Tasmania Department of Resources and Energy

Division of Mines and Mineral Resources — Report 1991/28

Geological investigation of a proposed water supply pipeline, Lower Dysart to Kempton

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Introduction

The geological investigation for the proposed Lower Dysart to Kempton water supply pipeline is one of a series of similar investigations carried out by the Division of Mines and Mineral Resources at the request of the Hobart Regional Water Board.

The investigation of this 4.8 km section sought to provide basic information on the following:

(i) the nature and range of subsurface materials likely to be encountered en route to a depth of two to three metres (average excavation depth);

(ii) the rippability or ease of excavation of materials;

(iii) soil corrosivity along the entire route;

(iv) foundation conditions for a proposed second reservoir at Kempton.

The investigation involved geological route mapping, continuous resistivity traversing, and subsequent seismic refraction surveys at selected locations along the route.

Survey details

Resistivity

Continuous resistivity traversing was carried out along the entire route in order that a guide to the soil corrosivity could be determined. The traversing was done using the constant electrode spacing Wenner configuration; electrode spacings of 4.0 m were used.

Seismic refraction

Five spreads were fired at locations selected on the results of the surface geology and resistivity survey. The seismic spreads were designed to determine a typical range of excavation conditions likely to be expected from the two rock types noted. Traverses were carried out in areas of outcrop or sub-outcrop and soil cover only.

A Nimbus 12-channel seismograph was used, with spread lengths of 24.0 m and 2.0 m geophone spacings. Shots were fired from both ends. Calculations were by the critical distance, intercept time, and where appropriate, the reciprocal time methods.

Results

Every effort has been made to predict, as accurately as possible, the likely nature and range of materials to be encountered along the proposed route. It is stressed that in any investigation employing geophysical methods, the results are an interpretation (based largely on experience) of the physical properties measured. No amount of investigative work at this preliminary survey level can accurately predict the extremes or rapid variability of materials (both laterally and vertically) that may exist over short distances.

Contractors should view the results as a guide only to conditions anticipated along the route. A series of trial excavations should preferably be undertaken to test the validity of the information inferred from the geophysical results. This would also enable contractors to assess the capability and suitability of their machinery for varying rock conditions.

Route geology

The Brighton 1:50 000 scale geological map sheet (Leaman, 1975) indicates that the proposed route is underlain by a varying sequence of Triassic age sandstone-mudstone sedimentary rocks. These rocks have, in places, a surficial cover of Quaternary alluvial and slope deposit (dolerite talus) materials. The pipeline terminates at its northern end at the Kempton reservoir which is founded on dolerite.

The distribution of rock types is indicated on Figure 1.

Bedrock outcrop along the proposed route was sporadic and mapping was based to a large degree on

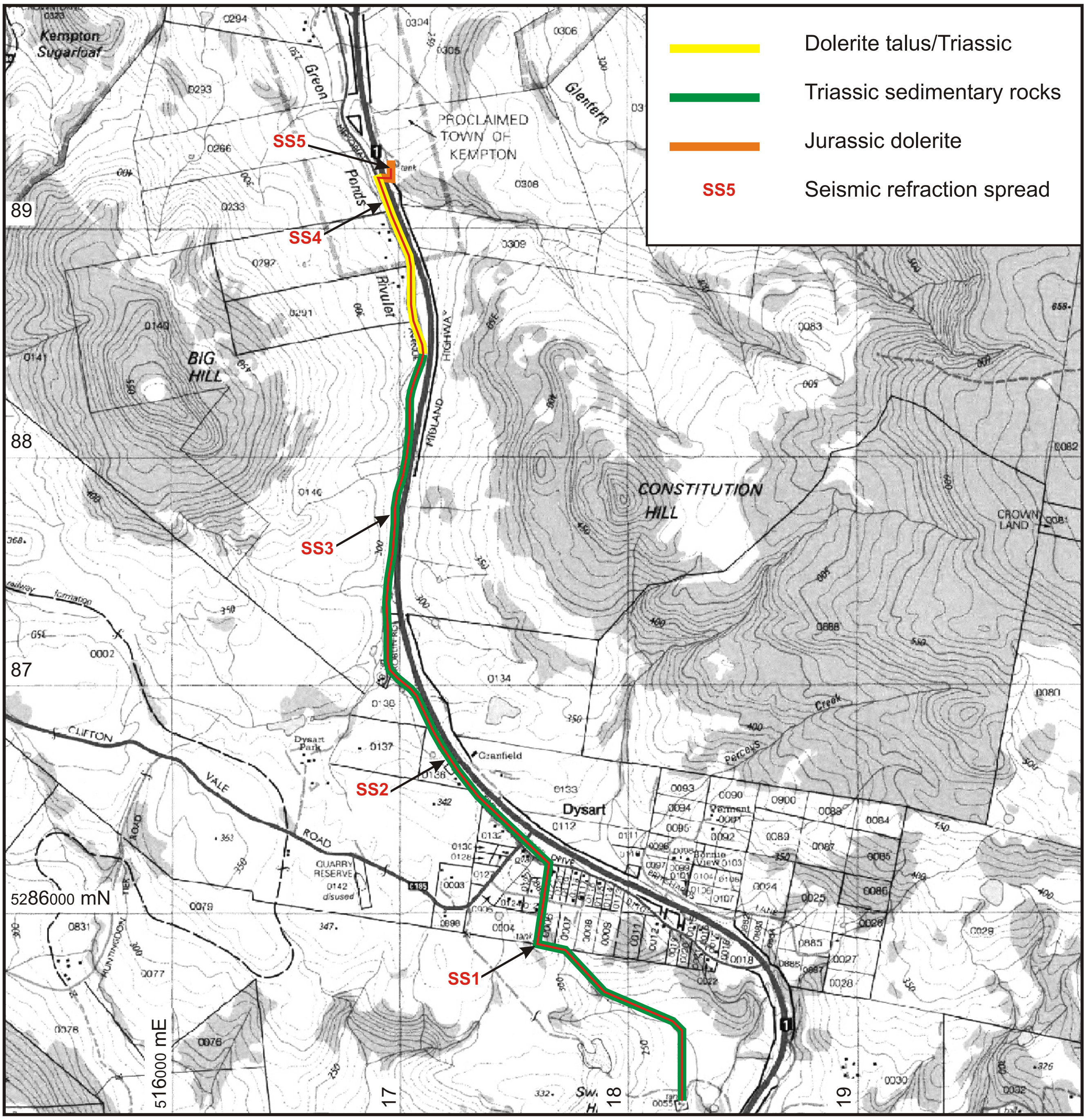

Figure 1

Pipeline route showing geology and seismic spread locations.

surface soil information and exposures observed in nearby roadside cuttings.

The route map differs slightly from the published Brighton geological map sheet over the final kilometre (northern end) of the proposed route. It is considered that the lateral extent of the dolerite talus deposits are greater than originally mapped, and in fact form a surficial cover over Triassic sedimentary rocks for the most part of this latter section.

Geophysics

The seismic refraction survey results (Table 1) clearly indicate the variability of excavation conditions likely to be encountered along the route. The velocity plots are typically symmetrical in the broad sense but have stepped segments throughout, indicating that variable conditions can be anticipated across the site. This steeping effect is considered to represent either variations in the weathering characteristics of the rock mass (i.e. from MW–SW) and/or variations in the lithology.

The velocity segments, with the exception of the V_1 velocity figures, tend to vary considerably between spreads. This highlights the likely variability in conditions along the route.

The resistivity survey results (fig. 3–7) can often be interpreted (with caution) in a qualitative manner to indicate areas of substantial soil development as distinct from areas of probable bedrock close to surface. Although the correlation is crude, deep soil profiles tend to have resistivity values less than 5000 ohm-m, whilst shallow hard rock conditions are probably present above 10 000 ohm-m. However it does not follow that the high resistivity areas necessarily indicate hard rock conditions close to the surface. For example, whilst the high resistivity values recorded between 1.0–1.25 km and 4.8–4.9 km are considered to be due to bedrock at relatively shallow depth, the remaining high resistivity segments are likely to be reflecting the base coarse and fill materials associated with the shoulder of the old road and highway formation along which much of the route lies. It is stressed therefore that these results should be used with caution, although they do give an indication and guide to those areas where either soil or rock conditions are likely to be prevalent.

Excavation conditions

Pipeline route

The mapping, together with the geophysical survey results, indicate the probability of varying conditions along the route. The majority of the materials that will be encountered during excavation (2–3 m average depth) are likely to be the soil and weathered material developed on the parent bedrock. There will also be sections of slightly weathered to fresh hard bedrock encountered.

The Triassic sandstone/mudstone sequence will typically have a gradational weathering profile of sandy clay soil (SC–CH) grading down into a highly weathered low–medium strength rock.

The dolerite is likely to have shallow and highly variable weathering characteristics which result in rapid changes in the nature and strength of the rock mass over short distances.

The rippability guide chart (fig. 2) relates the excavation capability of heavy machinery (D9 or similar) to seismic velocities over a range of rock types. Velocities in excess of about 2500 m/s (dolerite) and 2200 m/s (sandstone) are considered to represent material that may require blasting. Velocities approaching these values have been recorded and with the possible exception of spread 1 they are towards or below the general excavation limit (refer to Table 1). The weathering, strength and joint (defect) characteristics of the rock mass will ultimately determine the ease of excavation of those areas of bedrock encountered along route.

There are numerous roadside cuttings adjacent to the proposed pipeline route where the soil/rock profile can be observed. These observations, combined with the seismic refraction survey results, suggest that the vast majority of hard rock conditions should be able to be worked with a large traxcavator employing a hydraulic impact rock breaker to loosen the material.

It is considered that very little use of explosives should be necessary. The general attitude of the bedding and spacing of the major joint sets observed in some of the hard rock areas suggest that only isolated sections may require blasting.

Reservoir site, Kempton

Excavation associated with the construction of an additional reservoir alongside the existing structure will entail very little removal of material as the site is virtually level. The results of seismic spread 5 indicate the presence of hard rock conditions below about 2.0–2.5 m depth. Blasting at this site should not therefore be an issue.

Soil corrosiveness

The resistivity plots (fig. 3–7) indicate the relationship between resistivity and the degree of soil corrosivity. The classes used are based on information obtained from the Board.

The materials appear to be mildly corrosive (2000–10 000 ohm-m) on the Triassic sedimentary rocks but less so on the dolerite. No comment is made on the degree of protection required to ensure the longevity of the pipes.

Summary

A variety of materials exhibiting different weathering characteristics and physical properties will be encountered during the excavation for the proposed 4.8 km water supply pipeline.

The Triassic sandstone/mudstone sequence is considered to have a sufficiently thick weathering profile or favourable bedding and jointing characteristics that it is unlikely explosives will be necessary, except perhaps in isolated locations.

The short segment of the route underlain by dolerite approaching the Kempton reservoir site is likely to have a variable soil/rock profile over short distances. Hydraulic rock breakers may be required and the possible use of explosives should not be discounted over isolated segments. Excavation of the proposed reservoir will not require blasting.

Both the alluvial and slope deposit materials are not expected to present any hard rock conditions requiring explosives.

The soil corrosivity results indicate that the pipeline will be laid in mildly corrosive soils.

It is recommended that contractors take time to view the numerous exposures along the route and follow up with a series of trial excavations to confirm and, if necessary, modify the above findings and predictions.

Reference

LEAMAN, D. E. 1975. *Geological Atlas 1:50 000 series. Sheet 75 (8312N). Brighton*. Department of Mines, Tasmania.

[9 September 1991]

TABLE 1

Seismic refraction survey results

Distance (m)	Rock type	Velocity (m/s)		Layer depth (m)	Geological interpretation
Spread 1					
1133–1157	Sandstone	V_1	350–400	0.8-1.3	Soil profile
		V_2	1900–2250	–	SW sandstone, joints tight
Spread 2					
2186–2200	Sandstone/mudstone	V_1	650–800	0.5–0.7	Soil profile
		V_2	1000–1600	3.2–4.4	HW–MW sandstone/mudstone sequence
		V_3	2285	–	SW sandstone/mudstone sequence
Spread 3					
3300–3324	Sandstone/mudstone	V_1	450–670	0.5–0.7	Soil profile
		V_2	800–1540	–2.5	HW–MW sandstone/mudstone sequence
		V_3	2000–2500	–	SW sandstone/mudstone sequence
Spread 4					
4650–4674	Talus over sandstone	V_1	350-500	2.8-3.2	Soil profile/talus
		V_2	1750-2100	–	MW–SW sandstone/mudstone sequence
Spread 5					
4930	Dolerite	V_1	570	0.5-0.7	Reservoir site — soil profile
		V_2	800–1300	2.0-2.5	EW–HW bedrock or closely fractured MW–SW bedrock
		V_3	2000–2500	–	SW bedrock — joints tight

EW = extremely weathered, HW = highly weathered, MW = moderately weathered, SW = slightly weathered, FR = fresh

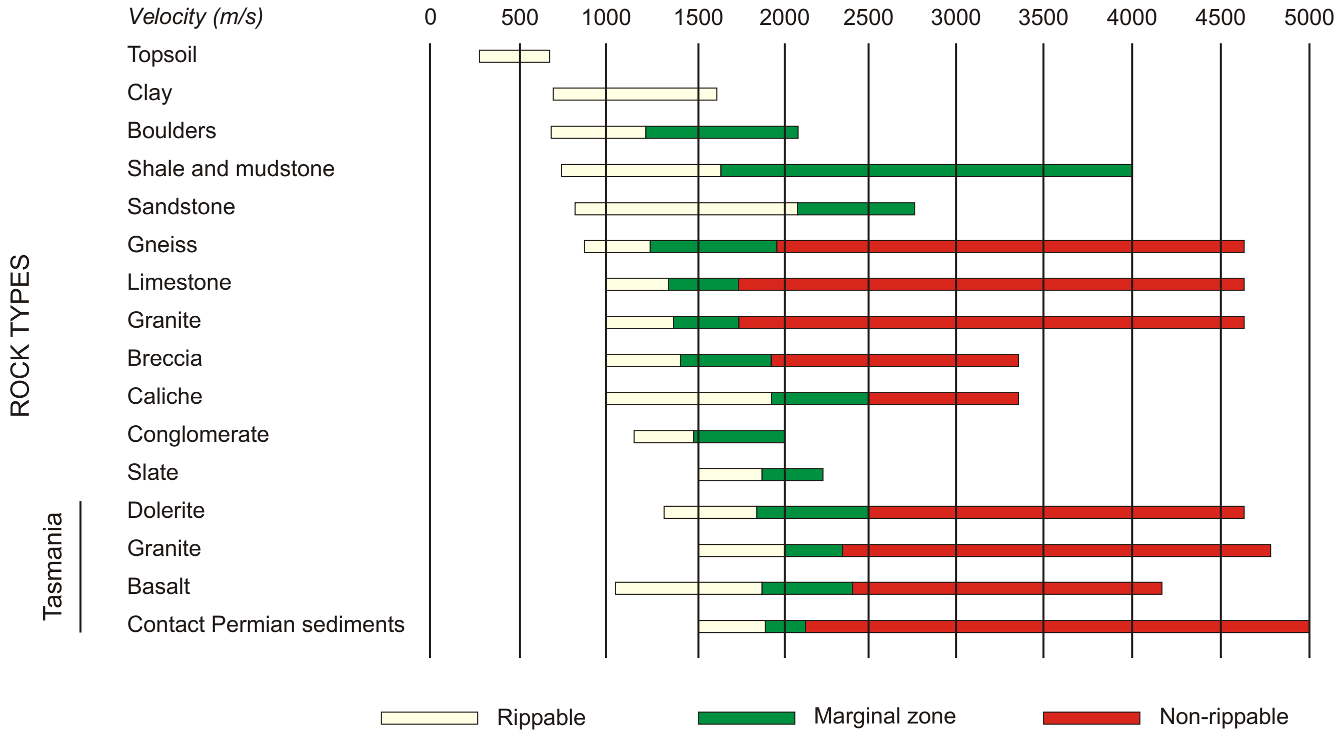

Figure 2

Guide to rippability (adapted from Soil Test Inc.).

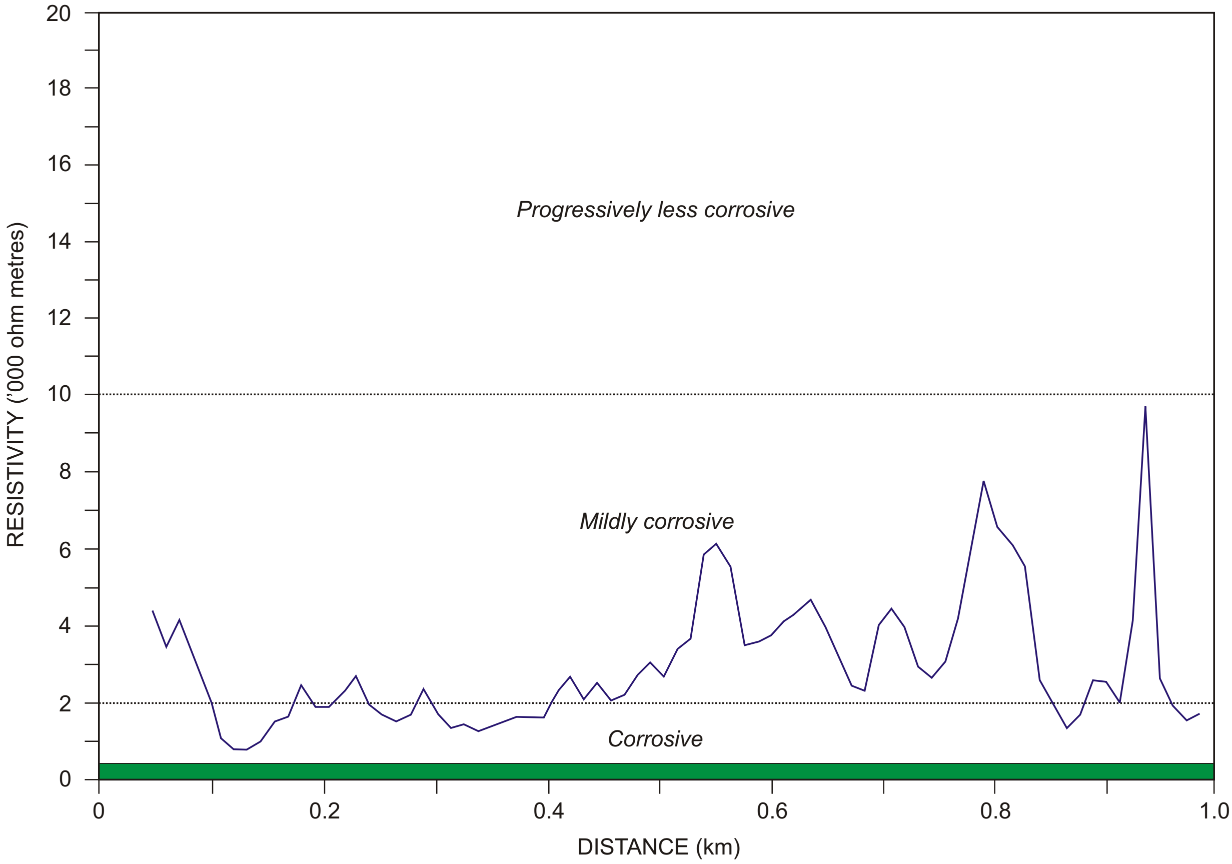

Figure 3

Resistivity survey, 0 to 1 km

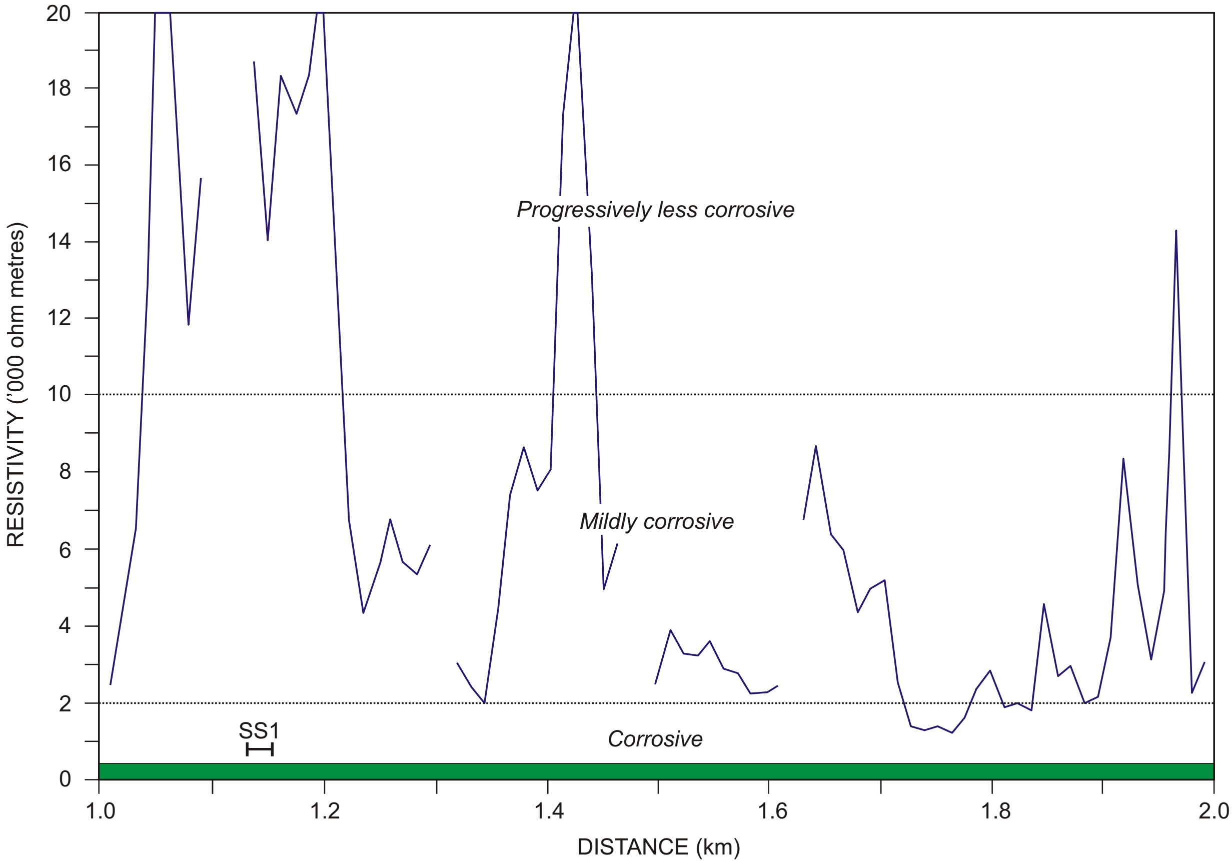

Figure 4

Resistivity survey, 1 to 2 km

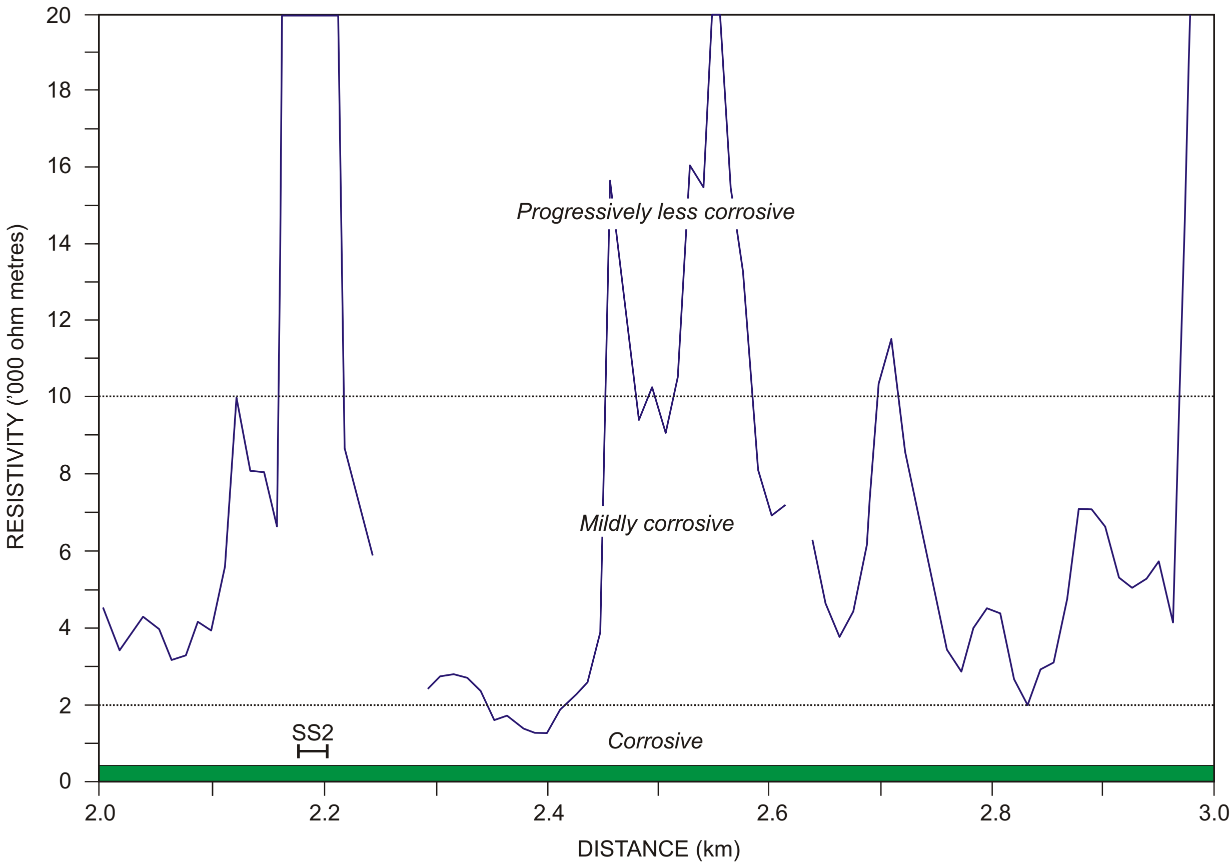

Figure 5

Resistivity survey, 2 to 3 km

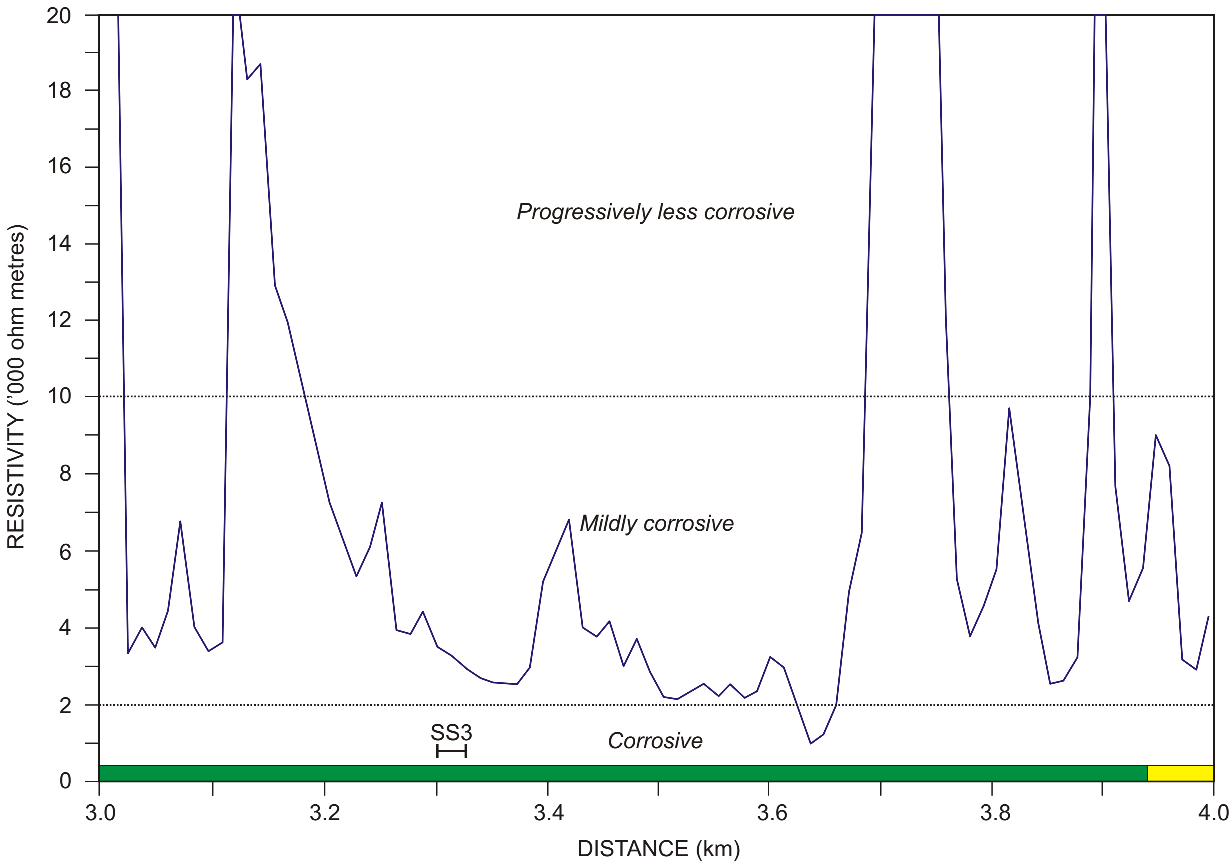

Figure 6

Resistivity survey, 3 to 4 km

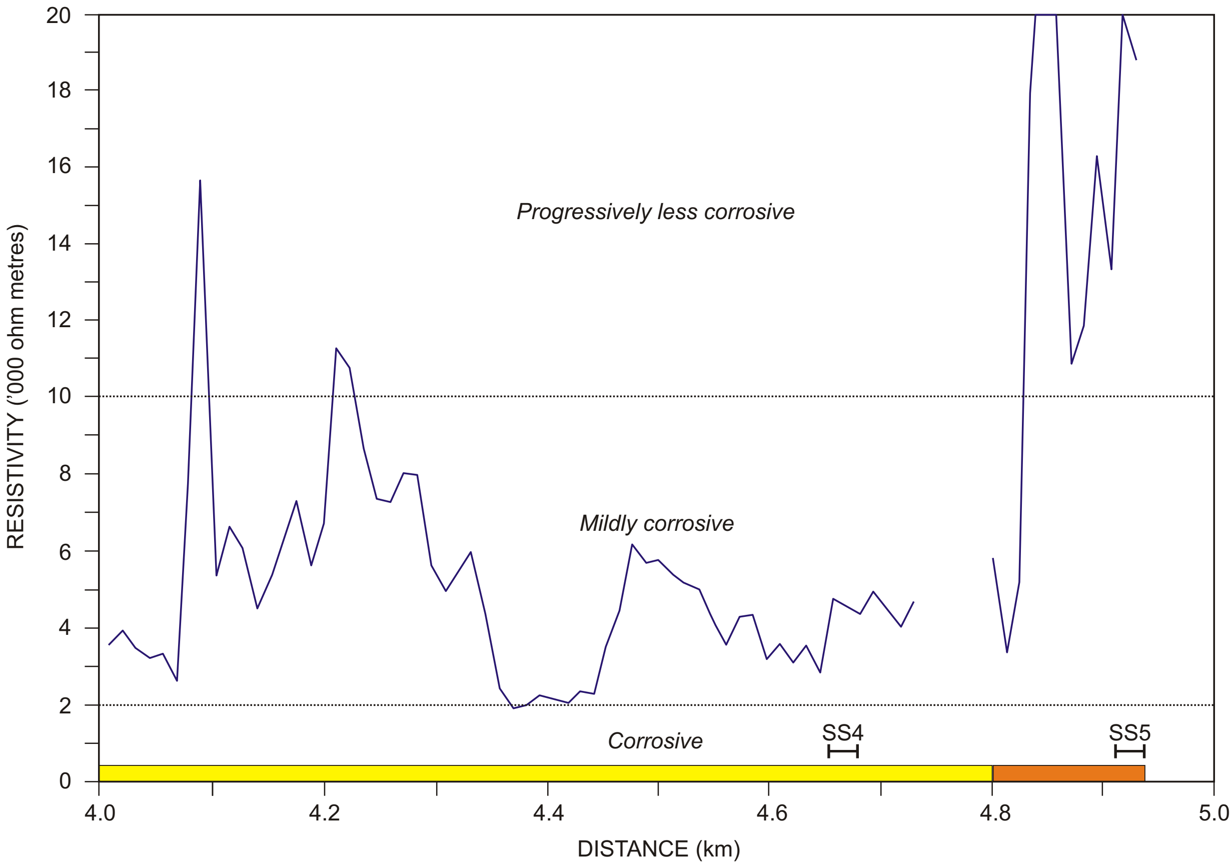

Figure 7

Resistivity survey, 4 to 5 km