangenberg (Second Great) Extinction Event at the end of the Devonian.

An important Waaipoort Formation Locality in the Eastern Cape is on the farm Schiethoogte near the Darlington Dam (formerly Lake Mentz), north of Port Elizabeth. Here, two unique mass mortality horizons, a few centimetres apart, have been studied, containing hundreds of whole-bodied palaeoniscoid fishes of a variety of taxa, embedded in a dark silty sandstone.

The Dirkskraal Formation (**Swartwaterspoort Subgroup**, **Witteberg Group**) has been found to contain plant fragments.

Within the study area fossils are not known from the **Dwyka Group (Karoo Supergroup)**.

Probably due to the lack of good outcrop in the Eastern Cape, body fossils have as yet not been found in rocks of the **Whitehill Formation (Ecca Group, Karoo Supergroup),** though invertebrate trace fossils are known from the top of the Ecca Pass. In other parts of the country the Whitehill Formation has, however yielded some exquisite fossils. These include Africa‟s earliest known reptile, the aquatic *Mesosaurus*, early crustaceans, and scarce but beautifully preserved ray-finned fish.

Plant fossils are found in strata of the Ripon **Formation (Ecca Group, Karoo Supergroup)**and **Fort Brown Formation (Ecca Group, Karoo Supergroup)**, for example along the cuttings of Ecca Pass, which is the type locality of the Ecca Group. These belong to the earliest appearance of the *Glossopteris* fauna – named after *Glossopteris*, an early genus of seed plant, that may ultimately have included the ancestors of flowering plants. Fish trails have also been found in the vicinity of the Ecca Pass, underlying the potential that fish fossils could be recovered from these horizons. A fish fossil was reliably reported from Ecca strata near Fort Brown, but it was destroyed by construction of a roadside drainage ditch before it was collected. Actinopterygian fish have been collected from these strata in other parts of the country.

The flood planes of the **Beaufort Group (Karoo Supergroup)** provide an internationally

important record of life during the early diversification of land vertebrates. Giant amphibians coexisted with diapsid reptiles (the ancestors of dinosaurs, birds and most modern reptiles), anapsids (which probably include the ancestors of tortoises) and synapsids, the dominant group of the time which included the diverse therapsids (including the ancestors of mammals). Rocks of the Beaufort Group provide the worlds most complete record of the important transition from early reptiles to mammals

Therapsid diversity, along with that of most plant and animals was decimated during the end-Permian extinction event, a serious contender for the most severe extinction event to affect life on Earth. Ongoing research on the effects of this extinction event is facilitated by the detailed record, afforded by Beaufort Group strata, of life immediately before and after the event, as well as the gradual recovery of life afterwards.

The Beaufort Group is subdivided into a series of biostratigraphic units on the basis of its faunal content. The lowermost, the Eodicynodon Assemblage Zone is not represented in this area.

The **Koonap Formation (Adelaide Subgroup, Beaufort Group, Karoo Supergroup)** within the study area largely corresponds with the *Tapinocephalus* Assemblage Zone, though also including the lower part of the *Pristerognathus* Assemblage zone. The *Tapinocephalus* Assemblage Zone contains a diversity of therapsids including a large range of Dinocephalia (including *Tapinocephalus*), Gorgonopsia and Therocephalia, as well as a small number of Dicynodontia, *Hipposaurus*, a member of the Biarmosuchia, and *Elliotsmithia*, a member of the Pelycosauria. Fish (*Namaichthys*, *Atherstonia* and *Elonichthys*), Amphibia (*Rhinesuchus*) and a number of captorinid Reptilia (*Bradysaurus*, *Eunotosaurus*, and *Embrithosaurus*) are known, in addition to trace fossils, plant fossils and the bivalve *Paeleomutela*. Transition to the *Pristerognathus* Assemblage Zone is market by the abrupt and permanent disappearance of all members of the Dinocephalia and massive (though not permanent) reduction in diversity of the Gorgonopsia and Therocephalia. Pelycosauria also do not occur beyond the *Tapinocephalus* Assemblage Zone.

The **Middleton Formation** (**Adelaide Subgroup, Beaufort Group, Karoo Supergroup)** includes the upper *Pristerognathus*, *Tropidostoma* and lower *Cistecephalus* Assemblage zones. These zones are characterised by a changing cast of captorhinind and eosuchian reptiles as well as therapsids of the Dicynodontia, Biarmosuchia, Gorgonopsia and Therocephalia. Small numbers of fish and Amphibia are also known. A diversity of plant fossils of the Glossopteris fauna, as well as a number of trace fossils have also been described.

Though including the upper *Cistephalus* Assemblage Zone and lowermost *Lystrosaurus* Assemblage Zones, the **Balfour Formation** (**Adelaide Subgroup, Beaufort Group, Karoo Supergroup)** corresponds to the *Dicynodon* Assemblage Zone. Characterised by the co-occurence of *Dicynodon* and *Theriognathus* this zone demonstrates the Beaufort Groups greatest diversity of vertebrate taxa, including numerous taxa of dicynodont, biarmosuchian, gorgonopsian and therocephalian and cynodont therapsid Synapsida, together with diverse captorhinid Reptilia and less well represented eosuchian Reptilia, Amphibia and Pisces. *Glossopteris* flora plants and trace fossils are also described.

A marked faunal change occurs between the *Dicynodon* and *Lystrosaurus* Assemblage Zones approaching the top of the Balfour Formation, corresponding with the major extinction event associated with the Permo-triassic boundary. The *Lystrosaurus* Assemblage Zone spans the uppermost (Palingkloof) member of the Balfour Formation, the **Katberg Formation (Tarkastad Subgroup, Beaufort Group, Karoo Supergroup)** and the lower part of the Burgersdorp Formation **(Tarkastad Subgroup**, **Beaufort Group, Karoo Supergroup).**

The *Lystrosaurus* Assemblage Zone is dominated by a single genus of dicynodont, *Lystrosaurus,* which together with the captorhinid reptile, *Procolophon*, characterise this zone. Biarmosuchian and gorgonopsian Therapsida do not survive into the *Lystrosaurus* Assemblage Zone, though therocephalian and cynodontian Therapsida exhibit moderate abundance. Captorhinid Reptilia are reduced, however an unprecedented diversity of giant amphibians characterises this interval. The effects of the end Permian extinction event are also evident in the extensive and important record of fossil plants present in the rocks of the Karoo. Whereas faunas of Permian age are dominated by a wide range of early seed plants, the Glossopteridales (which probably include the ancestors of modern gymnosperms and ultimately angiosperms), this group appears to have gone entirely extinct during the end-Permian extinction. The rocks of the Karoo provide an unrivalled sequential record of these changes and the diversification of other groups of plants in the aftermath of the extinction. The strata of the Karoo basin have also yielded fossil insects and insect leaf damage of a range of ages.

Dolerite, being an intrusive igneous rock, contains no fossils.

The Cretaceous deposits of the **Sundays River Formation** (**Uitenhage Group**) contain a wealth of marine invertebrate remains, including a range of ammonite species, nautiloids, bellomnites, bivalves and gastropods. In addition, the skull and partial skeleton of a 3 metre long Plesiosaur (marine reptile) is known from Sundays River Formation rocks in the Zwartkops River valley.

The Kirkwood Formation is South Africa‟s primary source of Cretaceous Dinosaur fossils. It was in Kirkwood Formation rocks, on the banks of the Bushman‟s River that South Africa‟s first dinosaur discovery was made in 1845 by William Atherstone and his wife. Originally dubbed “Cape Iguanadon” the fragmentary remains have, more recently been shown to be those of a Stegosaurus. Remains of two types of Sauropod Dinosaur, as well as a Theropod Dinosaur and an Ornithopod Dinosoar have subsequently been collected from Kirkwood Formation strata at various localities. Recent research has also revealed the remains of a primitive lizard, a type of crocodile and a primitive early mammal. These remains are sometimes found in association with fossil logs and chunks of fossil wood, which are fairly common in Kirkwood Formation rocks. Associated mudstones have yielded a range of finely preserved plant leaves and fructifications, including those of a number of species of ferns, cycads and conifers

In the sandstones of the **Alexandria Formation** (**Algoa Group**) some gastropod and pelycopod shells are preserved, as well as *in situ Echinodiscus* (“pansy shells”), and burrows. Oyster shells occur within the conglomerate, whereas the coquinite layer consists of about 70 percent invertebrate remains, including the remains of pelycopods, gastropods, corals, bryozoans,

brachiopods, echinoids and sharks teeth. Some mammal bones have also been recorded.

The **Bluewater Bay Formation** (**Algoa Group**) and **Nanaga Formation** (**Algoa Group**) have not proven to be fossiliferous.

Site Visit

After a preliminary desktop investigation a drive through survey of the more sensitive portion of the Port Elizabeth to Durban route (from Port Elizabeth in the Eastern Cape to Harding in Southern Natal) was conducted in order to assess the actual outcrop of palaeontologically sensitive strata along the cable route. Due to time limitations only very limited sampling was possible. As a general rule, palaeontologically sensitive outcrop was found to occur where the highway, and therefore the route, cuts through the valleys of large rivers, set back from the coast.

Between Port Elizabeth and Grahamstown along the cable route, there is negligent outcrop of fossiliferous strata within the Algoa Basin so Cretaceous and Tertiary aged palaeontological material is unlikely to be disturbed.

Where the route descends into the valley of the Komga River the road passes between shale rich cuttings into strata of the Weltevrede Subgroup (Witteberg Group, Cape Supergroup). Approaching Seven Fountains cuttings intersecting potentially fossiliferous strata of both the Weltevrede Formation and Witpoort Formation (Lake Mentz Subgroup,Witteberg Group, Cape Supergroup) are encountered. Similar cuttings become increasingly numerous between Seven Fountains and Grahamstown. **Significantly the cable route passes through the only two known productive Witpoort Formation fossil localities, the lower Witpoort Formation Howisonspoort locality, a type locality for a number of plant taxonomic groups, and the upper Witpoort Formation Waterloo Farm locality, the only high palaeolatitude site of its age in the world, and the type locality for a broad range of algal, plant and fish taxa** (see maps and photos 1 and 2).

Photo 1. The Howisonspoort site in the lower Witpoort Formation

Photo 2. Black shale horizons just west of the Waterloo Farm locality (upper Witpoort Formation)

Passing through the Fish River Valley extensive road cuttings through Ecca Group (Karroo Supergroup) shale are intercepted by the route (see maps and photo 3).

Photo 3. Ecca strata exposed in the Fish River valley

The long cuttings that negotiate the Keiskamma River valley, in turn expose good outcrops of the Middleton Formation (Adelaide Subgroup, Beaufort Group, Karroo Supergroup) (see maps and photo 4).

Photo 4. Middleton Formation strata along the route approaching the Keiskamma River

Further Adelaide Subgroup strata of the Middleton and Balfour Formations outcrop along the route, particularly in the vicinity of Buffalo River, near King Williams Town and East London, for about 40 kilometers north of East London as the road cuts its way back up into the interior, in the Kei River Pass (see maps).

As the road makes its way through the valley of the Mbashe River, steep cuttings expose strata of the Katberg Formation (Tarkastad Subgroup, Beaufort Group) (see maps and photo)

Photo 5. Katberg Formation interbedded sandstones and mudstones west of the Mbashe River

Occasional outcrops occur in Tarkastad Group strata, principally of the Katberg Formation, as far north as mount Frere.

Photo 6. Tarkastad Subgroup strata exposed at point marked on map

Between Mount Frere and Tarkastad the route once more traverses strata of the Adelaide subgroup, which outcrop beneath the massive 1000 metre thick dolerite sill that forms the Insizwa mountain to the north of the road.

Photo 7. Adelaide Subgroup strata south of Mount Ayliff (30˚46'31S, 029˚23'30E) (see map)

Photo 8. Fossilised invertebrate burrows at site south of Mount Ayliff.

Photo 9. Impressions of Paracalamites (Sphenophyte) stems at site south of Mount Ayliff

Potentially fossiliferous outcrops of Adelaide Subgroup strata continue for 30 km south of Kokstad along the road to Harding.

The route from Harding to Durban was not surveyed as it was assumed to be of low palaeontological sensitivity. This is for two reasons. Firstly, it mainly lies along a deeply weathered subtropical coastline with low topography. Secondly most of the route is underlain by rocks with little or no palaeontological potential. These include ancient granites and metamorphic gneiss and schists of the Natal Metamorphic Suite, coarse Ordivician sandstones of the Natal Group, and Tertiary Aeolian sands of the Berea Formation.

Due to time constraints side routes and alternative routes within the Eastern Cape were not evaluated as part of this survey.

Conclusion and Recommendations

There are a large number of road cuttings along this route consisting of strata of potentially very high palaeontological importance. These include very important type localities in Witteberg strata near Grahamstown, as well as a virtual cross section through Karoo strata exposed in the former Ciskei and Transkei. For historical reasons these latter areas have been extremely under researched in the past and any palaeontological material that can be recovered through this process would be extremely valuable in helping to complete the biostratigraphic map of the Karoo Group, for which a data hole exists in these areas.

It is therefore recommended that:

1. Excavations into road cuttings identified as sensitive during the survey are monitored on site by a qualified palaeontologist, who should collect and log important palaeontological material identifiable prior to cutting, as well as material freshly disturbed during cutting.

2. Excavation crews should be warned to be on the lookout for palaeontological material when working in areas between those identified to be of likely palaeontological sensitivity. Any suspected palaeontological material should immediately be reported to the palaeontologist for assessment.

3. No side routes or alternate routes should be utilised without prior palaeontological assessment.