PALAEONTOLOGICAL HERITAGE ASSESSMENT OF THE COEGA IDZ, EASTERN CAPE PROVINCE – DRAFT SUMMARY

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The Coega IDZ, situated inland of Algoa Bay about 20km to the northeast of Port Elizabeth (Eastern Cape Province) is underlain by a wide spectrum of sedimentary rocks spanning an age range of some 470 million years. These sediments are assigned to the Palaeoozic **Table Mountain Group**, the Mesozoic **Uitenhage Group** and the Caenozoic **Algoa Group**. They have been geologically mapped at 1: 250 000 and 1: 50 000 scales (Fig. 1). Most of the rock units concerned contain fossil heritage of some sort but in most cases this is very limited, with the notable exception of three marine successions – the Sundays River Formation of Early Cretaceous age (*c*. 136 Ma = million years old), the Alexandria Formation of Miocene / Pliocene age (*c*. 7-5 Ma), and the Salnova Formation of Mid Pleistocene to Holocene age (< 1 Ma). Levels of bedrock exposure within the Coega IDZ are generally very low due to extensive cover by superficial drift (*eg* soil, alluvium, *in situ* weathering products) as well as by surface calcrete (pedogenic limestone). Man-made excavations such as road and railway cuttings, stormwater drainage channels, reservoirs and quarries, of which there are a considerable number within the Coega IDZ, often provide the best opportunities to examine and sample fresh, potentially fossiliferous bedrock. During the course of the present field study, carried out over ten days in February – March 2010, over one hundred natural and artificial exposures of sedimentary rocks within or very close to the Coega IDZ were examined for palaeontological heritage.

Fluvial quartzites of the Mid to Late Ordovician **Peninsula Formation** (**Op**) (Table Mountain Group) crop out only at Coega Kop where they are extensively quarried for building and road material (Fig. 2). A limited range of trace fossils (*eg* burrows, trackways) are recorded from this unit elsewhere within the Cape Fold Belt and its overall palaeontological sensitivity is low.

Two Early Cretaceous formations within Uitenhage Group – the Kirkwood and Sundays Formations - underlie most of the Coega IDZ at depth (Figs. 3a,b). However they mainly occur at or near-surface along the margins of the Coega River Valley and its northern tributary the Brakrivier (Small coastal outcrops are also known). Levels of exposure are very low, with the exception of a few erosional gullies, clay quarries (mostly disused and overgrown) *plus* new and old road and railway cuttings. The terrestrial (meandering fluvial) to estuarine **Kirkwood Formation** (**J-Kk**) of the Algoa Basin consists of multi-hued, often reddish-brown mudrocks with subordinate greenish-grey sandstones. The formation has a moderate to high, occasionally very high, palaeontological sensitivity. It is famous for its plant fossils (mainly gymnosperms and ferns), including locally abundant petrified wood (Figs. 4a,b), as well as its rare but palaeontologically significant dinosaur remains. The Kirkwood dinosaur fauna includes a small range of gigantic sauropods, juvenile iguanodonts, stegosaurs and small-bodied theropods (Figs. 5a,b). Most species are only known from isolated bones and teeth, however. Apart from a single small fragment of bone, no fossils were recorded from the Kirkwood Formation during this study. Extensive recent excavations into these beds for stormwater channels in Zone 5 and new road cuttings west of Coega were

not checked for fossil material while they were still fresh – an unfortunate lost opportunity in palaeontological heritage terms.

Grey to greenish-grey mudrocks and subordinate sandstones of the **Sundays River Formation** (**Ks**) were laid down in a range of estuarine to offshore marine shelf settings. Of the dozen or more natural and artificial exposures of these sediments examined within the Coega IDZ, mostly along the eastern escarpment of the Coega River Valley, almost all yielded a range of shelly invertebrate fossils. The palaeontological sensitivity of this formation is therefore rated as high (*NB* Huge numbers of scientifically valuable fossils are inevitably lost during brick making in the Swartkops and Coega Valleys). The Sundays River fossil faunas mainly consist of locally abundant, thick-shelled bivalve mollusks (*eg* free-living and cemented oysters, strongly ornamented trigoniids, large elongate girvillellas) (Fig. 6) together with much rarer gastropods and ammonites (Fig. 7) and locally abundant trace fossil assemblages within non-calcareous silty sandstones. Apart from spirorbid worm tubes, the majority of the shelly fossils occur within dense shell beds (*coquinas*) at the base of storm-generated sandstones. It is noteworthy that several previously unrecorded invertebrate groups have recently been discovered within the Sundays River Formation of the Coega IDZ region. These include numerous current-orientated scaphopod mollusks (tusk shells) from Bontrug 301 (Zone 14) collected by the author during this study (Fig. 8a) and fossil crabs embedded within calcareous nodules rich in plant debris from the main Coega brick pit (pers. comm., Dr Billy de Klerk, Albany Museum, Grahamstown). The new Bontrug fossil site also yields thin sandstones containing carpets of well-preserved nuculid bivalves (Fig 8b) as well as abnormally high concentrations of small branching corals (probably reworked) associated with a peculiar pebbly conglomeratic lens.

Five separate formations of the Late Caenozoic Algoa Group are mapped within the study area (Fig. 9). Their geological complexity reflects deposition during an interval of fluctuating global sea levels, climate and episodic uplift of the South African subcontinent. Limestone-rich estuarine to coastal marine sediments of the **Alexandria Formation** (**Ta**) overlie the greater part of the Coega IDZ, with an average thickness of 7-10m. Locally they contain a rich diversity - over two hundred taxa - of Miocene marine fauna. These are mainly bivalves and gastropods (Figs. 10, 11), but there is also a wide range of rarer groups such as flat sea urchins (“sea pansies”), corals, brachiopods (lamp shells), barnacles, crabs and sharks’ teeth. Many of the most prolific collecting localities for the Alexandria fauna that are mentioned in the palaeontological literature are situated within the Coega IDZ, but most of these are shallow, abandoned and overgrown quarries that no longer yield abundant fossil material. One officially designated stratotype locality for the Alexandria Formation northeast of Coega has already been destroyed by new road development. In both palaeontological and sedimentological terms, the most interesting exposures of the Alexandria Formation by far are seen in the upper (limestone) quarry at Coega. A wide range of sedimentary facies (rock types) are seen here, including cross-bedded channeled conglomerates, flat-bedded beach sands, coquinites (fine shell hash) and probable estuarine muds, among others (Fig. 12). Unfortunately, many of these features are already being covered over by ongoing quarry rehabilitation. The conglomeratic basal portion of the Alexandria succession, here as elsewhere, is typically rich in disarticulated fossil oysters and other robust mollusc shells (*eg Glycimeris*, cowries and large gastropods). In the Grassridge area (Zone 14) the basal conglomerate sometimes consists largely of fossil oyster shells (Fig. 13). The Alexandria Formation is also very rich in trace fossils of various sorts. Laminated beach sands are

frequently riddled with invertebrate burrows, such as the distinct pellet-lined crustacean burrow *Ophiomorpha* that is well seen at the main Coega limestone quarry as well as at the NW end of the stormwater channel running beneath the N2 in Zone 5 (Fig. 14a). Elegant vase-shaped cavities (*Gastrochaenolites*) were excavated into the firm sea bed by boring bivalves following the initial transgression of the Miocene seas across the Algoa coastal plain (Fig. 14b). They are well seen at the contact of the Alexandria and Sundays River Formations in the main Coega quarry as well as the Alexandria / Kirkwood contact in the railcutting north of the N2 (Zone 5). A remarkable range of delicate borings made by sponges, polychaetes and other invertebrates are preserved in exquisite detail in shell moulds that are embedded within upturned blocks of basal Alexandria conglomerate near the western edge of the Coega limestone quarry. These blocks are the subject of ongoing research by Dr Billy de Klerk and colleagues and need to be safeguarded.

Despite its unsually rich fossil record, in practice the palaeontological sensitivity of the Alexandria Formation is very variable, ranging from high to low. Apart from the more robust species such as oysters and *Glycimeris*, many fossil shells are fragmentary and unidentifiable. Examination of several deep stormwater drainage trenches and reservoirs within the Coega IDZ shows that usually much of the succession has been secondarily calcretised by circulating groundwater, normally destroying most fossil remains in the process. They are sometimes preserved as fossil moulds (impressions) and occasionally coquinites with scattered, well-preserved shells are found. On the whole, however, the impact of these voluminous stormwater trenches and reservoirs on Alexandria palaeontological heritage appears to be remarkably low.

Karstic (solution) weathering of the extensive Alexandria Formation limestone plateau has led to the formation of a distinctive reddish-brown pebbly deposit that was previously assigned to a separate stratigraphic unit (the so-called **Bluewater Bay Formation**, **T-Qb**). It infills numerous solution cavities in the upper surface of the Alexandria limestones and on the 1: 250 000 Port Elizabeth geological map it is indicated across large expanses of the IDZ. The only fossils recorded from this unit so far are sparse freshwater mussels and land snails. NE-SW trending zones of larger-scale (*c*. 100m) depressions known as *dolines* are clearly seen in aerial and satellite images as rounded grassy patches within darker thicket vegetation. These features are also formed by solution of the underlying limestone, are often infilled with clay-rich soils and may form pans after rain. New road construction in Coega Zone 6 has transected one of these deep doline infills which here comprises several meters of dark, mottled soil with oxidized traces of plant rootlets. Moist grassy pans might be expected to attract game, but no mammal bones or teeth were observed within the doline infill.

The youngest highly fossiliferous marine succession within the Coega IDZ is the **Salnova Formation** (**Qs**) of Mid Pleistocene to Recent age. It crops out intermittently along the coastline from the Marine Growers abalone farm northeastwards to Mellville. The formation comprises a spectrum of well-indurated sandy and conglomeratic beach deposits that form low benches close to modern sea level and are locally rich in marine shell remains. A geologically important stratotype section for the Salnova Formation has been identified at Hougham Park (Fig. 15). Here the conglomeratic and sandy Salnova beds unconformably overlie the Sundays River Formation and are overlain in turn by consolidated aeolianites of the Nahoon Formation. A comparable (but even larger) range of marine invertebrates to that seen in the older Alexandria Formation has been recorded from the Salnova Formation.

However, many of these taxa are mainly found in finer-grained, estuarine facies that are not well exposed in the Coega IDZ itself (Some are seen at the important stratotype locality for this formation located near the Salnova saltworks within the Portnet area). The majority of the Salnova fossil and subfossil species are still alive, though some warm-loving species like the gigantic "geoduck" clam *Panopea* no longer occur naturally in the Algoa Bay area (Fig. 16). The overall palaeontological sensitivity of the Salnova Formation is judged to be high, although many occurrences are not especially shell-rich or contain mainly fragmentary remains.

Three separate successions of calcareous dune sands (*aeolianites*) are recognized within the upper part of the Algoa Group (Fig. 9). For the most part these sediments contain only sparse fossil remains – notably several extant genera of land snails such as *Achatina* and *Tropidophora* – and their overall palaeontological sensitivity is low. The oldest, and topographically most elevated, aeolianites are assigned to the **Nanaga Formation** (**T-Qn**) of Pliocene to Early Pleistocene age. They are usually semi-consolidated, are often stained a deep reddish-brown and may show large scale dune cross-bedding (excellent examples are seen in N2 roadcuts between Colchester and Grahamstown). Recent re-mapping of the Coega IDZ has revealed a narrow band of Nanaga sands overlying Alexandria Formation limestones inland of the modern dune cordon. Deep trenching through surface calcretes near Hougham Park has exposed spectacular vertical sections through calcretized column-like structures and dense rhizoliths (root casts) (Fig. 17). These trace fossils are embedded within pale brown, unconsolidated dune sands that are currently mapped within the Nanaga Formation. The origins of these complex, column-like structures is currently unclear; they may be related to subsurface calcrete precipitation around plant (tree / shrub?) root systems in response to root exudates, the decomposition of woody root material or perhaps termite activity; possible calcretised termite nests with a spongy fabric are also seen here. Several genera of fossil land snails, including *Achatina*, *Tropidophora* and probable *Natalina* are abundant within the sandy matrix (Fig. 18). Relict patches of more typical, orange-red Nanaga aeoliantes are scattered further inland across the Alexandria Formation and older rocks. A good example is seen near the western entrance to the main Coega brick quarry; here partially calcretised and apparently unfossiliferous orange-hued aeolianites overlie pebbly conglomerates of "Bluewater Bay" – type facies.

Small exposures of Mid to Late Pleistocene aeolianites of the **Nahoon Formation** (**Qn**) are currently only mapped just east of the Coega River mouth, within the Portnet area. These outcrops may well have been obliterated by later development at the Ngqura Port. However, probable representatives of the Nahoon Formation have been identified during this study in the Sea Arc / Marine Growers region as well as directly overlying the Salnova Formation stratotype E succession at Hougham Park and further northeastwards along the coast. Here buff, well-consolidated aeolian sands situated just a few meters above sea level contain abundant terrestrial snail shells (*Achatina*, *Tropidophora*), occasional storm-tossed coquinite intraclasts and sparse marine shells (*eg Turbo*, oysters) (Fig. 19). Embedded within them are sparse human artifacts of quartzite that are possibly referable to the Middle Stone Age (confirmation required). The Nahoon beds are planed off by a well-developed wave-cut platform (possibly the Eemian highstand, *ie* 120 000 BP) and are overlain by ancient storm beach gravels and younger dunes of the Schelm Hoek Formation.

Unconsolidated to semi-consolidated, well-vegetated dune sands along the modern coastline of Algoa Bay are assigned to the **Schelm Hoek Formation** (**Qw**). Good examples of vertically sectioned dunes showing large scale aeolian cross-bedding are seen in the active sand quarries near the Sea Arc factory site and at Sonop (Coega Zone 10). Apart from the usual concentrations of wind-deflated dune snails (notably superabundant *Tropidophora* and *Natalina* here; Fig. 20), a range of subfossil remains can be seen, especially in deflation hollows. Among these are millipede exoskeletons, small mammal and reptile bones, fragments of charcoal, buried mats of plant roots and incipient rhizocretions (possibly termite-mediated). Shell middens of oysters and other edible marine shells situated close to the shoreline are attributable to Late Stone Age (and later) humans and will be considered in more detail under archaeological heritage.

Recommendations for the Coega IDZ Heritage Management Plan

The likely impact of future developments within the Coega IDZ on local fossil heritage can be assessed in advance on the basis of this palaeontological report when used in conjunction with the relevant geological maps. The key factors to consider here are (a) the location of the proposed development, (b) the extent (depth, volume) of the bedrock excavations involved, and (c) the palaeontological sensitivity of the stratigraphic units affected.

- Palaeontological mitigation is not necessary in the case of stratigraphic units with a low palaeontological sensitivity (*eg* Peninsula Formation, Nanaga, Nahoon and Schelm Hoek aeolianites).
- Substantial (*ie* high-volume) new excavations into either the Kirkwood Formation or the Sundays River Formation should be examined by a professional palaeontologist *while they are still fresh* so that any fossil material or interesting sedimentological features can be recorded and sampled. New fossil taxa continue to be discovered within these formations and most fossil groups still require modern systematic and palaeobiological attention.
- Despite its rich fossil record, the Alexandria Formation is usually only sparsely fossiliferous in the Coega area, especially in its upper parts which are frequently heavily calcretised. Most excavations here are unlikely to have serious consequences for fossil heritage.
- Coarse-grained (conglomeratic) sediments within the Salnova Formation rarely contain much identifiable fossil material. However, finer-grained facies (*eg* estuarine mudrocks) such as occur within the Coega estuary may be richly fossiliferous. Substantial excavations into any fine-grained marine or estuarine beds should be examined and sampled by a professional palaeontologist.

(*NB* The above recommendations will be tabulated according to stratigraphic unit in the final report)

A small number of sites of special palaeontological and / or geological heritage significance have been identified within the Coega IDZ . Examples include:

- Main Coega brick quarry – eastern face preserving fossil-rich sandstones and contact with overlying Alexandria Formation

- Main Coega limestone quarry – eastern face and large disturbed blocks of basal Alexandria shelly conglomerate at the western edge of the quarry
- Upper, eastern face of Tossies Quarry South – well-preserved contact between Alexandria and Sundays River Formations
- Erosion gullies into Sundays River Formation just north of Tossies Quarry North as well as on Bontrug 301 – highly fossiliferous sandstones, rare fossil taxa
- Railway cutting north of N2, SW of marshalling yard as well as the nearby stormwater channel – contact between the Alexandria and Kirkwood Formations, trace fossils near contact
- Stratotype section of Salnova Formation on coast at Hougham Park, also showing unconformable contact with Sundays River Formation

These sites should be specially noted in the heritage management plan for the Coega IDZ and safeguarded from further development where at all feasible.