CONSULTING SERVICES FOR THE uMKHOMAZI WATER CONVEYANCE INFRASTRUCTURE (uMWP-1)

Construction Method Evaluation for Ventilation and Surge Shafts on the uMWP-1 Water Transfer Tunnel Project

GIBB-Knight Piésold JV - SANCOT

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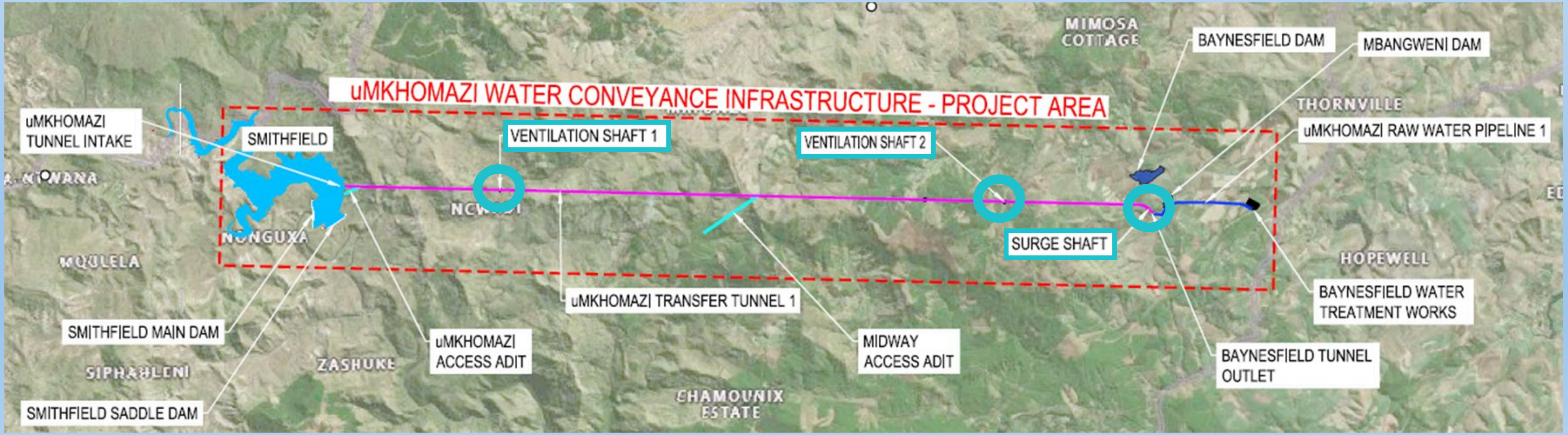
Project Context

- Part of the uMngeni Water Supply System augmentation
- 34 km water transfer tunnel
- Two TBM drives are from separate access adits
- Three vertical shafts are required:
  - Two ventilation shafts
  - One surge shaft



(GIBB Knight Piésold Joint Venture, 2026)

Why Shaft Method Selection Matters

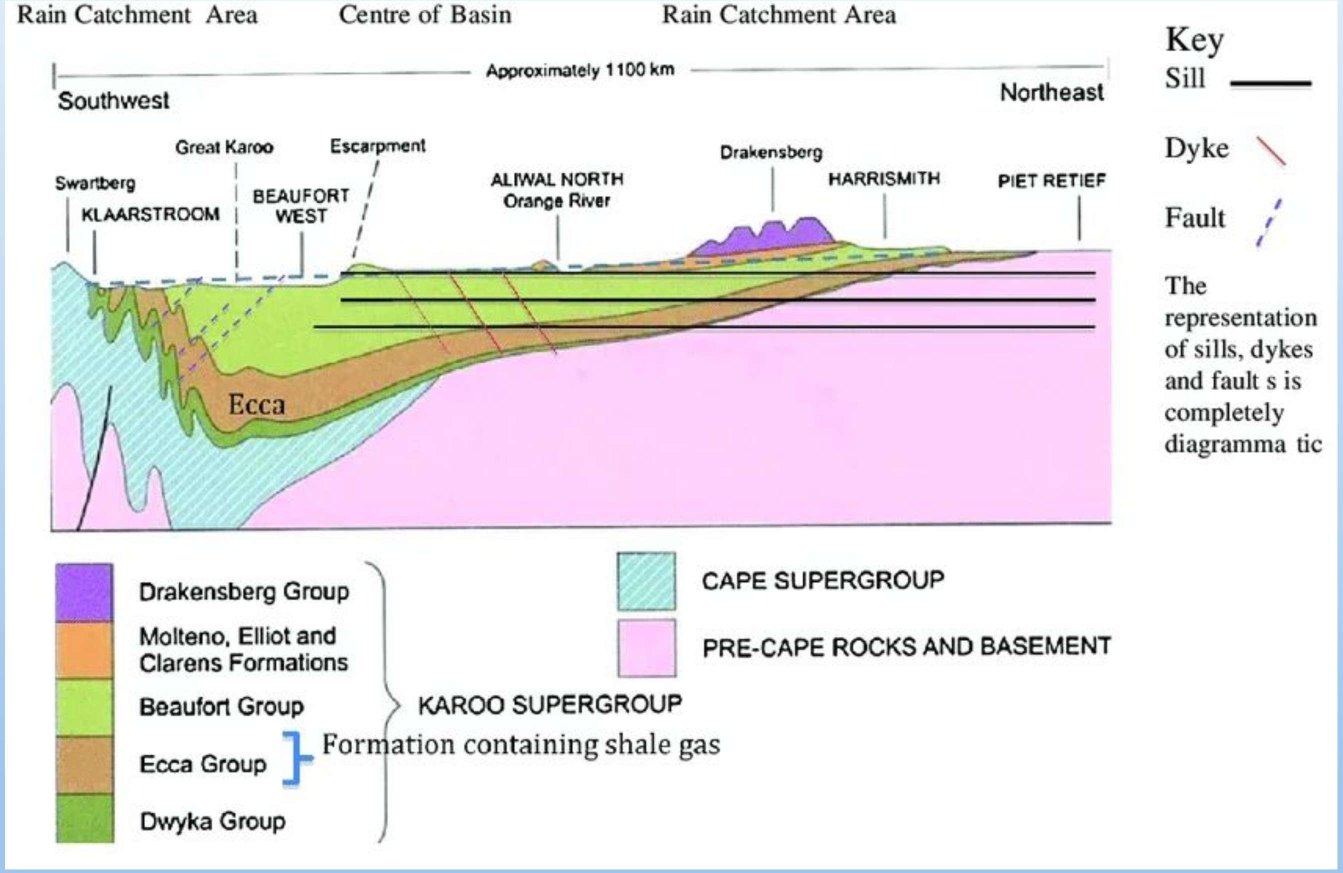
- Method selection is not governed by depth alone
- Key controls:
  - diameter and function
  - ground conditions
  - groundwater
  - support demand
  - programme and environmental constraints
- Ventilation shafts and surge shaft required different approaches

Shaft Summary

Shaft	Depth Below Surface (m)	Excavated Diameter (m)	Function
VS1 – Ventilation Shaft 1	**125**	**2.0**	Ventilation for TBM Drive 1 and emergency access.
VS2 – Ventilation Shaft 2	**190**	**2.0**	Ventilation for TBM Drive 2 and emergency access.
SS – Surge Shaft	**110**	**6.0**	Hydraulic surge control in operation

Geological Setting

- Underlain by the Karoo Supergroup
- Predominantly shale, mudstone and siltstone
- Extensive dolerite intrusions as sills and dykes
- Strong contrast between weaker sedimentary rocks and hard abrasive dolerite
- Structural lineaments and faulting influence rock mass quality and groundwater



(Tucker & van Tonder, 2014)

Geotechnical Setting

Shaft	Dominant ground condition	Main geotechnical concern
VS1 – Ventilation Shaft 1	Indurated shale with dolerite sills	Local fractured and water-bearing zones
VS2 – Ventilation Shaft 2	Massive dolerite	Fault zone with elevated groundwater inflow potential
SS – Surge Shaft	Variable shale with dolerite sill	Extended weak fractured shale interval

Investigation Approach

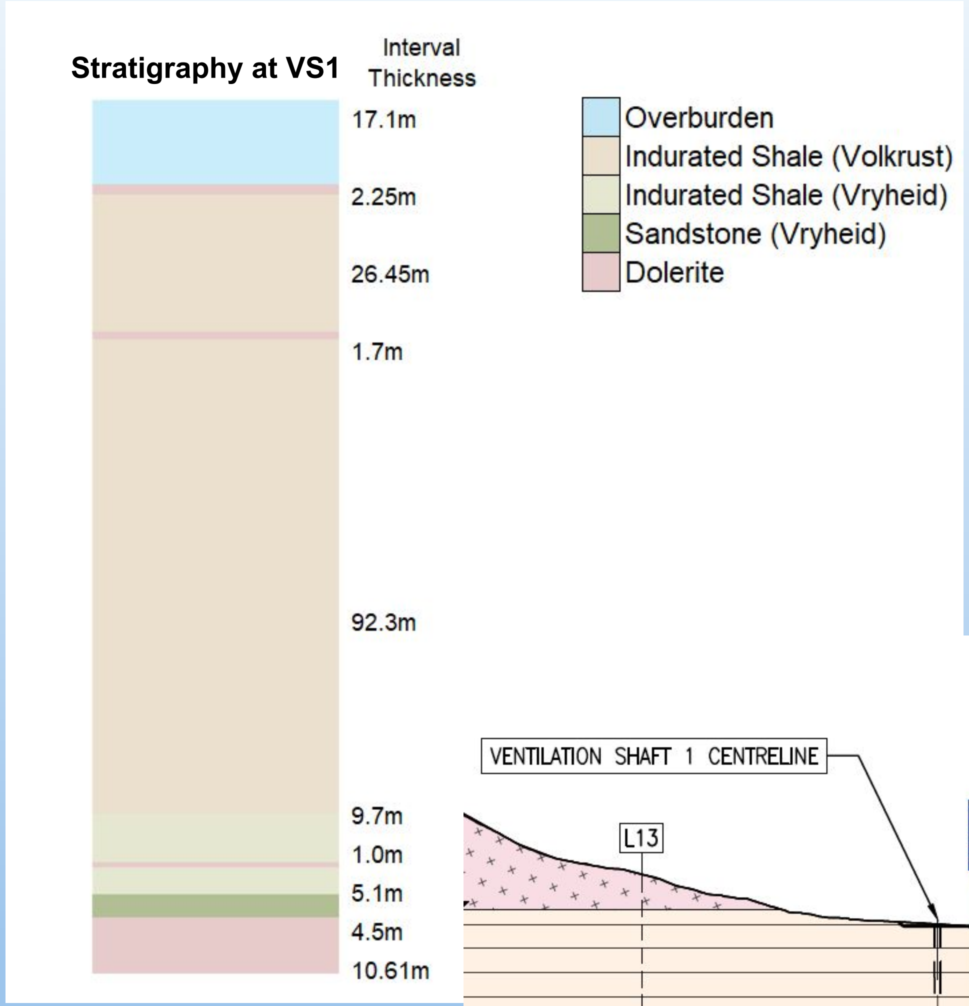
- One core borehole drilled at each shaft location
- Boreholes advanced beyond shaft depth
- Televiewer logging used for structural assessment
- Laboratory testing completed on representative core
- Packer testing and groundwater monitoring informed inflow assessment
- Assessment informed by structural interpretation and anticipated ground behaviour

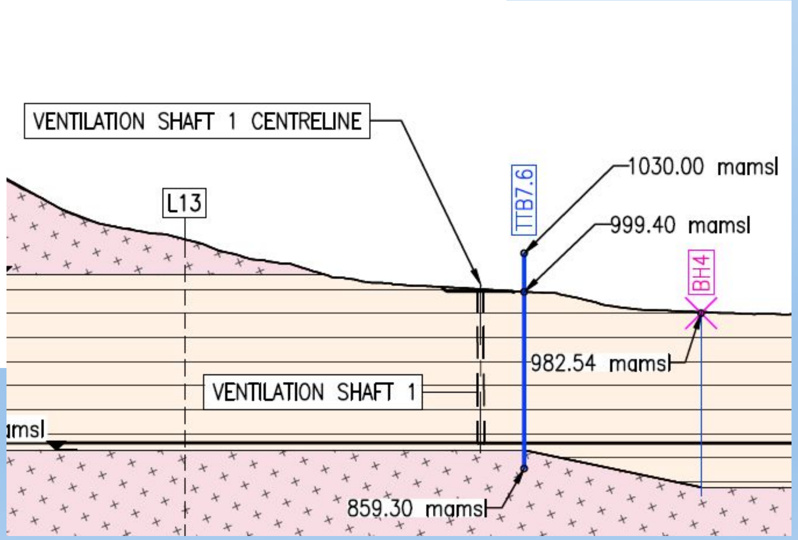
Ventilation Shafts Overview

- Small diameter shafts: 2.0 m excavated / 1.5 m finished
- Primary role: fresh air supply during TBM construction
- Key requirements:
  - efficient excavation
  - limited footprint
  - safe construction at depth
- Methods considered:
  - RC drilling
  - raise boring
  - conventional shaft sinking

Ventilation Shaft 1 (VS1)

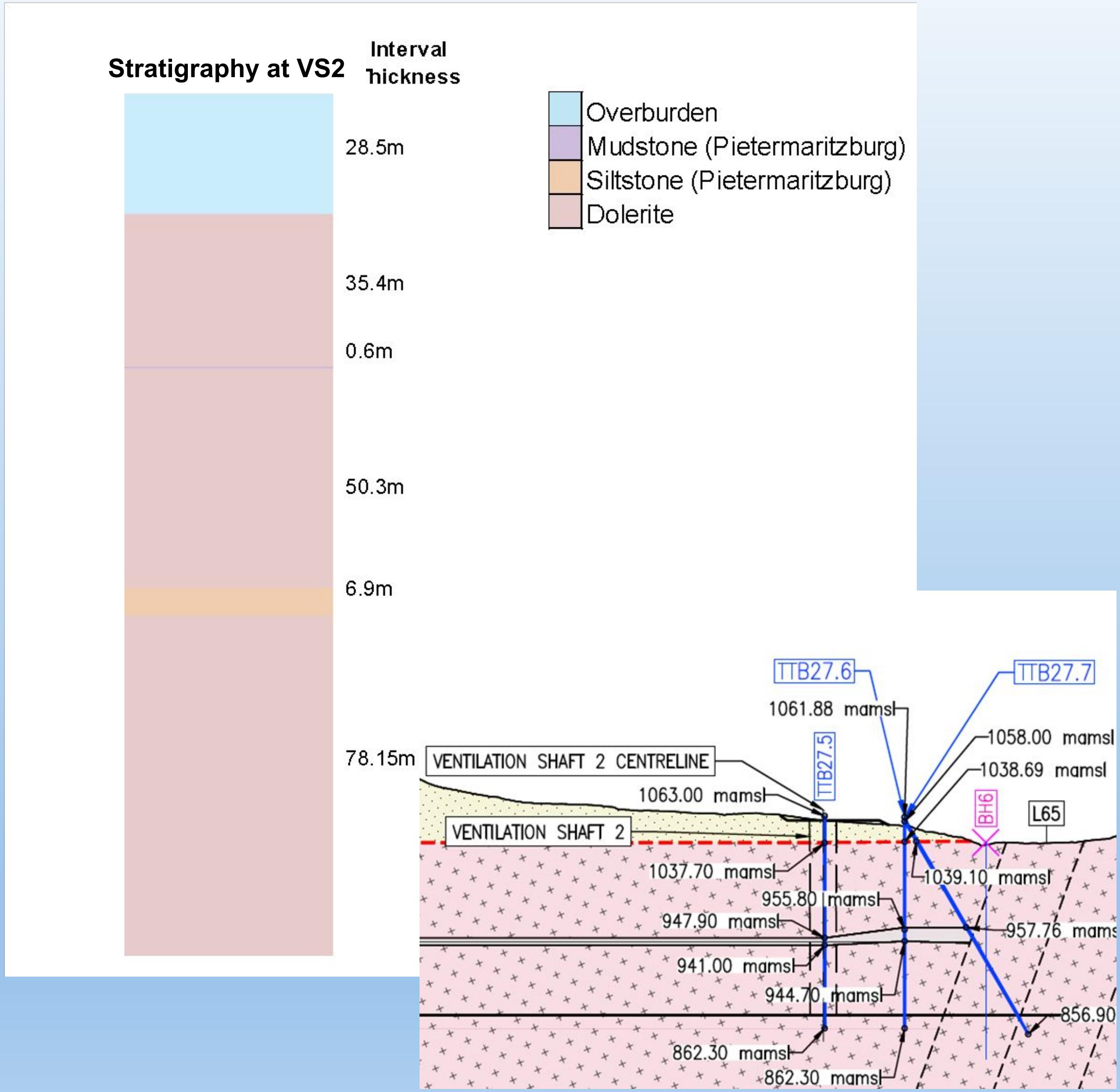
- 125 m deep
- Predominantly Volksrust Formation indurated shale
- Two dolerite sills present
- Generally fair to good rock mass quality
- Local challenges:
  - fractured zone at 28-29 m
  - water-bearing broken zone at 42-44 m
  - fractured ground near tunnel intersection





Ventilation Shaft 2 (VS2)

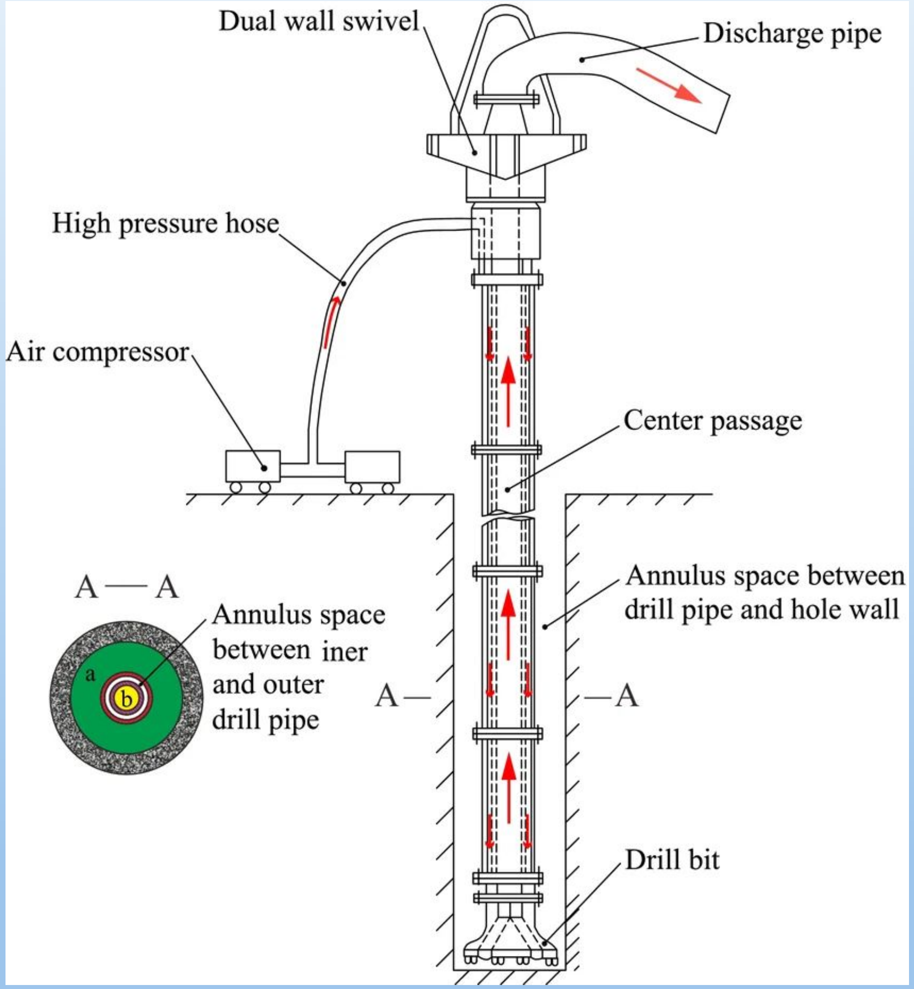
- 190 m deep
- Dominated by massive dolerite
- Highest overall rock mass quality of the three shafts
- Main challenge: 6 m fault zone at 117-123 m depth
- Faulted interval linked to elevated groundwater inflow
  - Estimated inflow: ~11 L/s



Preferred Method for Ventilation Shafts

Reverse circulation drilling selected as preferred reference method.

- Suited to small shaft diameter
- Efficient advance rates
- Smaller surface footprint
- Reduced personnel exposure at depth
- Drilling fluid provides temporary confinement
- Fractured and faulted zones manageable with contingency measures



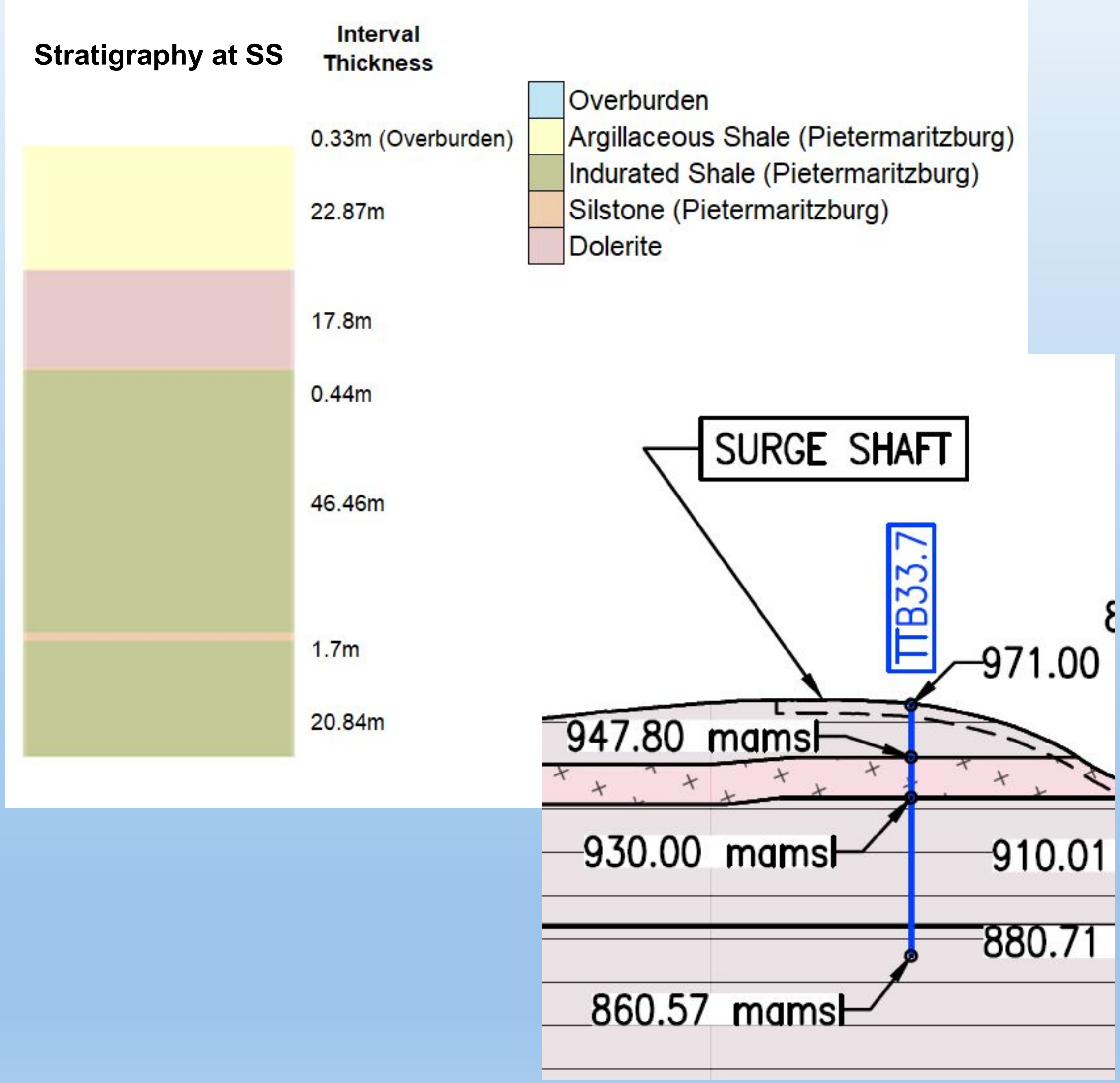
(Zhang, et al., 2019)

Surge Shaft Overview

- 110 m deep with 6.0 m excavated diameter
- Permanent hydraulic structure
- Requires:
  - tighter excavation control
  - greater support demand
  - permanent lining
- Environmental restriction:
  - blue swallow habitat
  - construction limited to September-February

Surge Shaft Governing Conditions

- Upper profile includes weathered shale
- Dolerite sill between about 23 m and 41 m
- Critical interval at 56-73 m depth
- This zone comprises:
  - weak shale
  - closely fractured ground
  - poor stand-up conditions
  - increased support demand
- Estimated inflow: ~1.2 L/s



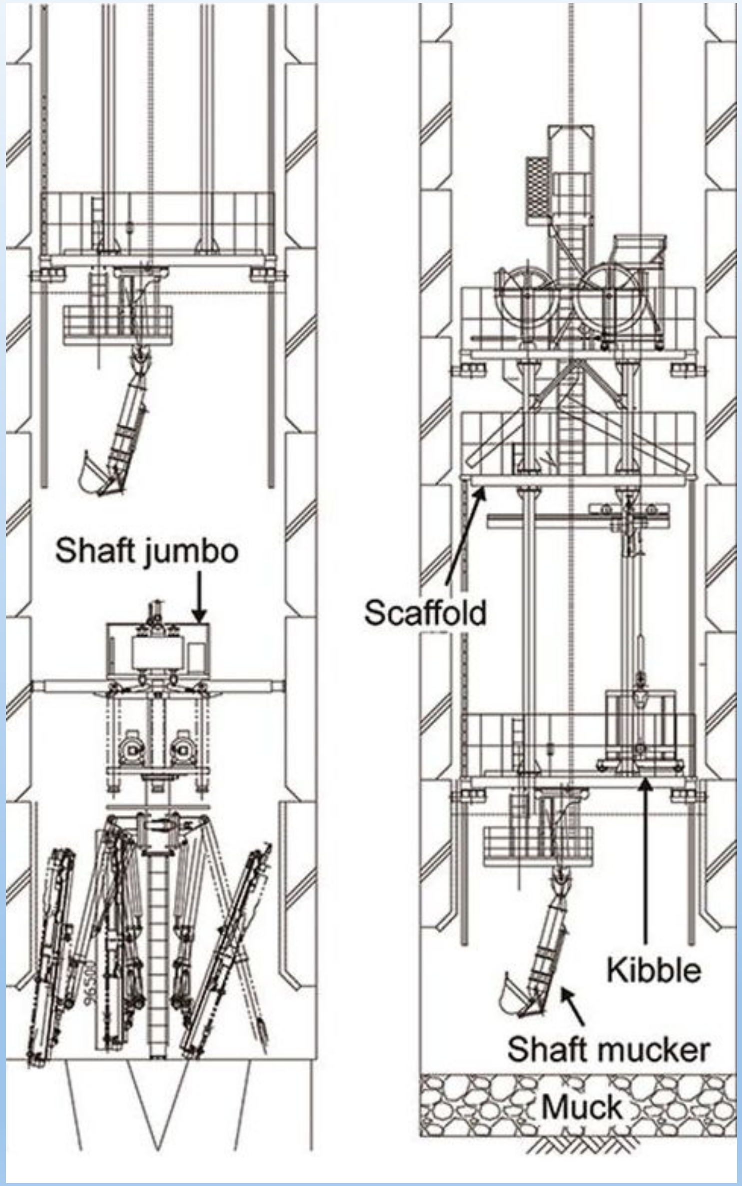
Surge Shaft Method Comparison

	Conventional shaft sinking	Raiseboring	Sinking with pre-RC drilled muck pass
Programme	Slower excavation, but can start earlier	Faster excavation, but only after bottom access	Similar constraint to raise boring
Ground control	Best control, support installed progressively	Less control in weak ground, support after excavation	Better than raise boring, but still bottom-access dependent
Footprint/Logistics	Largest surface setup	Smallest footprint	Intermediate

Preferred Method for the Surge Shaft

Conventional shaft sinking selected as the reference method.

- Best control in weak fractured shale
- Progressive support installation possible
- Does not depend on prior shaft-bottom access
- More robust under sequencing and environmental constraints
- Raise boring remains a possible contractor alternative



(Sanada, et al., 2015)

Construction Implications Beyond Method Selection

Support and lining	Groundwater and durability	Footprint and logistics
• Ventilation shafts: drilling fluid provides temporary stabilisation; steel casing forms final lining • Surge shaft: bolts, mesh, shotcrete and reinforced concrete lining • Progressive support is a key advantage for the surge shaft	• Water handling and treatment required for all methods • VS2 fault zone is the main local inflow risk • Argillaceous rocks should not remain exposed for long periods	• RC drilling has the smallest footprint • Conventional shaft sinking requires the largest setup • Raise boring offers a smaller footprint at the surge shaft site

Key Conclusions

- Shaft geometry was the main discriminator in method selection
- Ventilation shafts and surge shaft required separate assessment
- RC drilling preferred for the ventilation shafts
- Conventional shaft sinking preferred for the surge shaft
- Ground behaviour, support demand, groundwater and constraints were all critical

THANK YOU

Questions?

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