Fig. 36. Poorly-sorted downwasted sandstone gravels capping Balfour Formation bedrocks, hill crest site on Klipfonteyn 150 (Loc. 234).

4. PALAEONTOLOGICAL HERITAGE WITHIN THE STUDY REGION

The overall palaeontological sensitivity of the Beaufort Group sediments is high (Almond *et al*. 2008). These continental sediments have yielded one of the richest fossil records of land-dwelling plants and animals of Permo-Triassic age anywhere in the world. A chronological series of mappable fossil biozones or assemblage zones (AZ), defined mainly on their characteristic tetrapod faunas, has been established for the Main Karoo Basin of South Africa (Rubidge 1995). Maps showing the distribution of the Beaufort assemblage zones within the Main Karoo Basin have been provided by Keyser and Smith (1977-1978) (Fig. 37) and Rubidge (1995), and for the Graaff-Reinet sheet area they are available in Hill (1993). According to the latest biozonation map produced by Van der Walt *et al.* (2010) the Nojoli study area to the east of Cookhouse lies largely or entirely within the *Cistecephalus* Assemblage Zone (Fig. 38).

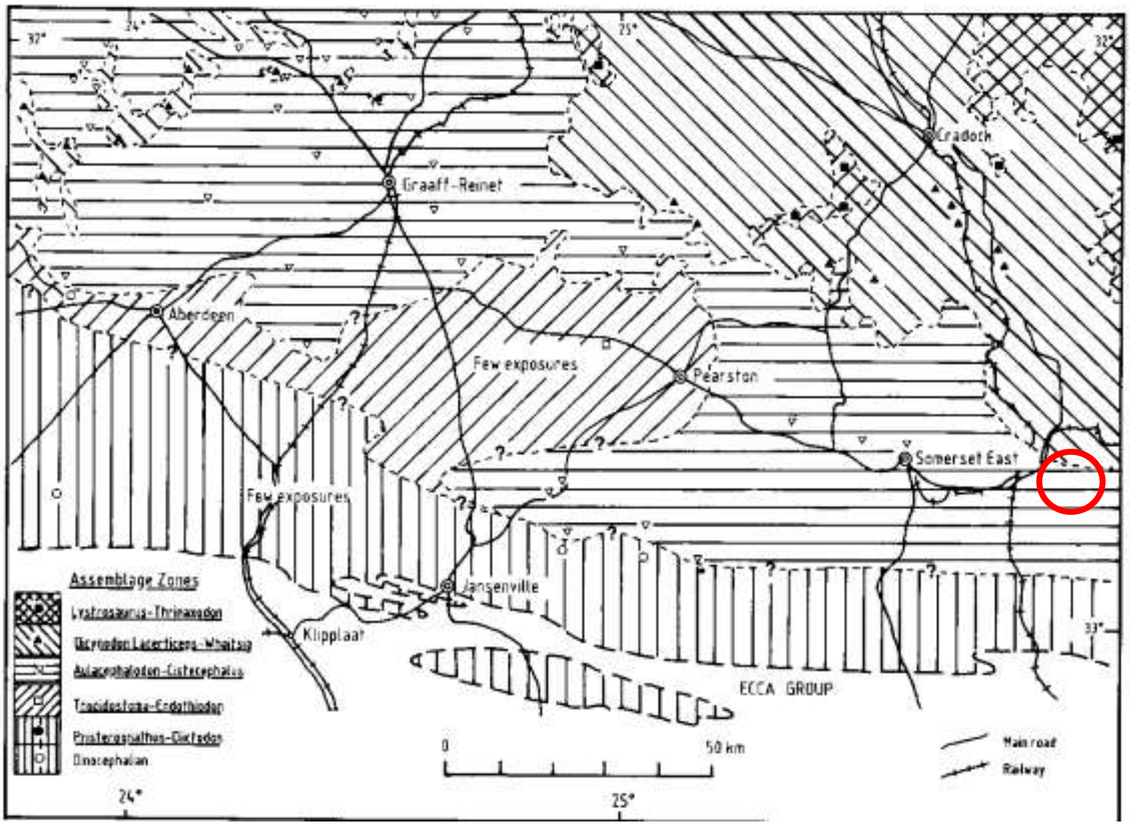

Fig. 37. Distribution of Beaufort Group fossil assemblage zones in the Graaff-Reinet sheet area (After Keyser & Smith 1977-78). The Nojoli Wind Farm study area to the east of Cookhouse, indicated by the red circle, lies largely in the *Cistecephalus* Assemblage Zone (previously known as the *Aulacephalodon – Cistecephalus* Zone) (Compare following figure). Note the absence of earlier fossil vertebrate records from this particular area of the Great Karoo.

Fossil vertebrate remains appear to be surprisingly rare in the Lower Beaufort Group outcrop area near Cookhouse compared to similar-aged deposits further west within the Great Karoo (Almond 2010, 2013c). The important compendium of Karoo fossil faunas by Kitching (1977) lists numerous finds from the *Cistecephalus* Assemblage Zone near Pearston, some 75 km to the WNW of the study area. A few therapsid genera - the dicynodonts *Emydops* and *Cistecephalus plus* the therocephalian *Ictidosuchoides* – are reported from Bruintjieshoogte, between Pearston and Somerset East, although fossils are recorded as rare even here, despite the excellent level of exposure. Sparse dicynodonts are also mentioned from Bedford, *c*. 30km to the ENE of Cookhouse. Fossils of the long-ranging, small, communal burrowing dicynodont *Diictodon* are recorded from Slaghtersnek to the south of Cookhouse (precise location not provided, Kitching 1977, p. 66).

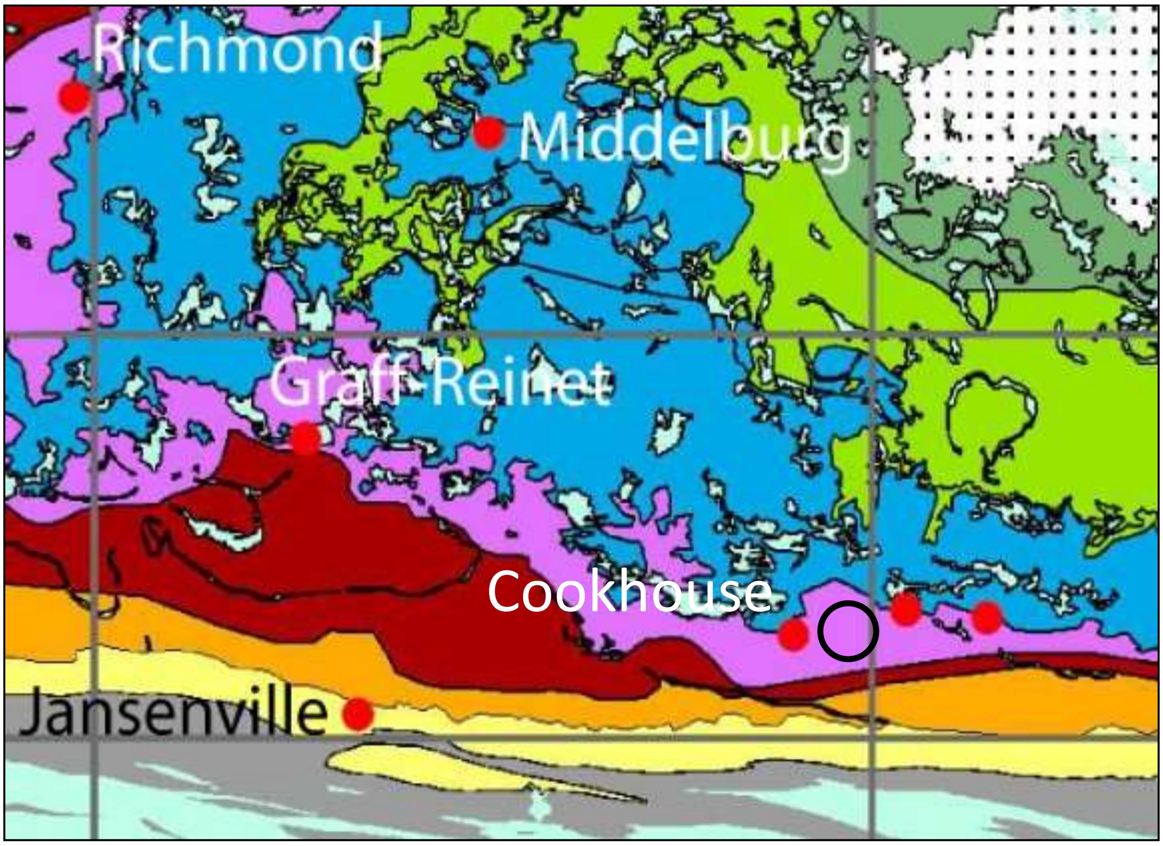

Fig. 38. Extract from the most recent fossil assemblage zone map for the Main Karoo Basin showing the main biozone represented in the Nojoli Wind Farm study area between Cookhouse and Bedford (black circle), *viz*. the *Cistecephalus* Assemblage Zone (lilac) (Map modified from Van der Walt *et al.* 2010).

Apart from a few isolated postcranial bone fragments, no vertebrate remains were found within the Lower Beaufort Group sediments during recent palaeontological field studies for wind farm projects near Cookhouse and Bedford by De Klerk (2010) and Durand (2012). A limited number of well-preserved dicynodont skulls (probably *Oudenodon, Diictodon*) as well as scattered postcranial therapsid remains, sphenophytes (horsetail ferns), locally abundant silicified wood (some showing insect borings), and low diversity assemblages of horizontal burrows (including *Scoyenia* arthropod scratch burrows) were recorded from the Middleton Formation in the Cookhouse – Middleton area during recent palaeontological field studies by the author (Almond 2010b, 2011, 2013c). A couple of poorly-preserved therapsid tracks are also recorded from this succession near Middleton (Prof. Bruce Rubidge, pers. comm., and Almond 2011, 2013c). The recent discovery of a specimen of the rare, turtle-like parareptile *Eunotosaurus* in the same area supports the assignation of the lower Middleton Formation succession to the *Pristerognathus*

Assemblage Zone, correlated with the Poortjie Member of the Teekloof Formation of the western Main Karoo Basin (Day *et al*. 2013).

The reason for the comparative scarcity of fossil material within the Beaufort beds near Cookhouse is unknown. It might be related to the area's southern, high palaeolatitudinal position within the N-S orientated Main Karoo Basin. The comparative scarcity of richly calcretized pedogenic horizons, gypsum pseudomorphs, desiccation cracks and maroon mudrocks may suggest colder, wetter climates here. The paucity of coarse clastic material, the rarity of deeply erosive channel bases within the river systems, the soft-sediment deformation seen at some channel sandstone bases, and the high proportion of ferruginous and pyritic calcrete nodules possibly suggest distal, swampy environments that may have been less conducive to terrestrial wildlife. Reducing conditions within the basinal mudrocks, as indicated by the common occurrence of pyrite within sandstones and secondary nodules, would have favoured the preservation of plant material, such as wood, over vertebrate bones and teeth. This is all highly speculative, however!

4.1. Middleton Formation

The Middleton Formation comprises portions of three successive Beaufort Group fossil assemblage zones (AZ) that are largely based on the occurrence of specific genera and species of fossil therapsids. These are, in order of decreasing age, the *Pristerognathus*, *Tropidostoma* and *Cistecephalus* Assemblage Zones (Rubidge 1995). The three biozones have been assigned to the Wuchiapingian Stage of the Late Permian Period, with an approximate age range of 260-254 million years (Rubidge 2005). According to published maps showing the distribution of the Beaufort assemblage zones within the Main Karoo Basin (Keyser & Smith 1979, Hill 1993, Rubidge 1995), the upper Middleton Formation succession to the east of Cookhouse lies within the ***Cistecephalus* Assemblage Zone** (= upper *Cistecephalus* Biozone or *Aulacephalodon-Cistecephalus* Assemblage Zone of earlier authors; see table 2.2 in Hill 1993 and Fig. 38 herein).

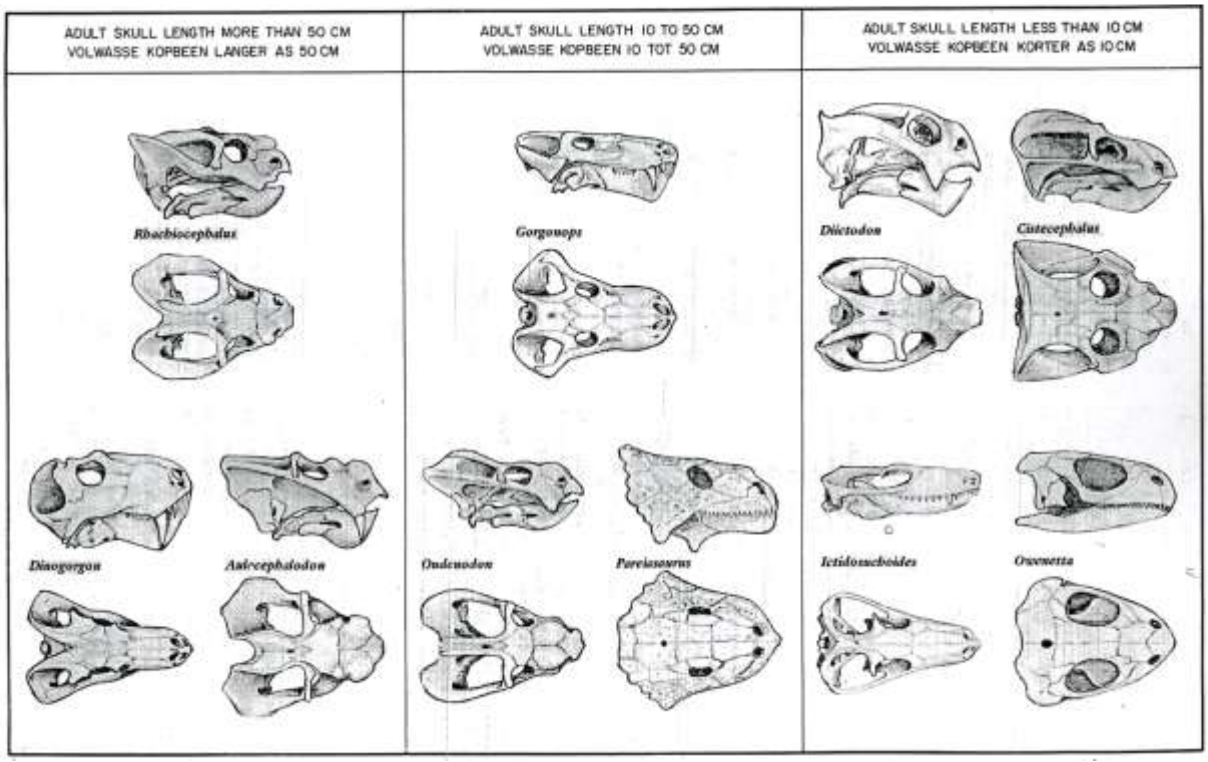

Fig. 39. Skulls of characteristic fossil vertebrates from the *Cistecephalus* Assemblage Zone (From Keyser & Smith 1977-1978). *Pareiasaurus* a large herbivore, and *Owenetta*, a small insectivore, are true reptiles. The remainder are therapsids or "mammal-like reptiles". Of these, *Gorgonops* and *Dinogorgon* are large flesh-eating gorgonopsians, *Ictidosuchoides* is an insectivorous therocephalian, while the remainder are small – to large-bodied herbivorous dicynodonts.

The following major categories of fossils might be expected within *Cistecephalus* AZ sediments in the study area (Keyser & Smith 1979, Anderson & Anderson 1985, Hill 1993, Smith & Keyser *in* Rubidge 1995, MacRae 1999, Cole *et al*., 2004, Almond *et al*. 2008):

- isolated petrified bones as well as rare articulated skeletons of **terrestrial vertebrates** such as true **reptiles** (notably large herbivorous pareiasaurs, small insectivorous owenettids) and **therapsids** or "mammal-like reptiles" (*e.g.* diverse herbivorous dicynodonts, flesh-eating gorgonopsians, and insectivorous therocephalians) (Fig. 39)
- aquatic vertebrates such as large **temnospondyl amphibians** (*Rhinesuchus*, usually disarticulated), and **palaeoniscoid bony fish** (*Atherstonia*, *Namaichthys*, often represented by scattered scales rather than intact fish)
- freshwater **bivalves** (*Palaeomutela*)
- **trace fossils** such as worm, arthropod and tetrapod burrows and trackways, coprolites (fossil droppings)

- **vascular plant remains** including leaves, twigs, roots and petrified woods ("*Dadoxylon*") of the *Glossopteris* Flora (usually sparse, fragmentary), especially glossopterid trees and arthrophytes (horsetails).

As far as the biostratigraphically important tetrapod remains are concerned, the best fossil material is generally found within overbank mudrocks, whereas fossils preserved within channel sandstones tend to be fragmentary and water-worn (Rubidge 1995, Smith 1993). Many fossils are found in association with ancient soils (palaeosol horizons) that can usually be recognised by bedding-parallel concentrations of calcrete nodules.

No fossil vertebrate remains were recorded from the limited Middleton Formation exposures examined in the Nojoli Wind Farm study area. Angular blocks of reworked, well-preserved petrified wood were recorded from colluvial gravels on the lower escarpment slopes on Bavians Krantz 151 (Loc. 249, 250, 251, 253) and on Rooy Draai 146 (Loc. 252) (Fig. 34). However, since the wood material was never seen *in situ* within Lower Beaufort sediments, it remains unclear whether the fossil wood fragments recorded in this area are derived from the Middleton Formation itself or, perhaps more likely, are downwasted from channel sandstones of the overlying Oudeberg Member at the base of the Balfour Formation.

4.2. Balfour Formation

The sandstone-dominated Oudeberg Member at the base of the Balfour Formation is also assigned to the *Cistecephalus* Assemblage Zone (Rubidge 1995) whose fossil biota has been treated above. The Assemblage Zone to which the overlying Daggaboersnek Member, whose occurrence within the Nojoli Wind Farm study area has not yet been unequivocally established, should be assigned is less clear (Cole *et al*., 2004). Le Roux and Keyser (1988) report *Cistecephalus* AZ fossils from this member in the Victoria West sheet area, whereas the Daggaboersnek Member in the Middelburg sheet area is assigned to the ***Dicynodon* Assemblage Zone** and this certainly applies to the greater part of the Balfour Formation (Rubidge 1995, Cole *et al*., 2004 p. 21). This younger biozone has been assigned to the Changhsingian Stage (= Late Tartarian), right at the end of the Permian Period, with an approximate age range of 253.8-251.4 million years (Rubidge 1995, 2005).

Fig. 40. Isolated fragment of unidentified fossil bone (2 cm across) embedded in Balfour Formation sandstone float, roadside quarry on Bavians Krantz 151 (Loc. 240).

Fig. 41. Large fragments of well-preserved petrified logs embedded in colluvial deposits overlying the upper Middleton Formation on Bavians Kranz 151 (but probably downwasted from the base of the Balfour Formation) (Loc. 251) (Hammer = 30 cm).

Good accounts, with detailed faunal lists, of the rich Late Permian fossil biotas of the *Dicynodon* Assemblage Zone have been given by Kitching (*in* Rubidge 1995) and by Cole *et al*. (2004). See also the reviews by Cluver (1978), MacRae (1999), McCarthy & Rubidge (2005) and Almond *et al*. (2008). In general, the following broad categories of fossils might be expected within the Balfour Formation in the Cookhouse - Bedford area:

- isolated petrified bones as well as articulated skeletons of terrestrial vertebrates such as true **reptiles** (notably large herbivorous pareiasaurs, small lizard-like millerettids and younginids) and **therapsids** (diverse dicynodonts such as *Dicynodon* and the much smaller *Diictodon*, carnivorous gorgonopsians, therocephalians such as *Theriognathus* (= *Whaitsia*), primitive cynodonts like *Procynosuchus*, and biarmosuchians) (See Fig. 42 herein).
- aquatic vertebrates such as large, crocodile-like temnospondyl **amphibians** like *Rhinesuchus* (usually disarticulated), and palaeoniscoid **bony fish** (*Atherstonia*, *Namaichthys*)
- freshwater **bivalves** (*Palaeomutela*)
- **trace fossils** such as worm, arthropod and tetrapod burrows and trackways, coprolites (fossil droppings)
- **vascular plant remains** including leaves, twigs, roots and petrified woods ("*Dadoxylon*") of the *Glossopteris* Flora (usually sparse, fragmentary), especially glossopterids and arthrophytes (horsetails)

The abundance and variety of fossils within the *Dicynodon* Assemblage Zone decreases towards the top of the succession (Cole *et al*., 2004). From a palaeontological viewpoint, these diverse *Dicynodon* AZ biotas are of extraordinary interest in that they provide some of the best available evidence for the last flowering of ecologically-complex terrestrial ecosystems immediately preceding the catastrophic end-Permian mass extinction (*eg* Smith & Ward, 2001, Rubidge 2005, Retallack *et al*., 2006).

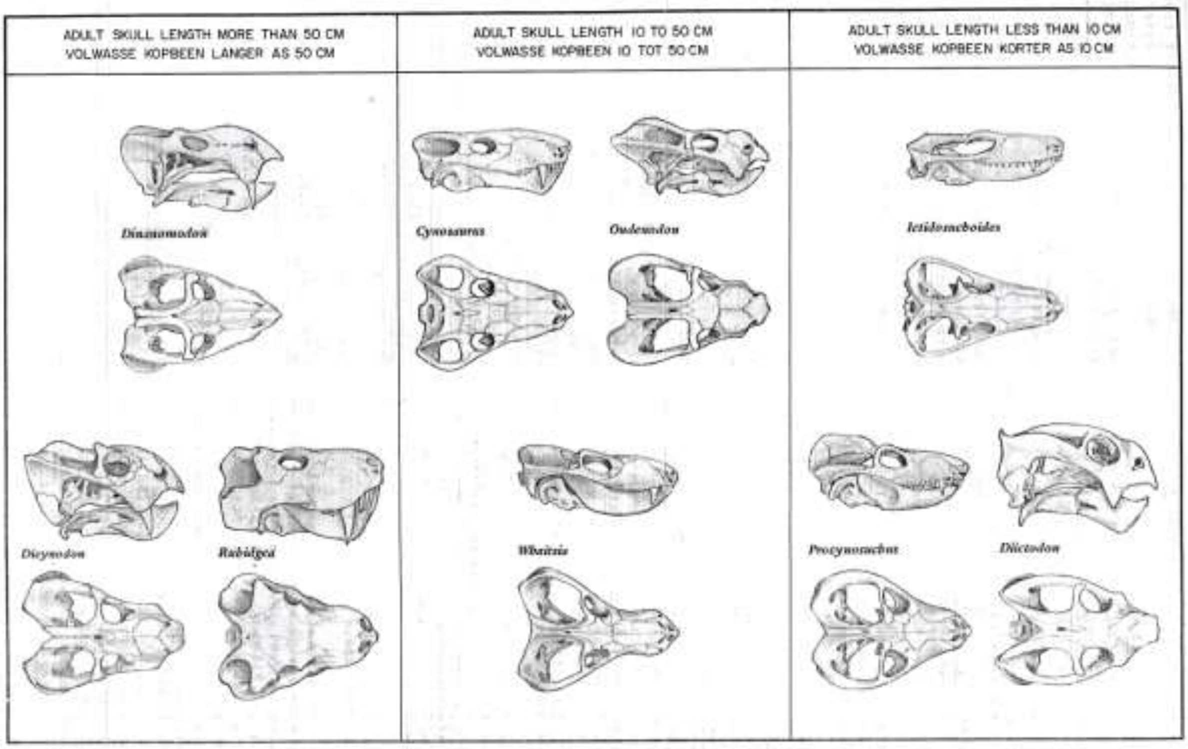

Fig. 42. Skulls of characteristic fossil vertebrates – all therapsids - from the *Dicynodon* Assemblage Zone (From Keyser & Smith 1977-1978). Among the dominant therapsids ("mammal-like reptiles"), *Rubidgea* and *Cynosaurus* are carnivorous gorgonopsians, *Whaitsia* (now *Theriognathus*) is a predatory therocephalian while *Ictidosuchoides* is a small insectivorous member of the same group, *Procynosuchus* is a primitive cynodont, and the remainder are large- to small-bodied dicynodont herbivores.

Even where exposure of potentially fossiliferous overbank mudrocks is quite good and several horizons of pedogenic calcrete nodules are present, no fossil vertebrate remains were recorded from the Balfour Formation within the Nojoli Wind Farm study area with the single exception of a small, unidentified bone fragment from a roadside quarry on Bavians Krantz 151 (Loc. 240) (Fig. 40) (*cf* similar results reported by De Klerk, 2010 and Durand, 2012 in the Cookhouse – Bedford region). Narrow, fairly straight to sinuous horizontal burrows (*cf Helminthoidichnites*) that were probably associated with algal mats were recorded from thin-bedded, grey-green sandstones on Farm 148 (Loc. 227) (Fig. 46). Alternatively, some of the sinuous traces might be *Undichnus* fish swimming trails generated in lacustrine (playa lake or pond) settings on the Late Permian flood plain. Possible sandstone palaeosurfaces, variously flat to undulose, were observed at several localities (*e.g.* Locs. 228, 242) but no convincing tetrapod trackways or other traces were identified. Occasional plant impressions, mainly of indeterminate woody stem material, are seen within the overbank mudrocks (*e.g.* Loc. 233) (Fig. 45). Reducing conditions within the floodplain sediments may have favoured preservation of plant material (including wood) rather than bones and teeth.

Numerous angular fragments of well-preserved silicified fossil wood, showing well-defined growth rings, were recorded from Quaternary alluvial deposits overlying the Balfour Formation bedrocks, where they are often associated with ESA / MSA stone tools (Locs. 237, 243, 244 *etc*) as well as from modern stream gravels (Loc. 246) (*cf* Almond 2011, 2013c) (Figs. 43 & 44, 48, 50). Some of the silicified wood fragments contain insect borings (Loc. 244). As noted earlier, petrified wood material from colluvial gravels overlying the uppermost Middleton Formation (Locs. 240, 250-253) may well have been downwasted from the overlying Oudeberg Member at the base of the Balfour Formation. In no case was the fossil wood observed *in situ* within the Lower Beaufort Group bedrocks. Some of the largest fragments of fossil wood (up to 50 cm across) were recorded within modern stream gravels just below the base of a package of Balfour Formation channel sandstones with locally developed intraformational (mudclast) basal breccias (Loc. 246) (Fig. 49). Waterlogged tree trunks preserved within the base of channel sandstones are regarded as the most likely source of the reworked fossil wood material found, but this has yet to be proven. Resistant-weathering silicified bones and teeth of Permian vertebrates might also be expected to be similarly reworked into overlying Quaternary superficial deposits. Their apparent scarcity may therefore suggest that the Beaufort Group beds in the Cookhouse region are indeed very poor in fossil vertebrate material.

Fig. 43. Angular fragments of well-preserved silicified wood reworked from the Balfour Formation on Klipfonteyn 150 (near Loc. 246).

Fig. 44. Float block of silicified wood showing insect borings (probably beetle larvae), Klipfonteyn 150 (Loc. 244) (Scale in cm and mm).

Fig. 45. Impression of a woody plant stem within overbank mudrocks of the Balfour Formation, Klipfonteyn 150 (Loc. 233) (Scale in cm and mm).

Fig. 46. Fine horizontal burrows within thin-bedded grey-green sandstones, roadside quarry into the Balfour Formation (Loc. 227) (Scale in cm and mm).

4.3. Karoo Dolerite Suite

The very minor dolerite outcrops within the study area (*e.g.* Loc. 241) (Fig. 25) are in themselves of no palaeontological significance since these are high temperature igneous rocks emplaced at depth within the Earth's crust. However, as a consequence of their proximity to subsurface dolerite intrusions, the Beaufort Group sediments often appear to have been thermally metamorphosed or "baked" (*i.e*. recrystallised, impregnated with secondary minerals). Embedded fossil material of phosphatic composition, such as bones and teeth, is frequently altered by baking – bones may become blackened, for example - and can be very difficult to extract from the hard matrix by mechanical preparation (Smith & Keyser, p. 23 *in* Rubidge 1995). Thermal metamorphism by dolerite intrusions therefore tends to reduce the palaeontological heritage potential of Beaufort Group sediments.

4.4. Late Caenozoic superficial deposits

Various types of superficial deposits ("drift") of geologically young, Late Caenozoic (Miocene / Pliocene to Recent) age occur throughout the Great Karoo region. They include pedocretes (*e.g.* calcretes), colluvial slope deposits (sandstone and dolerite scree *etc*), river alluvium, as well as spring and pan sediments (*e.g.* Partridge *et al*. 2006). These Karoo drift deposits have been comparatively neglected in palaeontological terms for the most part. However, older (Quaternary) alluvial sediments, such as seen along larger stream valleys on Klipfonteyn 150, may occasionally contain important fossil biotas, notably the bones, teeth and horn cores of mammals (*e.g.* Skead 1980, Klein 1984, MacRae 1999, Partridge & Scott 2000, Brink & Rossouw 2000, Churchill *et al.* 2000, Rossouw 2006). Other late Caenozoic fossil biotas from these superficial deposits include non-marine molluscs (bivalves, gastropods), ostrich egg shells, trace fossils (*e.g.* calcretised termitaria, coprolites, *rhizoliths* or plant root casts), and plant remains such as peats or palynomorphs (pollens) in organic-rich alluvial horizons.

In the Nojoli Wind Farm study area the commonest fossils recorded from the Late Caenozoic superficial deposits are angular fragments of silicified wood that have been reworked from the Lower Beaufort Group bedrocks into the overlying alluvium and colluvium, as discussed earlier (Sections 4.1 and 4.2). Most of the petrified wood specimens were observed as surface float material within sandstone colluvial gravels or downwasted onto the top of the older calcretised alluvium (Figs. 43 & 44). Wood specimens can also be found within modern stream gravels and on or within modern soils (Fig. 48). Within the richly-calcretised older silty alluvium can also be found occasional elongate fragments of calcretised rhizoliths of presumed Quaternary age (*e.g.* Loc. 232) (Fig. 47).

An isolated, cracked mammalian cheek tooth with a complex occlusal surface was found as float overlying calcretised alluvial deposits on Klipfonteyn 150 (between Locs. 245 and 246) (Fig. 52). It is noted that the closest wind farm infrastructure is over 200m away from this location. The specimen is some 4 cm high and 3 cm across the crown. It has been identified as an upper molar (P4 or M1) of a medium-sized equid (horse / zebra family) (T. Steele, J. Brink, G. Avery & L. Rossouw, pers. comm., April 2014). Given the association with abundant ESA and MSA stone artefacts and the apparent antiquity of the calcretised alluvial deposits concerned, the tooth may belong to the extinct Cape Horse or Cape Zebra *Equus capensis*. This large, mixed-feeding equid is widely recorded from Pleistocene (Makapanian – Florisian) deposits in southern Africa and may have become extinct some 10 000 to 12 000 years ago, although some authors regard the extant Grevy's Zebra of East Africa as belonging to the same species (Klein 1984, Churcher 1986, Klein 1980, Kaiser & Franz-Odendaal 2004, Churcher 2006). The tooth specimen from Klipfonteyn 150 is of scientific importance since Pleistocene fossil mammals have not yet been recorded from this area. This underlines the palaeontological potential of the thick, calcretised older alluvial deposits of the Cookhouse area and of the Eastern Cape in general.

Fig. 47. Dense calcrete glaebules within older, Quaternary alluvial deposits, Klipfonteyn (Loc. 232) (Hammer = 30 cm). Some of the more elongate and branching calcrete structures may be fragments of rhizoliths (root casts).

Fig. 48. Large, angular blocks of petrified wood reworked into modern stream gravels on Klipfonteyn 150 (Loc. 246) (Hammer = 30 cm).

Fig. 49. Erosive base of a Balfour Formation channel sandstone overlying dark grey overbank mudrocks. The basal sandstones contain mudflake breccias and are a likely source of the reworked petrified wood fragments in this area, Klipfontein 150 (Loc. 246).

Fig. 50. Small fossil wood fragment embedded within well-consolidated, orange-brown Pleistocene alluvium, Klipfonteyn 150 (Loc. 243) (Scale in cm and mm).

Fig. 51. Earlier Stone Age biface of hornfels embedded within Pleistocene alluvial deposits on Klipfonteyn 150 (Loc. 236) (Scale in cm and mm).

Fig. 52. Fossil tooth (upper molar or premolar) of an equid, possibly a Pleistocene form of *Equus capensis*, collected as float from Pleistocene alluvial deposits on Klipfonteyn 150, close to Loc. 246 (Scale in mm) (Photos kindly provided by Hedi Stummer).

5. CONCLUSIONS AND RECOMMENDATIONS

The Nojoli Wind Farm project area is almost entirely underlain by potentially fossiliferous fluvial sediments of the Karoo Supergroup of Late Permian age but bedrock exposure levels here are very limited. The Lower Beaufort Group sediments (Middleton and Balfour Formations) underlying the study area contain important fossils of terrestrial animals such as reptiles and therapsids ("mammal-like reptiles") as well as representatives of the Late Permian *Glossopteris* Flora of Gondwana. However, the present two-day field palaeontological field assessment, as well as a number of recent field studies carried out in the Cookhouse – Middleton – Bedford area, suggest that Late Permian vertebrate remains tend to be very sparse in this part of the Eastern Cape, even where bedrock exposure is good. Apart from an isolated, unidentified fragment of fossil bone and occasional low-diversity trace fossil assemblages, the only significant Permian fossils recorded from the Nojoli Wind Farm study area comprise locally abundant fragments of petrified logs up to 50 cm across. The well-preserved fossil wood probably originates from channel sandstones within the Lower Beaufort Group (*e.g.* the Oudeberg Member of the Balfour Formation) but has not yet been recorded *in situ*. Instead, the resistant wood material been reworked into ancient, partially calcretised alluvial deposits as well as modern stream gravels and colluvial (hillslope) gravels in the larger stream valleys (*e.g.* on Bavians Krantz 151, Klipfonteyn 150). Associated Early and Middle Stone

Age artefacts as well as a large fossil horse tooth (perhaps *Equus capensis*) recorded on Klipfonteyn 150 suggest a probable Pleistocene age for the older alluvial deposits here.

The great majority of infrastructure developments (*e.g.* wind turbines, access roads) for the proposed Nojoli Wind Farm are located in elevated plateau or hilly areas where exposure of Beaufort Group bedrocks is poor, due to soil and vegetation cover, and no fossil remains were recorded is these areas during the field assessment. Significant impacts on thick, potentially fossiliferous Pleistocene alluvium in major stream valleys (palaeontologically sensitive green areas on Klipfonteyn 250 outlined in Fig. 53 herein) are not anticipated. The inferred impact significance of the proposed Nojoli Wind Farm project as far as palaeontological heritage is concerned is LOW (negative). Confidence levels for this assessment are moderate, given the limited bedrock exposure within most of the study area.

Unless significant new fossil finds are made during the construction phase of the development, or substantial excavations are made into the potentially sensitive older alluvial deposits indicated in Fig. 53, further specialist palaeontological studies or mitigation of the project are not regarded as warranted here. The cumulative impact on fossil heritage of the Nojoli Wind Farm in conjunction with several other wind energy projects in the Cookhouse - Middleton - Bedford region of the Eastern Cape is probably low.

The ECO for the project should be alerted to the potential for, and scientific significance of, new fossil finds during the construction phase of the development. They should familiarise themselves with the sort of fossils concerned through museum displays and accessible, well-illustrated literature.

Should either (1) substantial excavations be planned into the older alluvial deposits indicated in Fig. 53, or (2) important new fossil remains such as vertebrate bones and teeth, plant-rich fossil lenses or dense fossil burrow assemblages be exposed during construction, the responsible Environmental Control Officer should alert ECPHRA (*i.e.* The Eastern Cape Provincial Heritage Resources Authority. Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; smokhanya@ecphra.org.za) as soon as possible so that appropriate action can be taken in good time by a professional palaeontologist at the owner’s expense.

Palaeontological mitigation would normally involve the scientific recording and judicious sampling or collection of fossil material as well as of associated geological data (*e.g.* stratigraphy, sedimentology, taphonomy). The palaeontologist concerned with mitigation work will need a valid fossil collection permit from SAHRA (Contact details: Mrs Colette

Scheermeyer, P.O. Box 4637, Cape Town 8000. Tel: 021 462 4502. Email: cscheermeyer@sahra.org.za) and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection).

All palaeontological specialist work should conform to international best practice for palaeontological fieldwork and the study (*e.g.* data recording fossil collection and curation, final report) should adhere as far as possible to the minimum standards for Phase 2 palaeontological studies recently developed by SAHRA (2013). These recommendations should be incorporated into the EMP for the Nojoli Wind Farm project.

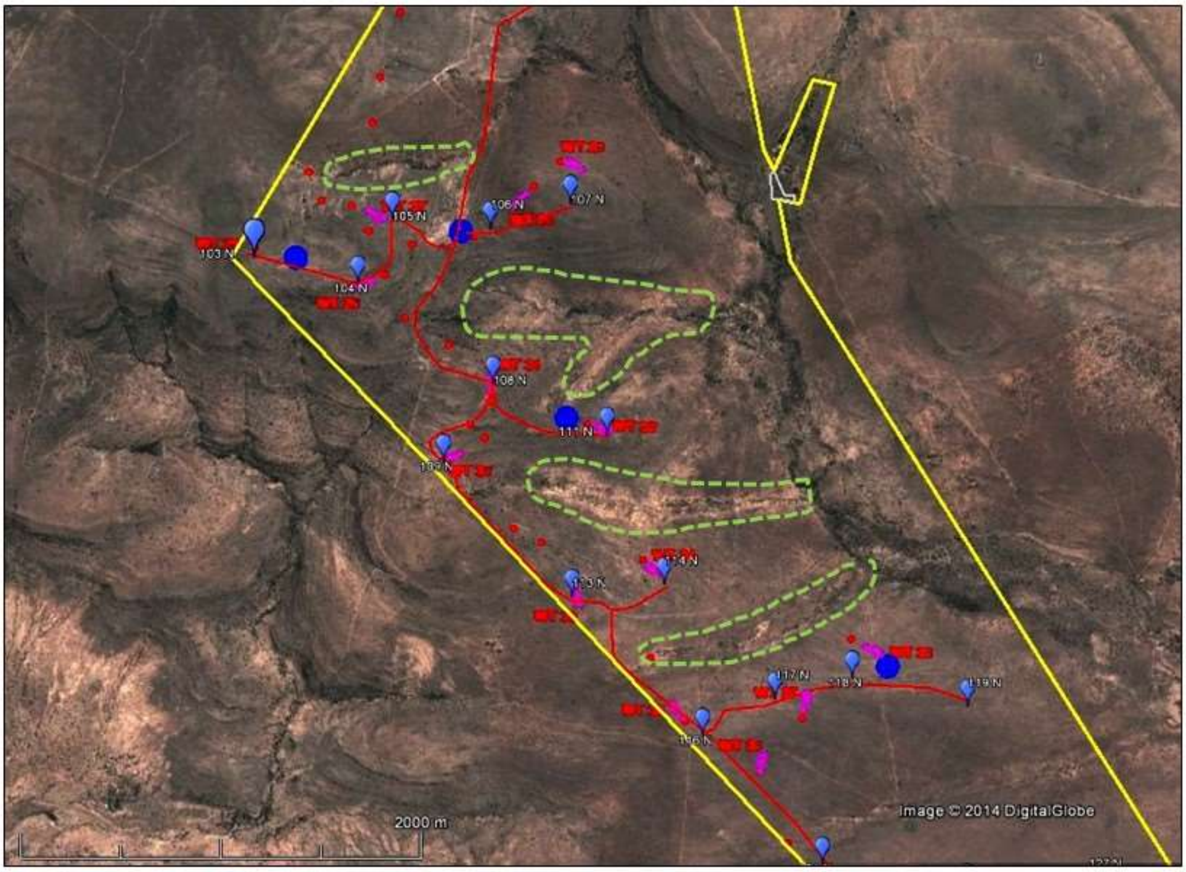

Fig. 53. Google earth© satellite image of part of Farm Klipfonteyn 150 within the south-central portion of the Nojoli Wind Farm study area east of Cookhouse, Eastern Cape (yellow polygon). The green dotted ellipses outline areas in stream valleys with thick deposits of Pleistocene alluvium rich in reworked fossil wood and exposed by later gulley erosion. Any infrastructure developments within these areas involving substantial excavations would require palaeontological mitigation (*i.e.* recording and sampling of fossil material before and during development). Note that the currently proposed wind turbine sites (blue symbols) and internal access roads (red lines) lie *outside* these palaeontologically sensitive areas.

6. ACKNOWLEDGEMENTS

Ms Lusani Rathanya of Savannah Environmental (Pty) Ltd is thanked for commissioning this study, for providing the relevant background information, and for facilitating the necessary fieldwork. Landowners Mnr Carolus van Aardt and Andrew Knott kindly gave permission to access their land. I am, as always, very grateful to team members Hedi Stummer, Erwin Stummer and Madelon Tusenius for their enthusiastic assistance in the field, for finding the best fossils, as well as for good companionship and logistical back-up throughout the trip. Professor Teresa Steele (Department of Anthropology University of California, Davis), Dr James Brink and Dr Lloyd Rossouw (National Museum, Bloemfontein) as well as Dr Graham Avery (Iziko Museums, Cape Town, retired) are thanked for kindly commenting on the Pleistocene fossil tooth from Klipfonteyn 150.

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8. QUALIFICATIONS & EXPERIENCE OF THE AUTHOR

Dr John Almond has an Honours Degree in Natural Sciences (Zoology) as well as a PhD in Palaeontology from the University of Cambridge, UK. He has been awarded post-doctoral research fellowships at Cambridge University and in Germany, and has carried out palaeontological research in Europe, North America, the Middle East as well as North and South Africa. For eight years he was a scientific officer (palaeontologist) for the Geological Survey / Council for Geoscience in the RSA. His current palaeontological research focuses on fossil record of the Precambrian - Cambrian boundary and the Cape Supergroup of South Africa. He has recently written palaeontological reviews for several 1: 250 000 geological maps published by the Council for Geoscience and has contributed educational material on fossils and evolution for new school textbooks in the RSA.

Since 2002 Dr Almond has also carried out palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape under the aegis of his Cape Town-based company *Natura Viva* cc. He is a long-standing member of the Archaeology, Palaeontology and Meteorites Committee for Heritage Western Cape (HWC) and an advisor on palaeontological conservation and management issues for the Palaeontological Society of South Africa (PSSA), HWC and SAHRA. He is currently compiling technical reports on the provincial palaeontological heritage of Western, Northern and Eastern Cape for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHP (Association of Professional Heritage Practitioners – Western Cape).

Declaration of Independence

I, John E. Almond, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed alternative energy project, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

Dr John E. Almond
Palaeontologist, *Natura Viva* cc

APPENDIX: GPS LOCALITY DATA FOR NUMBERED SITES MENTIONED IN TEXT

All GPS readings were taken in the field using a hand-held Garmin GPSmap 62sc instrument. The datum used is WGS 84. Only those localities mentioned by number in the text are listed here.

LOC. NO.	GPS POSITION	COMMENTS
227	32 45 03.7 S 25 55 54.9 E	Small roadside quarry into Balfour Fm mudrocks and channel sandstone, Farm 148, *c*. 800 m SE of Poseidon Substation. Pyritic calcrete nodules. Horizontal burrows (*Helminthoidichnites*) probably associated with algal mats.
228	32 45 55.7 S 25 56 17.5 E	Small quarry in Balfour Fm mudrocks and thin lenticular sandstones *c*. 330 m NNE of Klipfontein homestead, Klipfonteyn 150. Possible undulose palaeosurface.
229	32 46 29.4 S 25 56 06.0 E	Stream bank exposure of Balfour sandstones, Klipfonteyn 150.
230	32 46 47.2 S 25 55 59.6 E	Good hillslope exposures of Balfour Fm mudrocks, thin crevasse splay sandstones, Klipfonteyn 150.
231	32 47 06.7 S 25 55 51.2 E	Flaggy baked fine-grained sandstones in stream section, Klipfonteyn 150. Small-scale wave ripples.
232	32 47 18.2 S 25 55 46.8 E	Good sections through calcretised older alluvium, sandstone gravels and modern soils overlying Balfour Formation bedrocks along stream section, Klipfonteyn 150. Possible calcretised root casts (rhizoliths).
233	32 47 36.9 S 25 55 36.8 E	Hill slope exposure of grey-green Balfour Fm mudrocks, Klipfonteyn 150. Rare woody plant impressions.
234	32 48 21.7 S 25 56 13.6 E	Hilltop exposure of downwasted sandstone gravels, Klipfonteyn 150.
235	32 48 06.5 S 25 56 36.7 E	Donga exposure of steeply-dipping Balfour Formation sandstones overlain by gravels, thick, bedded, orange-brown calcretised older alluvium with embedded stone tools, Klipfonteyn 150.
236	32 48 05.5 S 25 56 37.3 E	ESA biface embedded within orange-brown older alluvium, Klipfonteyn 150.
237	32 48 06.5 S 25 56 36.7 E	Concentrations of petrified fossil wood fragments, stone tools within downwasted surface gravels, Klipfonteyn 150.
239	32 46 31.8 S 25 56 12.1 E	Afrimat Cookhouse hardrock quarry c. 800 m south of Klipfontein homestead, excavated into thick package of amalgamated sandstones of the Balfour Formation, Klipfonteyn 150.

240	32 45 41.6 S 25 52 18.8 E	Small roadside quarry into Middleton Fm mudrocks overlain by dolerite-rich colluvial gravels, Bavians Krantz 151. Isolated fossil bone and petrified wood fragments in sandstone gravels.
241	32 46 08.9 S 25 52 54.2 E	Dolerite intrusion in road cutting along the Patryshoogte road, Bavians Krantz 151.
242	32 46 12.5 S 25 53 41.3 E	Good exposures of Balfour channel sandstones near Baviaanskrans homestead, Bavians Krantz 151.
243	32 48 06.5 S 25 56 35.4 E	Concentrations of petrified fossil wood fragments, stone tools within downwasted surface gravels, Klipfonteyn 150. Also fossil wood and tools within calcretised older alluvium.
244	32 48 07.3 S 25 56 32.8 E	Concentrations of petrified fossil wood fragments, stone tools within downwasted surface gravels, Klipfonteyn 150. Also fossil wood and tools within calcretised older alluvium.
245	32 48 07.2 S 25 56 22.5 E	Deep dongas eroded into superficial deposits down to underlying Beaufort Group bedrocks, Klipfonteyn 150.
246	32 48 08.2 S 25 56 19.8 E	Numerous large blocks of petrified wood in modern stream gravels, Klipfonteyn 150. Fossil mammal tooth recorded just to the east.
247	32 48 07.8 S 25 56 19.2 E	Concentration of 6 or more Late Stone Age lower grindstones as well as one or ore upper grindstones overlying eroded consolidated alluvium, Klipfonteyn 150.
248	32 48 03.47 S 25 56 10.13 E	Spectacular donga erosion of superficial deposits (silty alluvium, gravels) overlying Balfour Formation bedrocks, Klipfonteyn 150.
249	32 45 49.6 S 25 53 30.9 E	Stream bank exposure of Middleton Formation mudrocks at base of escarpment on Bavians Krantz 151.
250	32 45 59.0 S 25 53 32.5 E	Fragments of petrified wood within colluvial surface gravels, Bavaians Krantz 151.
251	32 45 59.1 S 25 53 33.4 E	Large fragments of petrified logs embedded in surface gravels, Bavians Krantz 151.
252	32 45 48.9 S 25 53 26.1 E	Hill slope exposure of Middleton Fm mudrocks and thin sandstones, overlain by colluvial gravels, Rooy Draai 146. Occasional fossil wood fragments.
253	32 45 54.5 S 25 53 21.1 E	Stream bank exposure of thick alluvial deposits and underlying weathered Middleton Fm bedrocks, Bavians Krantz 151. Reworked fossil wood in surface gravels.