

**SAIEG**

**South African Institute for Engineering  
& Environmental Geologists**



**ROAD PAVEMENT FORUM 2019**

**Basic Crystalline Material Durability**

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# Introduction

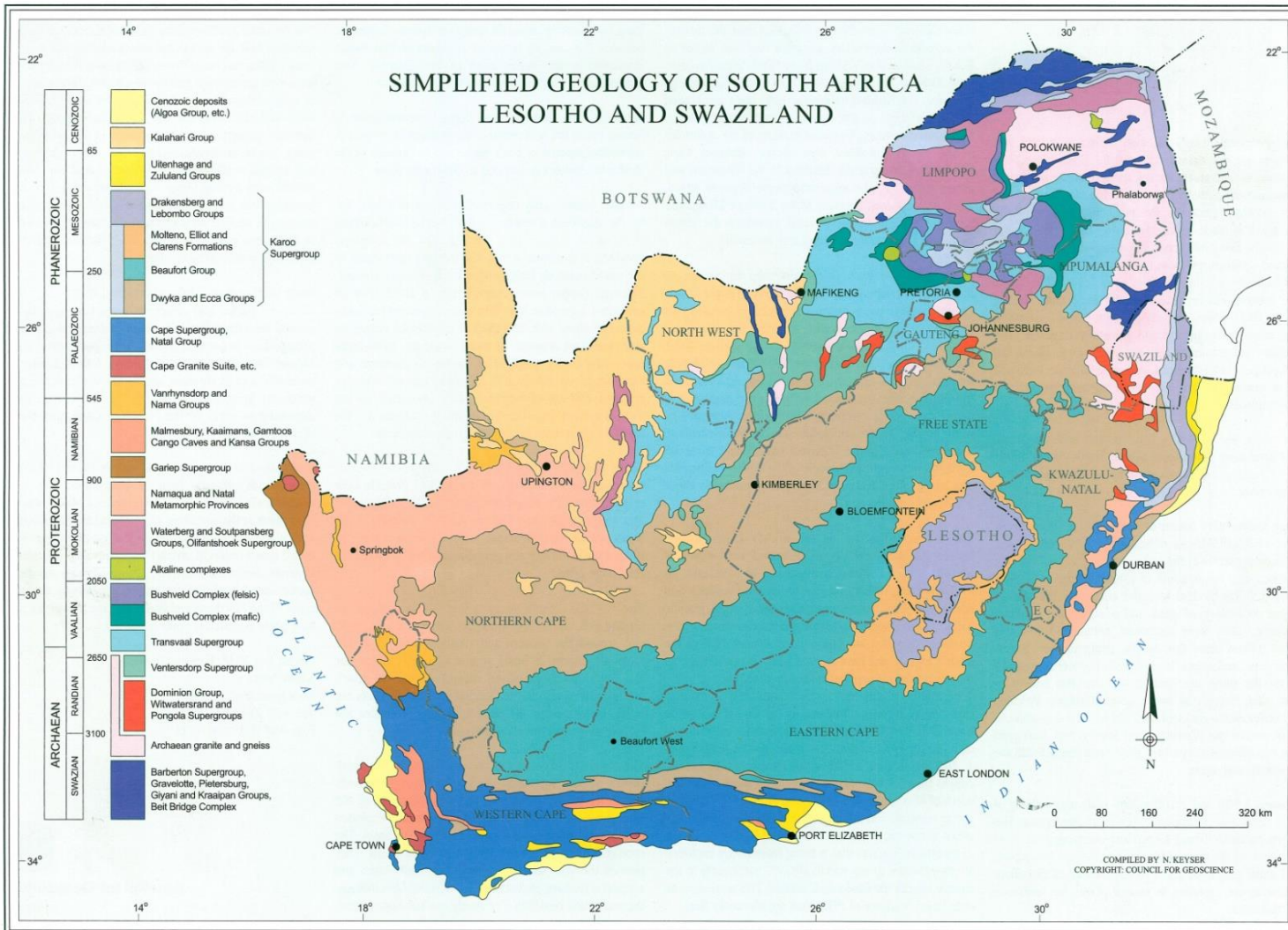


- Basic crystalline materials commonly used for road construction aggregate in South Africa
- Dolerite, basalt, diabase...but also amphibolite, andesite, anorthosite, diorite, gabbro, greenschist, norite, peridotite, phonolite, serpentinite.
- Used for road construction: dolerite, basalt, diabase, andesite, amphibolite, diorite, gabbro and norite.

**Question:** If we know it is problematic, why do we use it?

**Answer:** Distribution and lack of alternatives.

# Introduction



# Durability Issues: New Problem?



- Dolerite durability problems have been researched in past decades (e.g. Clauss, 1967; Orr, 1979; Weinert 1964; Weinert, 1980; etc.)
- Basalt durability assessed during Lesotho Highland Water Scheme (Van Rooy and Nixon, 1990; Van Rooy, 1991; Van Rooy and Van Schalkwyk, 1993; etc.)
- More recent research, specifically related to road construction aggregate (Bell and Jermy, 2000; Paige Green, 2007; Leyland *et al*, 2013; Leyland *et al*, 2014)
- New COTO?

# What is the problem?



- Seemingly competent/sound/hard rock completely deteriorates in service or during quarrying/production
- Durability problems see two main changes (Leyland, 2014):
  - The production of more fines during construction
  - An increase in plasticity index and linear shrinkage of fines
- Mechanism: Active clay minerals in the rock material which originate from mineral weathering becomes liberated/activated, usually when exposed to atmospheric conditions (i.e. quarrying and construction)

# What is the problem?



Photograph by R.C. Leyland

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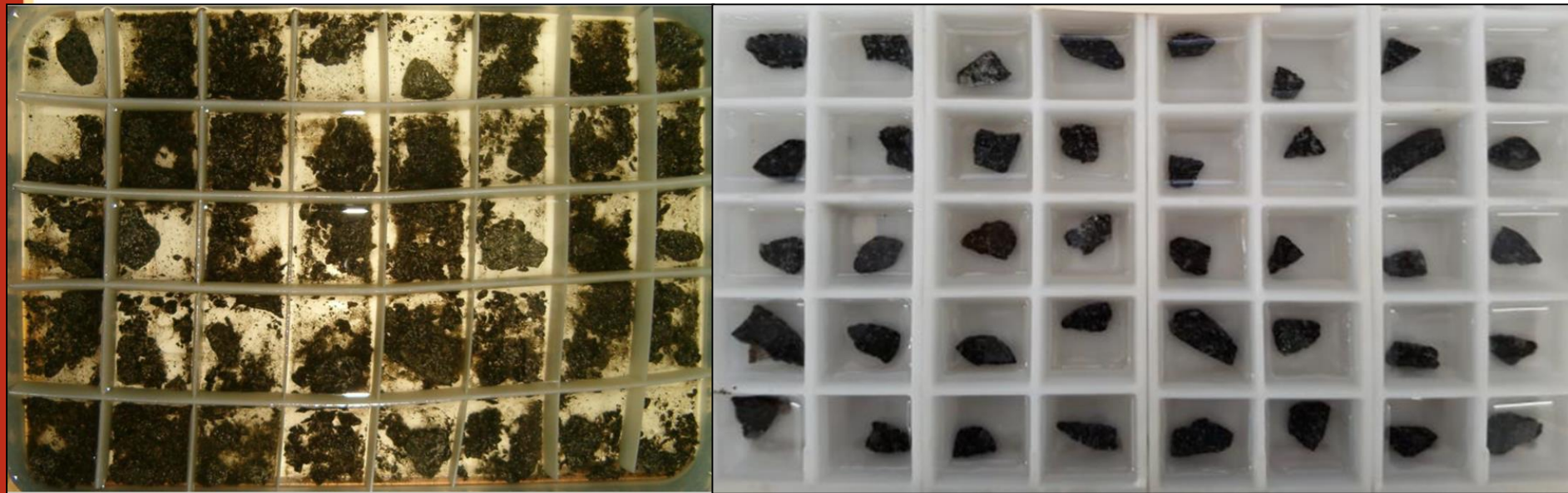


# What is the problem?



Photograph by R.C. Leyland

# What is the problem?



Photograph by R.C. Leyland

# Is durability always the problem?



- Definitely not!
- Section 3602 (a) of COLTO (1998) for aggregate:
  - “...It shall not contain any deleterious material such as weathered rock, clay, shale or mica...”
- Consider the geological origin of dolerite/basalt: mostly intrudes through country rock (e.g. sandstone, shale, tillite, etc.)
- Materials are often contaminated by assimilated sedimentary rock originating from the country rock (i.e. xenoliths)
- Know your geology!

Is the problem always durability?



# Is the problem always durability?



# What to do?

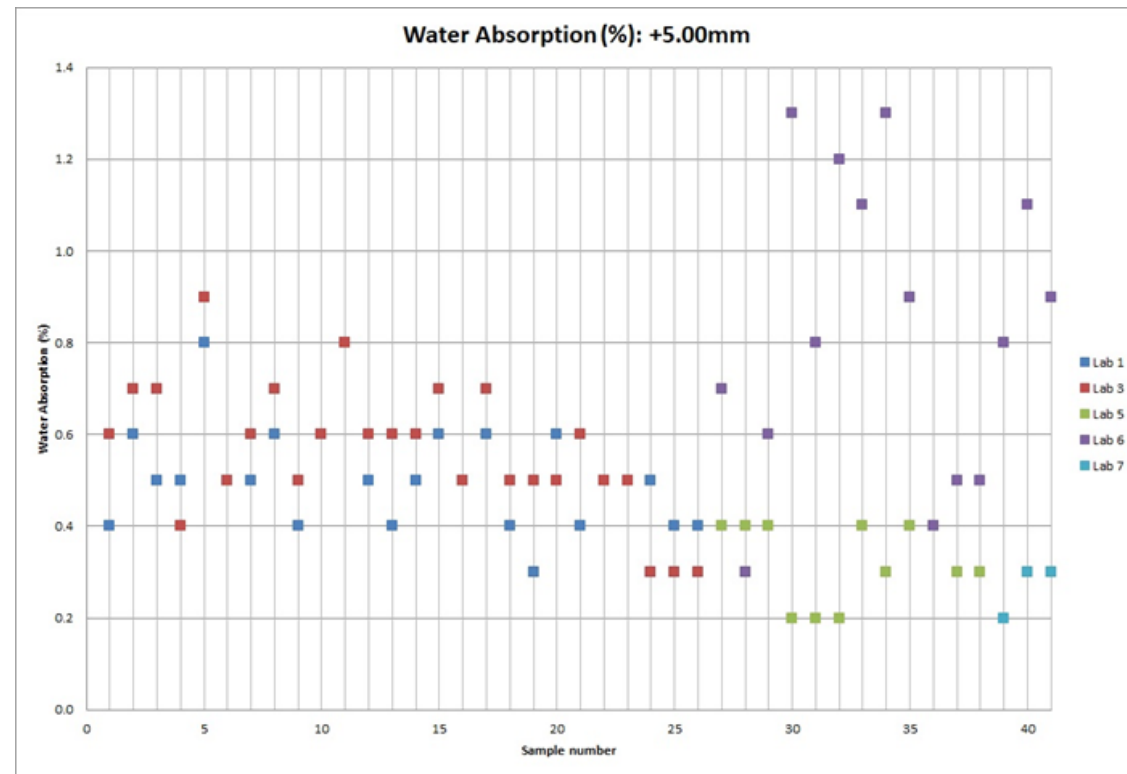


- Investigate thoroughly:
  - Invasive drilling investigations
    - SAPEM Chapter 8: “The depth and spacing of boreholes will be dependent on the nature of the rock source being investigated. However it is recommended that boreholes should be spaced *no greater than 30 metres apart* and be drilled to a depth at least 5 metres below the proposed bottom of the quarry...”
    - i.e. 11 boreholes per hectare vs cost of drilling/tender
    - NWD4/TNW barrel =  $\pm 60\text{mm}$  diameter core ( $0.0113\text{m}^2$ )
    - $0.124\text{m}^2$  vs  $10\,000\text{m}^2$
- SAPEM is not a specification, but a guideline

# What to do?



- Comprehensive laboratory test programs for intended application (e.g. G1)
- Be mindful of sample size vs volume of aggregate to be procured. Do multiple sets of tests
- Duplicate testing where possible/relevant



# Specific tests focussing on basic crystalline material durability



- Current tests in isolation are not sufficient
- Best tests that indicate durability problems include:
  - Modified ethylene glycol durability index
  - Durability mill index (for G1?!)
  - 10% FACT / Aggregate crushing value (dry, wet and ethylene glycol soaked)
  - Aggregate impact value
  - Petrographic analyses (i.e. XRD with thin section review)
  - Water absorption (especially fine fraction)
- Do not test in isolation!
- Consult an engineering geologist; start a rocky relationship!



# Closing Remarks



- Do not assume that basic crystalline material durability is always the problem
- Investigate thoroughly and test comprehensively. Cost of additional drilling and laboratory tests is negligible compared with the costs of rebuilding a road
- Avoid marginal materials!

# References



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Thank you!

