

Phase 1 Palaeontological Impact Assessment of 2 Quarries and 6 Borrow Pits, between Willowvale and Dwesa, EC Province.

Report prepared for:
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Executive Summary

- A Phase 1 Palaeontological Impact Assessment was carried out at a two quarries and six borrow pit sites between Willowvale and Dwesa in the Eastern Cape.
- Quarry 1 and 2 are exclusively doleritic and therefore not palaeontologically significant.
- Borrow Pit 1 and 3 are located in Adelaide Subgroup strata, while an intrusive dolerite outcrop (dyke) and Adelaide Subgroup metasediments are represented at Borrow Pit 2.
- Borrow Pits 4, 5 and 6 are located in older Ecga Group strata.
- No fossils or trace fossils were located near or in the vicinity of the borrow pits during the baseline survey.
- The survey of exposed strata has indicated no evidence for potential palaeontological impact.
- There is no indication for the accumulation and preservation of intact fossil material within the Quaternary sediments (topsoils) covering the underlying sedimentary rocks.

Introduction

At the request of Control Civil Services, a Palaeontological Impact Assessment was carried out along designated areas between Willowvale and Dwesa in the Eastern Cape with the aim to investigate six borrow pit localities and two quarries that will be utilized to maintain and rehabilitate the gravel road infrastructure in the region. The survey is required as a prerequisite for new development in terms of the National Environmental Management Act and is also called for in terms of the National Heritage Resources Act 25 of 1999. In terms of Section 38 of the National Heritage Resources Act 25 of 1999 the survey is required as a prerequisite for any development which will change the character of a site exceeding 5 000 m² in extent. A site visit and subsequent assessment took place in January 2013.

The task involved identification of possible paleontological sites or occurrences in the proposed zone, an assessment of their significance, related impact by the proposed development and recommendations for mitigation where relevant.

Description of the Affected Area

Details of area surveyed

Locality data

1 : 50 000 scale topographic map: 3228 AD Willowvale
3228 BA Fort Malan
3228 BC Mazeppa Bay
3228 BD Dwesa

1 : 250 000 scale geological map: 3228 Kei Mouth

The localities are located on 1:50 000 scale topographic map sections 3228 AD, BA, BC and BD (**Fig. 1**) and are also indicated on 1 : 250 000 scale geological map 3228 Kei Mouth (**Fig. 2**). Site coordinates of each borrow pit are presented as reference points in **Table 1**. The study area is largely located along a coastal platform on mountainous and undulating terrain. Extent of the borrow pits will be ≤ 1.5 hectares (**Fig. 3**).

Table 1. Site coordinates of the study areas.

Locality	Coordinates
WV BP1	S32 14 43.2 E28 35 07.8
WV BP2	S32 14 05.9 E28 39 01.5
WV BP3	S32 14 23.3 E28 40 58.7
WV BP4	S32 16 12.1 E28 44 48.7
WV BP5	S32 16 12.3 E28 44 57.0
WV Q1	S32 15 13.1 E28 27 51.4
WV Q2	S32 13 55.6 E28 47 14.8

Survey Method

A pedestrian survey was conducted in the affected area. A Garmin Etrex Vista GPS hand model (set to the WGS 84 map datum) and a digital camera, were used to record relevant data. Relevant palaeontological information was assimilated for the report and integrated with data acquired during the on-site inspection.

Regional Geology

The geology of the area has been described by Johnson and Carston (1979) and Partridge *et al.* (2006). The underlying geology of the region is represented by sedimentary rocks that range from Late Carboniferous or Early Permian to Early Triassic in age (**Fig. 4**). The sedimentary sequence includes strata belonging to the Dwyka Formation, the Eccca Group and the Beaufort Group (Karoo Supergroup). Conformably overlying the Dwyka tillites is a succession of shale and subordinate sandstone representing the Permian Eccca Group (***Pe***). In this region, along the eastern flank of the Karoo basin, the Eccca Group consists of undifferentiated mudrock. It has not been studied in detail because of poor exposures and repeated faulting. Carbonaceous shales, fine-grained graywackes and alternating dark-grey shales are exposed along the coastal margin between the Nqabara and Mtonjane Rivers. The Eccca Group grades upward into the Permo-Triassic Beaufort Group, which in the region is represented by the Adelaide and Tarkastad Subgroups. The Tarkastad Subgroup is generally distinguished from the Adelaide Subgroup (***Pa***) by a distinct increase in the sandstone to mudstone ratio.

From oldest to youngest, the Adelaide Subgroup is represented by the Koonap, Middleton and Balfour Formations respectively, but they are difficult to separate due

to poor exposures in the study area. Upward –fining cycles, lenticular sandstones and massive mudstones point to a fluvial mode of deposition for the origin of the Adelaide Subgroup.

Jurassic-age dolerites (*Jd*) are represented by numerous dykes, sills and inclined sheets in the region (see **Fig. 2**).

Valley-sediments are made up of geologically recent alluvial deposits and reworked colluvium. Unconsolidated alluvial and overbank sediments represent the bulk of the Quaternary component in the region.

Regional Palaeontology

The potential fossil heritage within geological units affected by the proposed development is summarized in **Table 2**.

Older sedimentary rocks in the region are assigned to the Eccla Group. Vertebrate fossil remains from the upper part of the Eccla Group include the mesosaurid reptiles *Mesosaurus tenuidens* and *Stereosternum tumidum* (Oelofsen and Araujo 1987) as well as crustaceans (*Notocaris tapscottii*) and palaeoniscoid fish. Rare ichnofossils have been recorded in the central part of the Group. Plant and invertebrate fossils include wood and leaves (*Glossopteris*), sponge spicules and rare insect wings (McLachlan and Anderson 1977).

The Eccla Group is overlain by the Adelaide Subgroup. East of 24°E the uppermost part of the Middleton Formation and lowermost part of the Balfour Formation of the Adelaide Subgroup are assigned to the *Cistecephalus* Assemblage Zone (AZ). The fossil record of these biozones – including a wide variety of terrestrial tetrapods, plants, silicified wood and trace fossils, is summarized in Rubidge (1995) and MacRae (1999). This zone is characterized by the predominance of a number of dicynodont species including *Diictodon*, *Pristerodon*, *Cistecephalus*, *Aulacephalodon* and *Oudenodon*. Plant fossils include *Glossopteris* and *Schizoneura*. The vertebrate fauna are mostly preserved as dispersed isolated fossils in interchannel mudrocks.

Between 24°E and 25°E the upper Balfour Formation are mainly occupied by the *Dicynodon* AZ, but east of 25°E the *Dicynodon* AZ becomes indistinguishable from the underlying *Cistecephalus* AZ. The *Dicynodon* AZ is characterized by the presence of both therapsids *Dicynodon* and *Theriongnathus*. Therapsid fossils are normally well-preserved in mudrock horizons and are usually found as dispersed isolated specimens

associated with an abundance of calcareous nodules. Fish fossils (*Atherstonia scutata*) and plant fossils such as *Dadoxylon* and *Glossopteris* also occur.

In the Tarkastad Subgroup the Katberg Formation strata (*Trk*) are assigned to the *Lystrosaurus* AZ, which overlies the *Dicynodon* AZ. The *Lystrosaurus* AZ is characterized by an abundance of *Lystrosaurus* in association with *Procolophon* and the absence of *Dicynodon lacerticeps*. Other common genera include *Moschorhinus*, *Proterosuchus* and *Lydekkerina*. Vertebrate fossils are primarily found in mudrock sequences between channel sandstones. Casts of large burrows have also been described from several localities within this biozone.

The Burgersdorp Formation strata (*Trb*) are assigned to the *Cynognathus* AZ, which overlies the *Lystrosaurus* AZ. The zone is characterized by the presence of *Cynognathus*, *Diadermodon* and *Kannemeyeria* and the absence of *Lystrosaurus*. Sediments assigned to this zone are well exposed in the Queenstown and Lady Frere districts and have been traced eastward as far as the Engcobo district. Rocks consist of blue-green, pale grayish green, dark red to very dark maroon mudstones that are in many instances more consolidated than those of the underlying *Lystrosaurus* AZ. The fossil record of the *Cynognathus* AZ includes a variety of plants, trace fossils, amphibians, fish reptiles, synapsids, and occasional molluscs.

Quaternary palaeontological sites are occasionally found in Pleistocene alluvial terraces and dongas along rivers and streams. Quaternary alluvial deposits, especially near water courses and drainage lines, have the potential to yield microfossil and fossil vertebrate remains.

Results of Survey

The baseline study involved a foot survey of the surroundings along each pit margin, and the exposures inside each pit. The borrow pits are easily accessible, being directly adjacent to an access road. Except for the two quarry sites (Q1 and Q2), all the borrow pits are located within Karoo Supergroup rocks and or areas where Karoo Dolerite intrusions occur. Quarry 1 and 2 are exclusively doleritic and therefore not palaeontologically significant. Borrow Pit 1 and 3 are located in Adelaide Subgroup strata (**Fig. 5 and 6**) Borrow Pit 2 is primarily underlain by an intrusive dolerite outcrop (dyke), but Adelaide Subgroup metasediments are also exposed. Borrow Pits 4, 5 and 6 are located in older Eccu Group strata (**Fig. 7 and 8**). No fossils or trace

fossils were located near or in the vicinity of the borrow pits during the baseline survey.

Unconsolidated Quaternary sediments overlying sedimentary rocks around the borrow pits are made up of thin residual deposits and are not fossiliferous. There is currently no record of Quaternary palaeontological exposures in the vicinity and no Quaternary vertebrate fossils were recorded in the geologically recent valley-sediments in the vicinity of the borrow pits.

Statement of Significance

The areas demarcated for development has been suitably recorded, mapped and documented in accordance with the types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (No 25 of 1999).

Quarry 1, 2 and Borrow Pit 2 are primarily underlain by intrusive igneous dolerites. Dolerites are not fossiliferous and can be excluded from further consideration in the present assessment. The geology of the remaining pits (Borrow Pits 1, 3, 4, 5 and 6) consists of fossil-bearing strata (Ecca Group and Adelaide Subgroup), which are considered to be of low to moderate palaeontological significance in the region.

Recommendations

There are no major palaeontological grounds to halt development of the sites. No mitigation is required for Quarry 1 and 2 and Borrow Pit 2. The Ecca Group and Adelaide Subgroup represent significant stages during the development of terrestrial life through the Permian, but based on the investigation of existing exposures, potential impact at Borrow Pits 1, 3, 4, 5 and 6 is, although not unlikely, considered to be low.

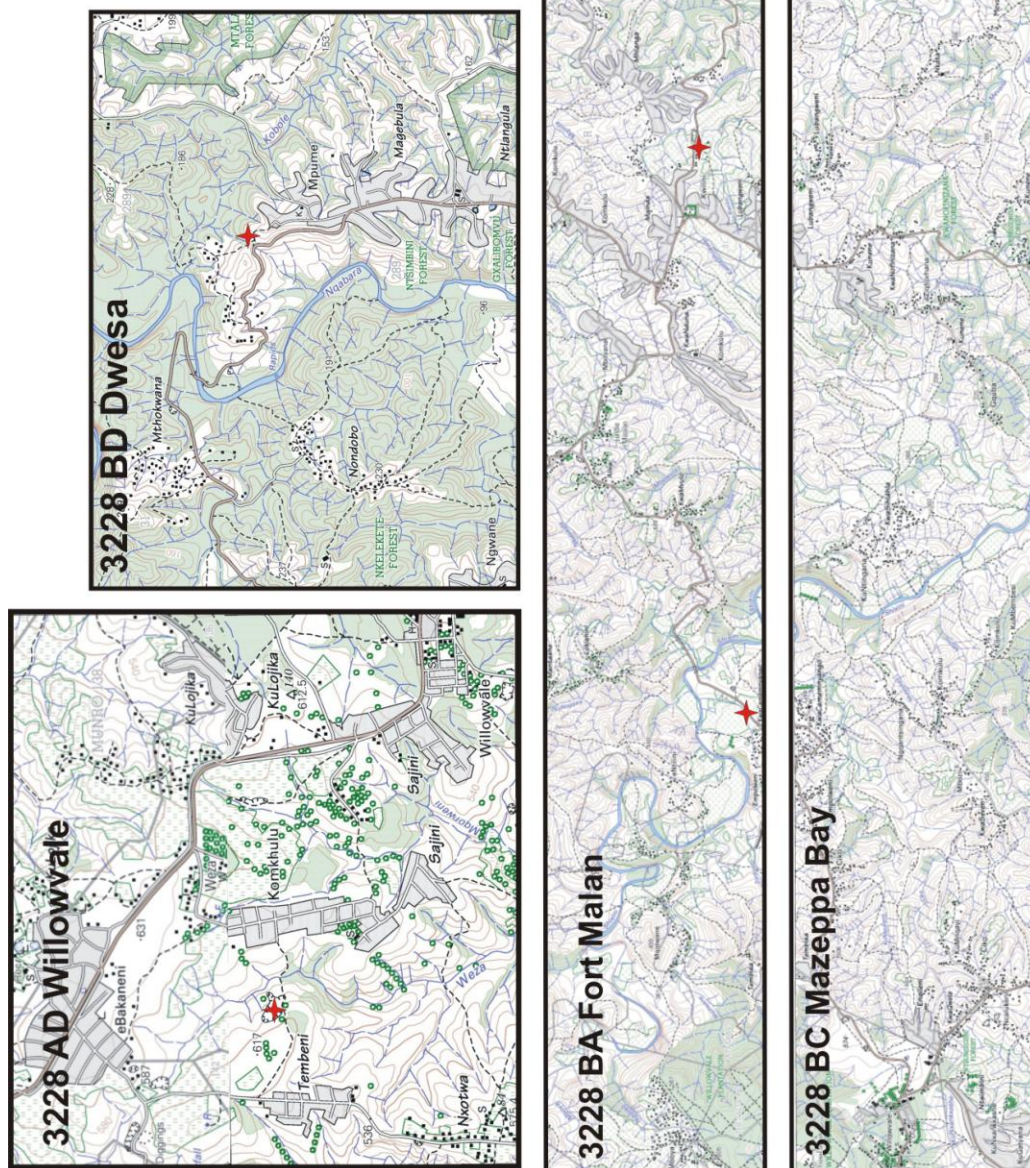
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Table 2. Potential fossil heritage within geological units present in the study area.

Geological Unit		Predominant rock types and Age	Previously recorded fossil heritage
	Alluvium Colluvium	Late Cenozoic to Recent	Large mammal bones, horn cores and dentition, coprolites, pollen, phytoliths, terrestrial gastropods (Florisian LMA)
	Intrusive feature	Igneous dolerite (<i>Jd</i>) Jurassic	Not fossiliferous
Beaufort Group	Tarkastad Subgroup Burgersdorp Frm. (<i>Trb</i>)	Fluvial and lacustrine mudstones and sandstones. Early Triassic	<i>Cistecephalus</i> Assemblage Zone
	Katberg Frm. (<i>Trk</i>)	Fluvial and lacustrine mudstones and sandstones. Early Triassic	<i>Lystrosaurus</i> Assemblage Zone
	Adelaide Subgroup Balfour Frm. (<i>Pa</i>)	Fluvial and lacustrine mudstones and sandstones. Late Permian	<i>Lystrosaurus</i> Assemblage Zone <i>Dicynodon</i> Assemblage Zone
Ecca Group (<i>Pe</i>)		Marine shales and sandstones; Permian	Mesosaurid reptiles, crustaceans, palaeoniscoid fish, rare ichnofossils plants, sponge spicules, insect wings



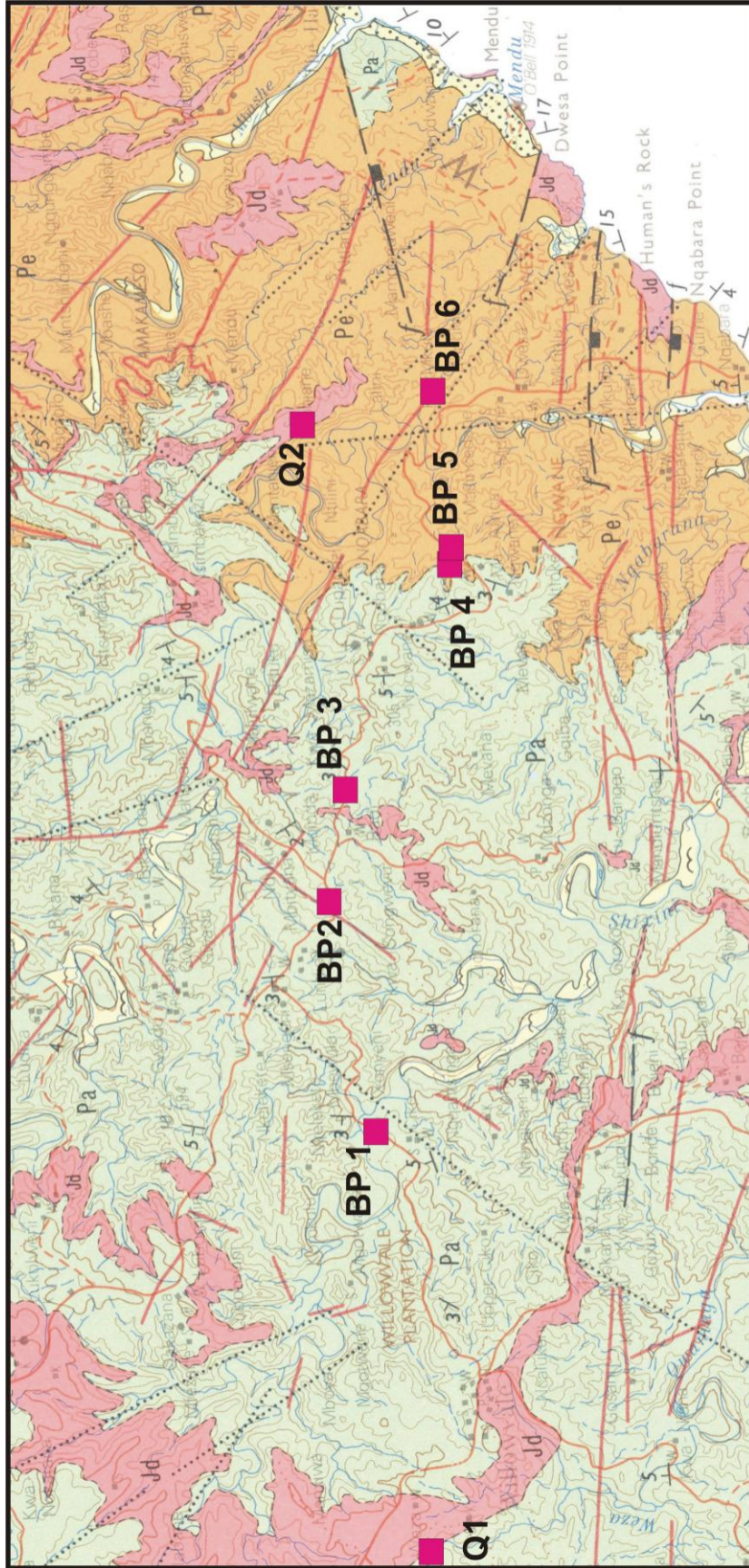


Figure 2. Portion of 1:250 000 scale geological map 3228 Kei Mouth.



Figure 3. The study area is largely located along a coastal platform on mountainous and undulating terrain.

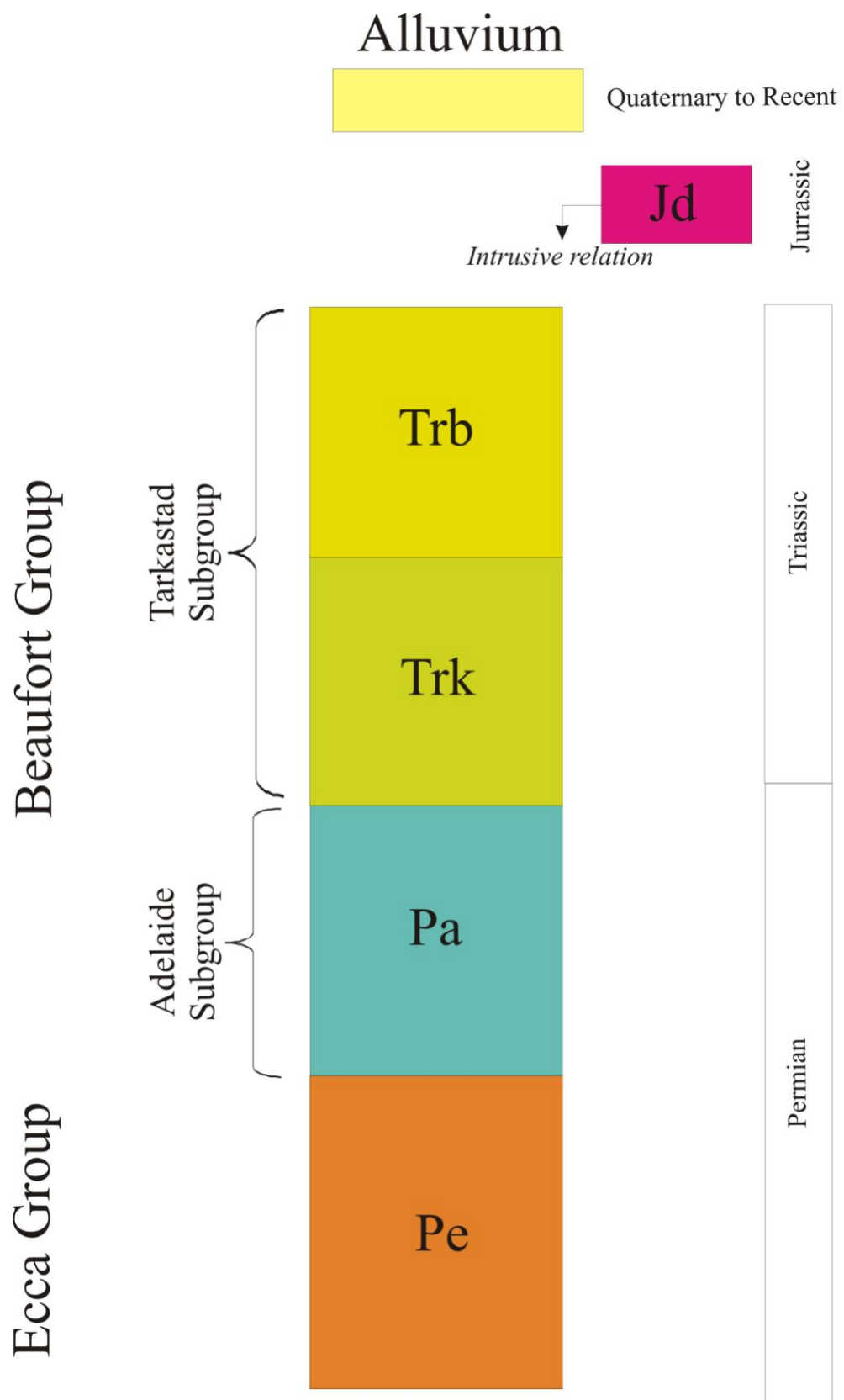


Figure 4. Schematic representation of the geology in the region.



Figure 5. Borrow Pit 1. Alternating units of grey, fine-grained sandstone and greenish-grey mudstone (Adelaide Subgroup strata)



Figure 6. Borrow Pit 3. Alternating units of fine-grained sandstone and greenish-grey mudstone (Adelaide Subgroup strata).



Figure 7. Borrow Pit 5. The site is covered by unconsolidated Quaternary sheet wash deposits that is underlain by very fine grained Eccca Group sandstones of the Eccca Group. .



Figure 8. Borrow Pit 6. Undifferentiated mudrock and alternating dark-grey shales (Ecca Group).