

# **PALAEONTOLOGICAL ASSESSMENT: DESKTOP STUDY**

## **Proposed extension of three existing borrow pits in the Port St Johns – Lusikisiki area and excavation of a new borrow pit near Coffee Bay, Eastern Cape Province**

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### **1. SUMMARY**

The three existing borrow pits in the Port St Johns / Lusikisiki area of the Eastern Cape Province whose extension is under consideration are all excavated into basinal mudrocks of the Permian Eccca Group (Karoo Supergroup). These well-laminated offshore sediments have not been assigned to a specific formation and are generally of low palaeontological sensitivity. Their sparse fossil content in the study area – mainly low-diversity trace fossil assemblages - has often been compromised by deep chemical weathering and nearby dolerite intrusions. The new borrow pit west-southwest of Coffee Bay is to be excavated into weathered dolerite that does not contain any fossils. The proposed borrow pit developments are therefore not considered to pose a significant threat to local fossil heritage and no further specialist palaeontological studies are required for this project.

Any substantial fossil remains (e.g. vertebrates, petrified wood) encountered during excavation should be reported to SAHRA for possible mitigation by a professional palaeontologist.

### **2. INTRODUCTION & BRIEF**

The Department of Roads and Transport (DRPW) is proposing to extend three existing borrowpits in the Lusikisiki /Port St Johns areas, Eastern Cape Province. Excavated material – predominantly weathered mudrock - will be used to maintain the existing surfaced and gravel road network for the local Area Wide Road Maintenance Programme. It will be used exclusively for this purpose and will not be sold to any other persons / entities.

The geographical locations of the three borrowpit sites (Figs. 1, 2) are:

1. **BP8151\_1:** S 31 27 47.9, E 29 33 30.8
2. **BP8156\_1:** S 31 22 46.4, E 29 18 16.5
3. **BP8158\_1:** S 31 25 09.1, E 29 22 54.0

It is furthermore proposed to excavate a new borrow pit (BP13) on a hilltop site some 8km west-southwest of Coffee Bay. The co-ordinates of the new site are:

**BP13:** S31 58 42.9, E29 04 49.7

The three existing borrowpits are excavated into potentially fossiliferous sediments of the Eccca Group (Karoo Supergroup). A desktop palaeontological assessment for the project has therefore

been commissioned by TERRECO Environmental cc in accordance with the requirements of the National Heritage Resources Act, 1999.

The various categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act include, among others:

- geological sites of scientific or cultural importance;
- palaeontological sites;
- palaeontological objects and material, meteorites and rare geological specimens.

## 2.1. General approach used for palaeontological impact desktop studies

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations *etc*) represented within the study area are determined from geological maps. The known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region, and the author's field experience (Consultation with professional colleagues as well as examination of institutional fossil collections may play a role here, or later following scoping during the compilation of the final report). This data is then used to assess the palaeontological sensitivity of each rock unit to development (Provisional tabulations of palaeontological sensitivity of all formations in the Western, Eastern and Northern Cape have already been compiled by J. Almond and colleagues; *e.g.* Almond *et al.* 2008). The likely impact of the proposed development on local fossil heritage is then determined on the basis of (1) the palaeontological sensitivity of the rock units concerned and (2) the nature of the development itself, most notably the extent of fresh bedrock excavation envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a field scoping study by a professional palaeontologist is usually warranted.



Fig. 1. Google Earth satellite image of the Port St. Johns area, Eastern Cape Province showing the location of the three borrowpit sites (Image kindly provided by TERRECO Environmental cc).

### 3. GEOLOGICAL BACKGROUND

The geology of the study area for the existing pits lies in the highly-dissected coastal interior to the north and northwest of Port St Johns and is shown on the 1: 250 000 scale geological map 3128 Umtata (Council for Geoscience, Pretoria) (Fig. 2). All three borrow pits lie within the outcrop area of the Early to Late Permian **Ecça Group (Pe)**; Kungurian to Tatarian) which here is extensively intruded by Early Jurassic basic intrusions of **Karoo Dolerite Suite (Jd)**. The precise stratigraphic position of the three borrow pits within the Ecça succession cannot be accurately determined on the basis of available maps. It is likely that the easternmost pit (BP8151\_1) lies low down within the Ecça Group, close to the Ecça / Dwyka contact, while the two western pits (BP8156\_1, BP8158\_1) lie somewhat higher up.

The Ecça Group succession in the south-eastern portion of the Main Karoo Basin near Port St Johns is not clearly differentiated into a series of well-differentiated formations (See outline maps of the Karoo Basin in Johnson *et al.* 2006, Johnson 2009; Fig. 3 herein). To the north, in Kwazulu-Natal, the Ecça Group comprises the mudrock-dominated Pietermaritzburg Formation (at the base) and Volksrust Formation (at the top) with deltaic sands of the Vryheid Formation sandwiched between the two (Johnson 1994 and previous references cited). The Vryheid sandstones taper out towards the south so that the basinal mudrocks of the Pietermaritzburg and Volksrust Formations can no longer be clearly differentiated in the Eastern Cape region around Port St Johns. According to Karpeta and Johnson (1979; see also Du Toit & Rogers 1917) the undifferentiated Ecça Group succession here comprises some 900m of dark, rhythmically-bedded, well-laminated mudrocks (shales, rhythmites) with intermittent thin sandy units. Dominant depositional processes in the offshore epicontinental basin here were suspension settling with occasional influx of fine-grained distal turbidites and tempestite (storm) sandstones. A 70m-thick feldspathic greywacke some 300m below the top of the Ecça at Double Falls, 32km west of Port St Johns is probably the distal, lateral equivalent of the Vryheid Formation to the north (*cf* Du Toit & Rogers 1917).

According to Du Toit and Rogers (1917, p. 9) the Ecça rocks of the previous Transkei region are generally poorly exposed, with bedrock usually only visible in road cuttings and stream beds. The readily-weathered dark mudrocks and flaggy sandstones decompose to give dark, clay-rich soils. According to these authors “A common manner of weathering results in a bright red sub-soil full of small flakes of pale blue shale, above which the soil is usually clayey in texture, seldom light and porous”.

The generally held view is that the Ecça Sea was a largely land-locked, non-marine depository (e.g. McLachlan & Anderson 1973) but the presence of the mineral glauconite in the Vryheid Formation as well as the recent report of a marine megadesmid bivalve from the upper Volksrust Formation in KZN suggests that a degree of marine influence persisted into Late Permian times in this portion of the Main Karoo Basin at least (Cairncross *et al.* 1998, 2005).

In the Port St Johns area, including the neighbourhood of the three existing borrow pits under consideration, the Ecça sediments have been extensively intruded and baked by dolerite sills of the Early Jurassic (183 Ma) **Karoo Dolerite Suite (Jd)** (Duncan & Marsh 2006). Such major intrusions are likely to have thermally metamorphosed the country rock for a considerable distance on either side of their edges to produce dark, splintery hornfels and minor quartzites. The Karoo dolerites are very vulnerable to deep chemical weathering under past and prevailing humid, pluvial climates, resulting in a friable zone of weathered *sabunga* (extensively used as a road material) containing scattered corestones, many of them displaying well-developed onion-skin weathering.

According to the geotechnical report, the proposed new borrow pit situated close to the southern edge of the 1: 250 000 Umtata geological sheet will be excavated into deeply-weathered dolerite overlain by a 0.5 to 2.5m of silty colluvium. Large dolerite intrusions in the study area WSW of Coffee Bay intrude sediments of the Ecça Group (Fig. 4). The material excavated here will be used for the upgrade of the district road between the Zithulele Mission Hospital and the town of Coffee Bay.



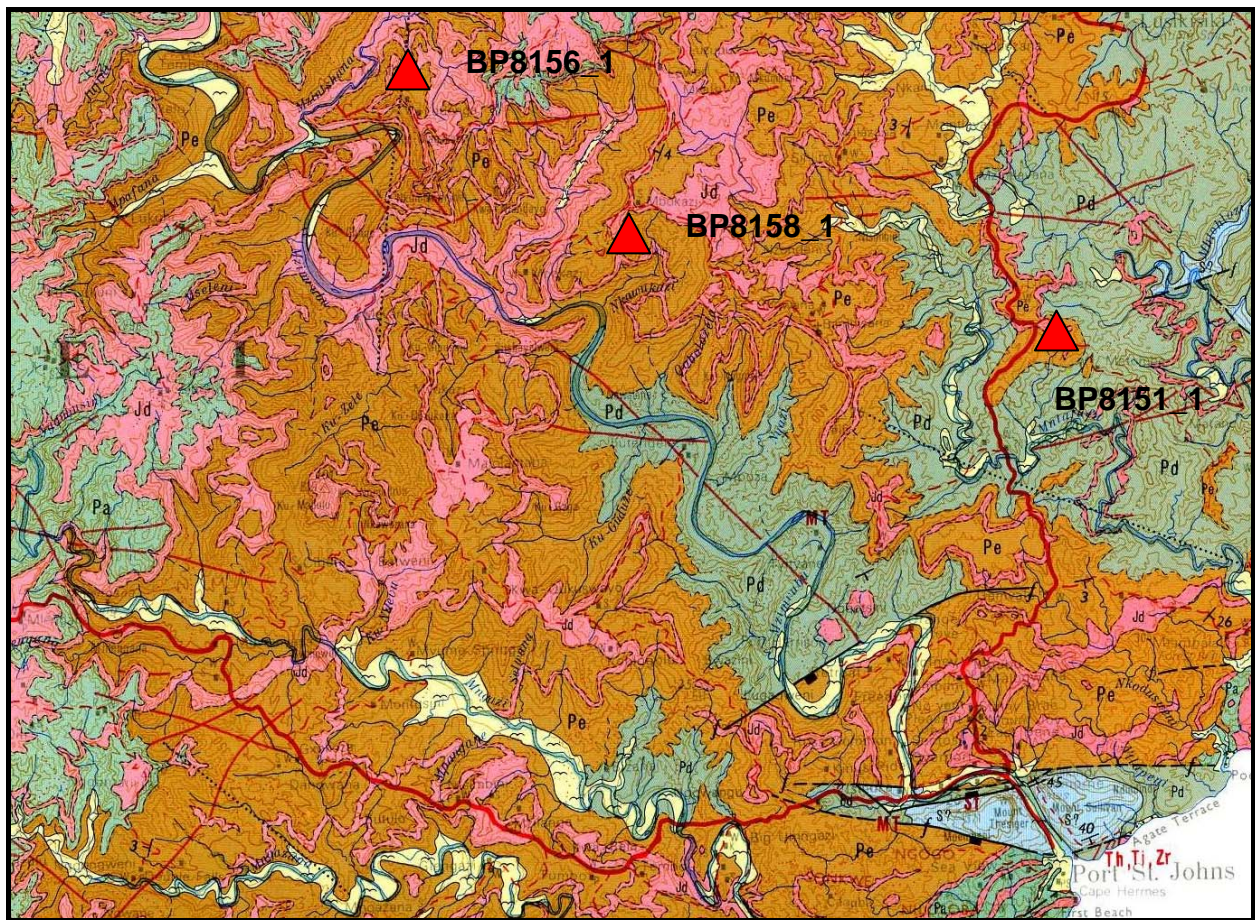
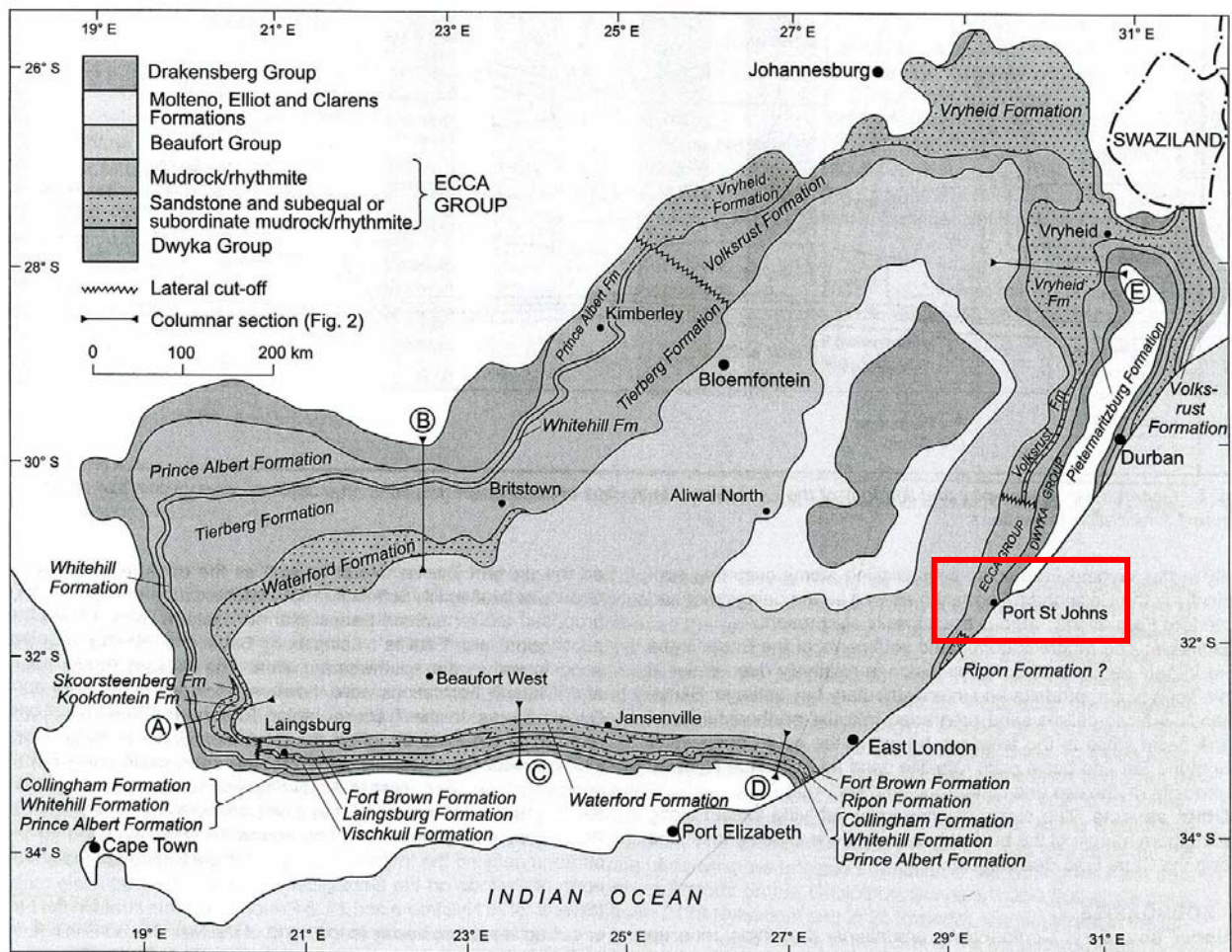


Fig. 2. Extract from 1: 250 000 geological map 3128 Umtata (Council for Geoscience, Pretoria) showing *approximate* location of the three existing borrow pits excavated into Eccca Group rocks to the north and northwest of Port St Johns.

Major rock units in the study area: Dwyka Group (Pd, grey-green); Eccca Group (Pe, brown); Karoo Dolerite Suite (Jd, pink).





**Fig. 3. Outline geological map of the Main Karoo Basin (modified from Johnson 2009) showing the undifferentiated Eccca Group outcrop area in the Port St Johns area of the Eastern Cape Province (red rectangle).**

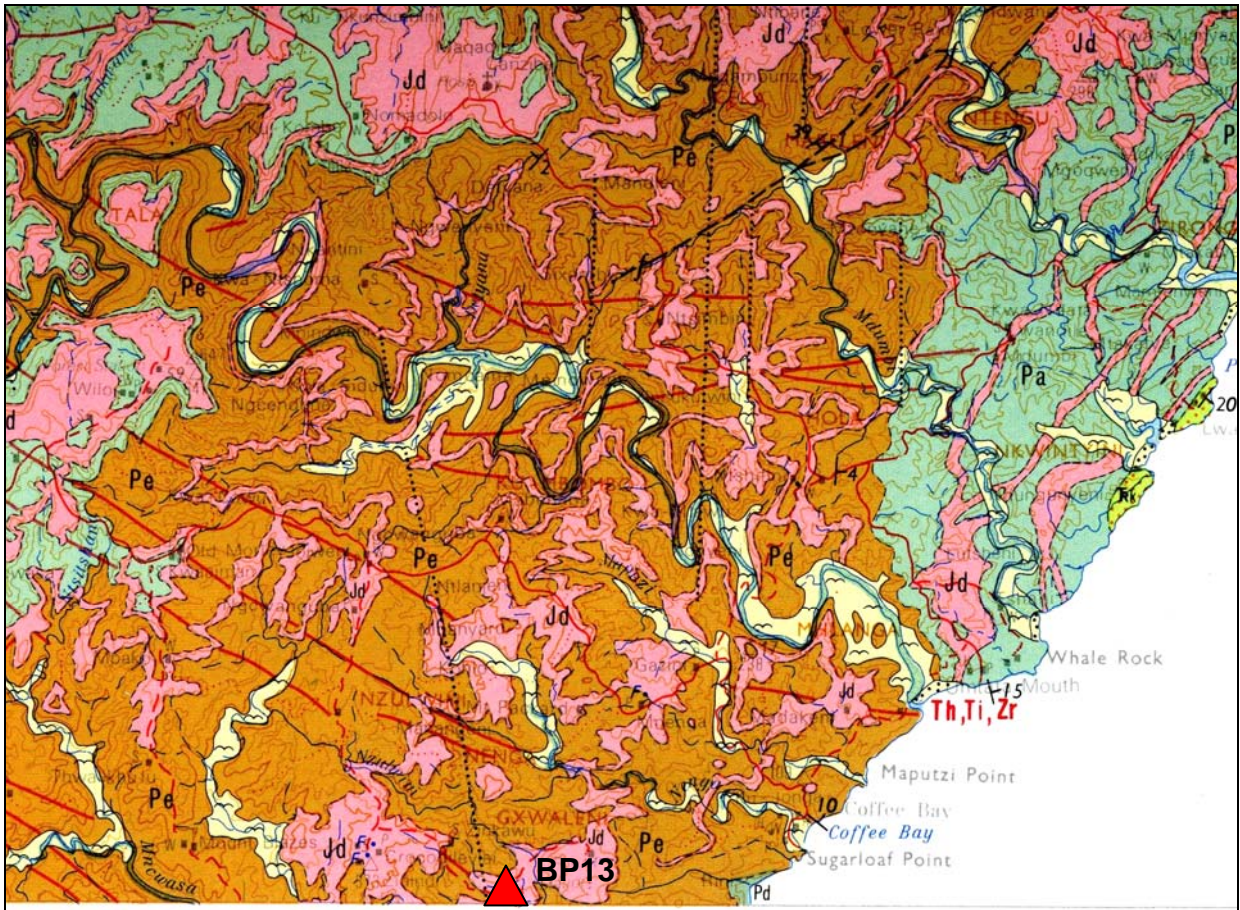


Fig. 4. Extract from 1: 250 000 geological map 3128 Umtata (Council for Geoscience, Pretoria) showing *approximate* location of the proposed new borrow pit, BP13, excavated into weathered dolerite to the WSW of Coffee Bay, Eastern Cape province (red triangle).

Major rock units in study area: Eccca Group (Pe, brown); Karoo Dolerite Suite (Jd, pink).



## 4. PALAEOONTOLOGICAL HERITAGE

The Mid to Late Permian fossil heritage of the basinal, mudrock-dominated Eccca Group succession in the Port St Johns area is very sparse and poorly-known. This is partially, but not entirely, attributable to poor levels of bedrock exposure and extensive surface weathering in the region as a whole. According to Du Toit and Rogers (1917) as well as Karpeta and Johnson (1979) body fossils have not been recorded from the Eccca beds here but trace fossils (“fucoid-like impressions”) are locally very abundant.

By comparison with the better-known, but still low-diversity, palaeontological record of the laterally equivalent Volksrust Formation (e.g. Taverner-Smith *et al.* 1998, Bamford 2004, Cairncross *et al.* 2005), the following fossil groups are likely to occur, albeit sparsely, within the Eccca Group study area near Port St Johns:

- acritarchs (organic-walled microfossils)
- megadesmid bivalves
- rare temnospondyl amphibian remains
- vertebrate microfossils (e.g. fish teeth, spines, scales) within diagenetic nodules
- wind-blown insect remains
- petrified driftwoods (“*Dadoxylon*”)
- low-diversity trace fossils assemblages of the *Cruziana*, *Scoyenia* and – especially - *Mermia* ichnofacies

The Karoo dolerites are not themselves fossiliferous, being hypabyssal igneous rocks. Thermal metamorphism of the Eccca Group mudrocks by adjacent dolerite intrusions may destroy some of their fossil heritage (e.g. organic-walled microfossils) but may even enhance the preservation of some other groups (e.g. some trace fossils). Vertebrate remains are difficult to extract from baked Karoo sediments.

## 7. CONCLUSIONS & RECOMMENDATIONS

The three existing borrow pits under consideration are all excavated into Permian mudrocks of the Eccca Group. These well-laminated offshore sediments are generally of low palaeontological sensitivity. Their sparse fossil content in the study area – mainly low-diversity trace fossil assemblages - has often been compromised by deep chemical weathering and nearby dolerite intrusions. Weathered dolerite rocks at the proposed new borrow pit site WSW of Coffee Bay are unfossiliferous igneous rocks. All four of the borrow pit projects covered here are therefore not considered to pose a serious threat to local fossil heritage and no further specialist palaeontological studies are required for this project.

Any substantial fossil remains (e.g. vertebrates, petrified wood) encountered during excavation should be reported to SAHRA for possible mitigation by a professional palaeontologist.

Should other fossils be encountered during excavations, they should be carefully collected, with adherent matrix where necessary, given a provisional reference number (e.g. marked on masking tape) and carefully wrapped in newspaper. It is *essential* that the locality where the fossil is found be accurately marked on a 1: 50 000 map or recorded by GPS. Specimens without locality information are of limited scientific value. The fossils should be submitted for inspection by a professional palaeontologist at the earliest opportunity. Some of this material may be of scientific interest - in which case it should be deposited ultimately in an approved repository (e.g. Albany Museum, Grahamstown or East London Museum) – while other specimens may be of educational value and might be donated for display purposes.

## 8. ACKNOWLEDGEMENTS

Mr Duncan Scott of TERRECO Environmental cc is thanked for commissioning this study and for kindly providing the necessary background information.

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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 APHAP (Association of Professional Heritage Assessment 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 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.



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