Tasmania Department of Resources and Energy

Division of Mines and Mineral Resources — Report 1990/34

Geological investigation of the Tea Tree–Campania water supply pipeline route

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Introduction

A geological investigation of the route of the proposed replacement of the ageing water supply pipeline between Tea Tree and Campania was undertaken at the request of the Hobart Regional Water Board. This report is one of a series of similar investigations carried out by the Division of Mines and Mineral Resources over the past few years.

Part of the proposed route was the subject of a previous investigation for the Board in May 1987 (Donaldson, 1987); the relevant information has been incorporated into the current report.

The investigation of this seven kilometre section sought to provide the following baseline information:

(1) the nature and range of subsurface materials likely to be encountered en route to a depth of 2.0 to 3.0 m (average excavation depth);

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

(3) soil corrosivity along the entire route.

The investigation, carried out over a four-day period, involved geological route mapping and continuous resistivity traversing, with subsequent seismic refraction work at selected locations along the route.

Survey details

Seismic refraction

A total of nine spreads were fired at locations selected on the results of the geological mapping and resistivity survey. These were designed to determine a typical range of excavation conditions likely to be expected from the major rock types. Traverses were carried out both 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 with 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.

Resistivity

Continuous resistivity traversing was carried out along the entire route in order that a guide to the soil corrosivity could be determined. Sections of the existing pipeline have had to be prematurely replaced due to the corrosive nature of some of the soils. The traversing was done using the constant electrode spacing Wenner configuration, with electrode spacings of 4.0 metres.

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 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.

Bedrock geology

Rock outcrop along the proposed route was sporadic and mapping was based largely on surface soil information. Fortunately most of the soils are considered to be residual and therefore reflect the underlying parent bedrock.

The distribution of the major rock types encountered is shown in Figure 1.

The Triassic sedimentary rocks are essentially a gently dipping quartz sandstone sequence with minor mudstone and will be the dominant rock type encountered (60% of the route), with Jurassic dolerite (35%) and Tertiary basalt (5%) making up the balance.

Outcrops observed along the proposed route, including profiles observed in nearby roadside cuttings, showed the sandstone to be generally highly or slightly-weathered and of low to medium strength. The rock varies from being either well bedded and jointed to massive.

The dolerite is essentially fine grained and displays highly variable weathering characteristics. This is particularly evident over the initial part of the route (Tea Tree end) where zones of fresh to slightly weathered hard, tightly-jointed blue-grey dolerite are observed interspersed with zones of highly weathered, sheared low-strength material.

Further comments relating to the general characteristics and physical properties of these materials are given below.

Excavation conditions

The mapping, together with the geophysical survey results, indicate that the vast majority of the materials that will be encountered in the trenching phase of the project (about 2–3 m average depth) are likely to be the soils and weathered materials of the parent bedrock. There will be isolated sections of slightly weathered to fresh hard bedrock encountered.

It is the weathering, strength and joint (defect) characteristics of the rock mass that will ultimately determine the ease of excavation of those areas of bedrock encountered along route.

The Triassic sandstone/mudstone sequence characteristically exhibits a gradational weathering profile that produces sandy clay soils (SC–CH) grading down into a highly weathered low to medium strength rock. These weathering profiles are commonly of the order of several metres in depth.

The dolerite and basalt have highly variable weathering characteristics which result in rapid changes in the nature and strength of the rock mass over short distances. These rocks tend to produce brown and black high plasticity (CH) clay soil profiles.

The seismic refraction survey results (Table 1) clearly indicate the variability of excavation conditions likely to be encountered along the route. As a general rule, velocities in excess of 2200–2500 m/s (dolerite) and 3000 m/s (sandstone) are considered to represent material requiring blasting and/or a hydraulic impact rock breaker to remove much of this rock. Whilst these velocities were recorded they were, with the probable exception of spreads 1 and 2, well below the general excavation level. Given the highly variable nature of the dolerite in particular, isolated sections requiring blasting would be anticipated.

The resistivity survey results (fig. 2–5) can 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-cm, whilst shallow hard rock conditions are probably present above 10 000 ohm-cm. However it does not follow that the high resistivity areas necessarily indicate hard rock conditions close to the surface. A comparison of spreads 5, 6 and 9 confirm this. It is stressed that these categories are, until further evaluation, only broad approximations although they do give an indication and guide to those areas where either soil or rock conditions are likely to be prevalent.

Based on the information presented above, it is considered that very little use of explosives should be necessary along the seven kilometre route. The anticipated areas of hard rock should be largely restricted to zones within the dolerite. However the general attitude and spacing of the major joint sets observed in some of these hard rock outcrop areas suggest that only isolated sections may require blasting.

Soil corrosiveness

The series of plots (fig. 2–5) indicate the relationship between resistivity and the degree of soil corrosivity. The classes used are based on information obtained from the Board.

The degree of soil corrosivity appears to be largely independent of rock type. For example, the Triassic sandstone section between Old Oakington and Rekuna has three distinct changes. The reason for this is not immediately clear. In broad terms, the high resistivity sections appear to be more closely related to the dry grey silty sand surface soils with the associated sandstone float or sub outcrop. The low resistivity sections tend to have soils with a higher clay (and moisture?) content.

Overall, the materials appear to be basically corrosive (0–2000 ohm-cm) to mildly corrosive (2000–10 000 ohm-cm). No comment is made on the degree of protection required to ensure the longevity of the pipes.

Summary

- The seven kilometre route is underlain by a Triassic sandstone/mudstone sequence (60%), Jurassic dolerite (35%) and Tertiary basalt (5%).
- The most variable and therefore unpredictable conditions will be associated with the dolerite; the depth and degree of weathering, both laterally and in profile, is known to vary rapidly. This makes any reliable estimate of excavation conditions difficult. The results suggest that most hard rock conditions encountered should be sufficiently well jointed and weathered to allow the materials to be loosened using a hydraulic impact rock breaker. It is probable that minor blasting will be required over short sections.
- The Triassic sedimentary rocks are considered to have a sufficiently thick weathering profile such that it is unlikely that explosives will be required except perhaps in isolated locations.
- The resistivity traverse results indicate that the pipe will be placed into a corrosive to mildly corrosive environment.
- It is recommended that contractors take time to view some of the 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

DONALDSON, R. C. 1987. Geological investigation of a proposed water supply pipeline route: Tea Tree–Richmond–Campania. *Unpublished Report Department of Mines Tasmania* 1987/69.

[24 October 1990]

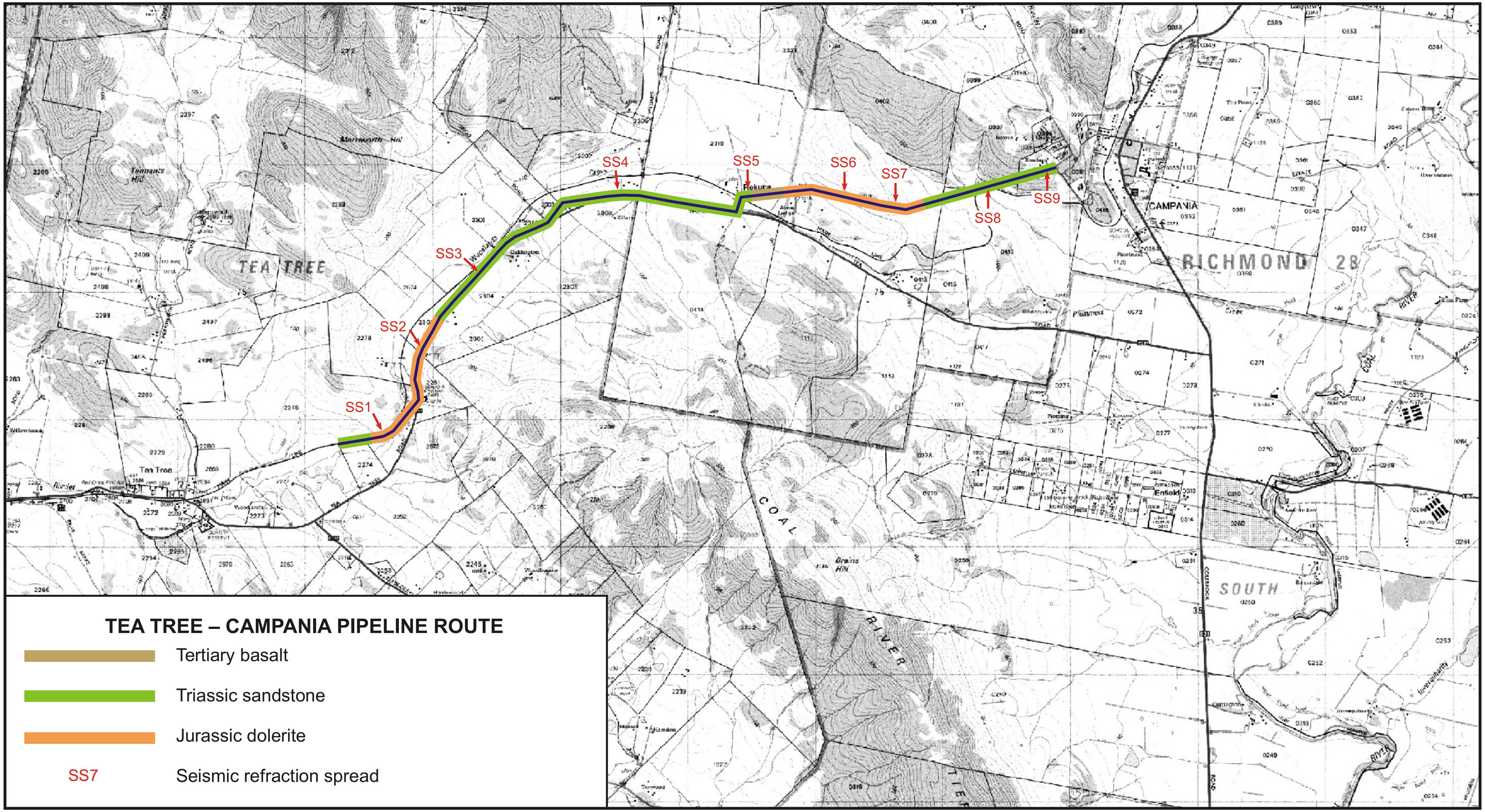

TEA TREE – CAMPANIA PIPELINE ROUTE
Tertiary basalt
Triassic sandstone
Jurassic dolerite
SS7
Seismic refraction spread
SS1
SS2
SS3
SS4
SS5
SS6
SS7
SS8
SS9
TEA TREE
RICHMOND
CAMPANIA
COAL
RIVER
SOUTH

Figure 1

TABLE 1

Seismic refraction survey, Tea Tree to Campania water supply pipeline

Spread + CH (m)	Rock type	Velocity (m/s)	Layer depth (m)	Thickness (m)	Geological interpretation
SS 1	Dolerite	V_1: 360–430	0.8–0.9	0.8–0.9	Unconsolidated surface clay (CH) layer
420–444		V_2: 2000 (N)	3.0	2.1	MW–SW bedrock; joints open-tight
		V_3: 5000	–	–	FR bedrock; massive, tightly jointed
SS2	Dolerite	V_1: 400–450	1.1–1.2	1.1–1.2	Unconsolidated surface clay (CH) layer
1152–1176		V_2: 2110–2500	–	–	SW–FR bedrock; joints generally tight
SS3	Sandstone	V_1: 310–460	1.5–2.0	1.5–2.0	Unconsolidated sandy clay (SC)
1820–1844		V_2: 1180–1330	4.6–5.0	3.0–3.1	Residual clay/EW rock
		V_3: 2000	–	–	HW–SW bedrock
SS4	Sandstone	V_1: 300–430	1.1–3.2	1.1–3.2	Unconsolidated silty sand/sandy clay (SM/SC)
3228–3252		V_2: 800 (E)	2.7	1.6	Residual clay (unsaturated)
		V_3: 1330–1850	–	–	EW–MW bedrock; joints open
SS5	Sandstone	V_1: 300	0.5	0.5	Unconsolidated sandy clay (SC)
4296–4320		V_2: 470–530	1.3–2.0	0.8–1.5	Similar to above
		V_3: 850–1000	3.8	2.5	Residual clay (unsaturated)
		V_4: 1200 (SW)	–	–	Residual clay/EW bedrock
SS6	Dolerite	V_1: 360–430	1.6–3.2	1.6–3.2	Unconsolidated surface clay (CH) layer
5136–5160		V_2: 1700–2000	8.3	5.1	Mean 1850 m/s. HW–SW bedrock; joints open-tight
		V_3: 5000 (SE)	–	–	FR bedrock; massive–tightly jointed
SS7	Dolerite	V_1: 290–310	0.7–0.8	0.7–0.8	Unconsolidated surface clay (CH) layer
5436–5460		V_2: 1000–1150	2.2–2.3	1.5	Residual clay and boulders and/or EW rock
		V_3: 2200–2650	–	–	SW–FR bedrock; joints generally tight
SS8	Sandstone	V_1: 350–410	2.9–3.3	2.9–3.3	Unconsolidated silty sand/sandy clay (SM/SC)
6408–6432		V_2: 1550–2650	–	–	Mean 1950 m/s. HW–SW bedrock; joints open–tight
SS9	Sandstone	V_1: 260–400	0.7–1.2	0.7–1.2	Unconsolidated silty sand/sandy clay (SM/SC)
6900–6924		V_2: 1300–1450	2.3–3.1	1.6–2.1	Residual clay/EW bedrock
		V_3: 1780–1840	–	–	HW–MW bedrock; joints generally open

N: velocity recorded from one end only (direction indicated)
FR = fresh, SW = slightly weathered, MW = moderately weathered, HW = highly weathered, EW = extremely weathered
(mean): probable dipping refraction layer, mean velocity indicated.

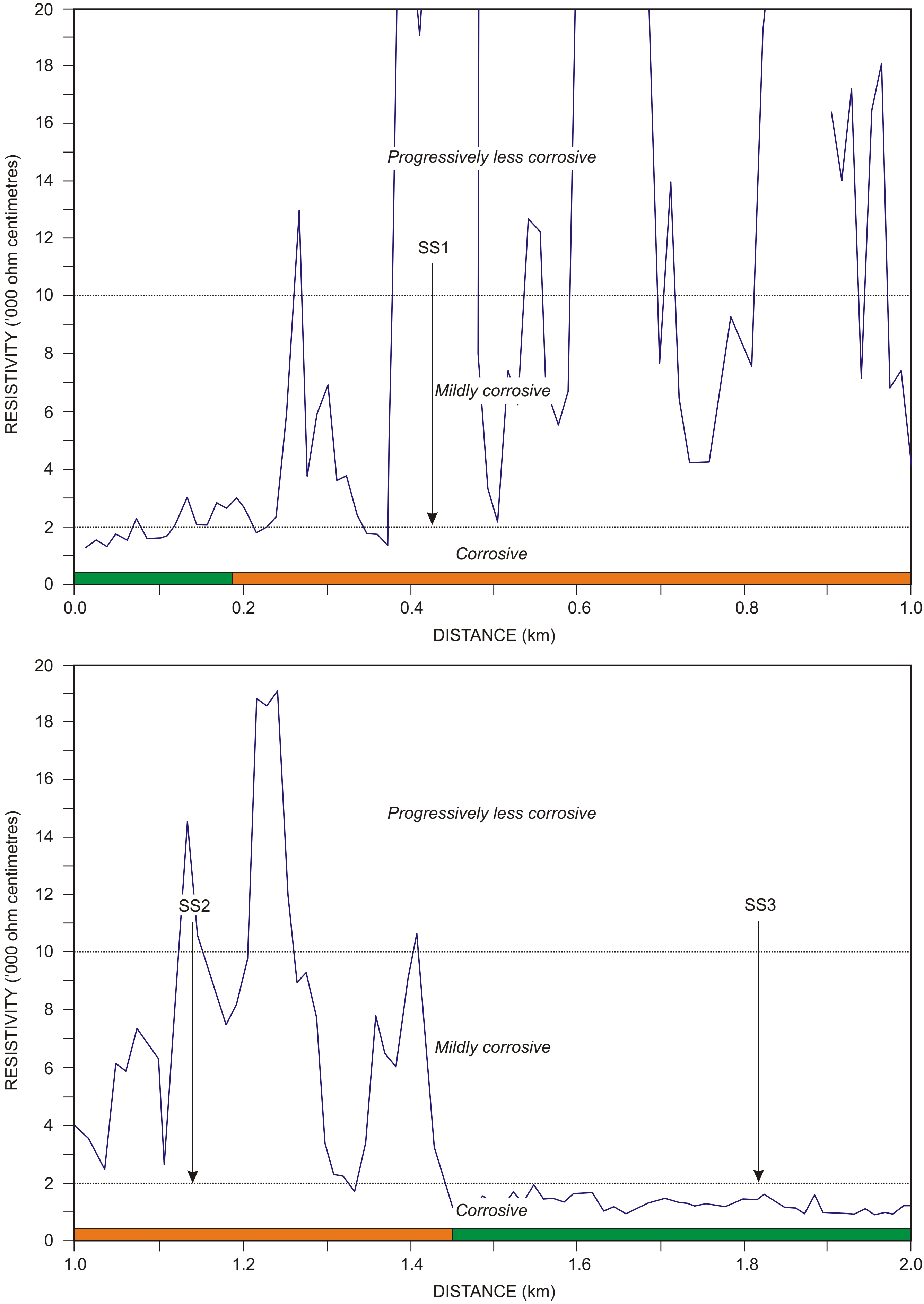
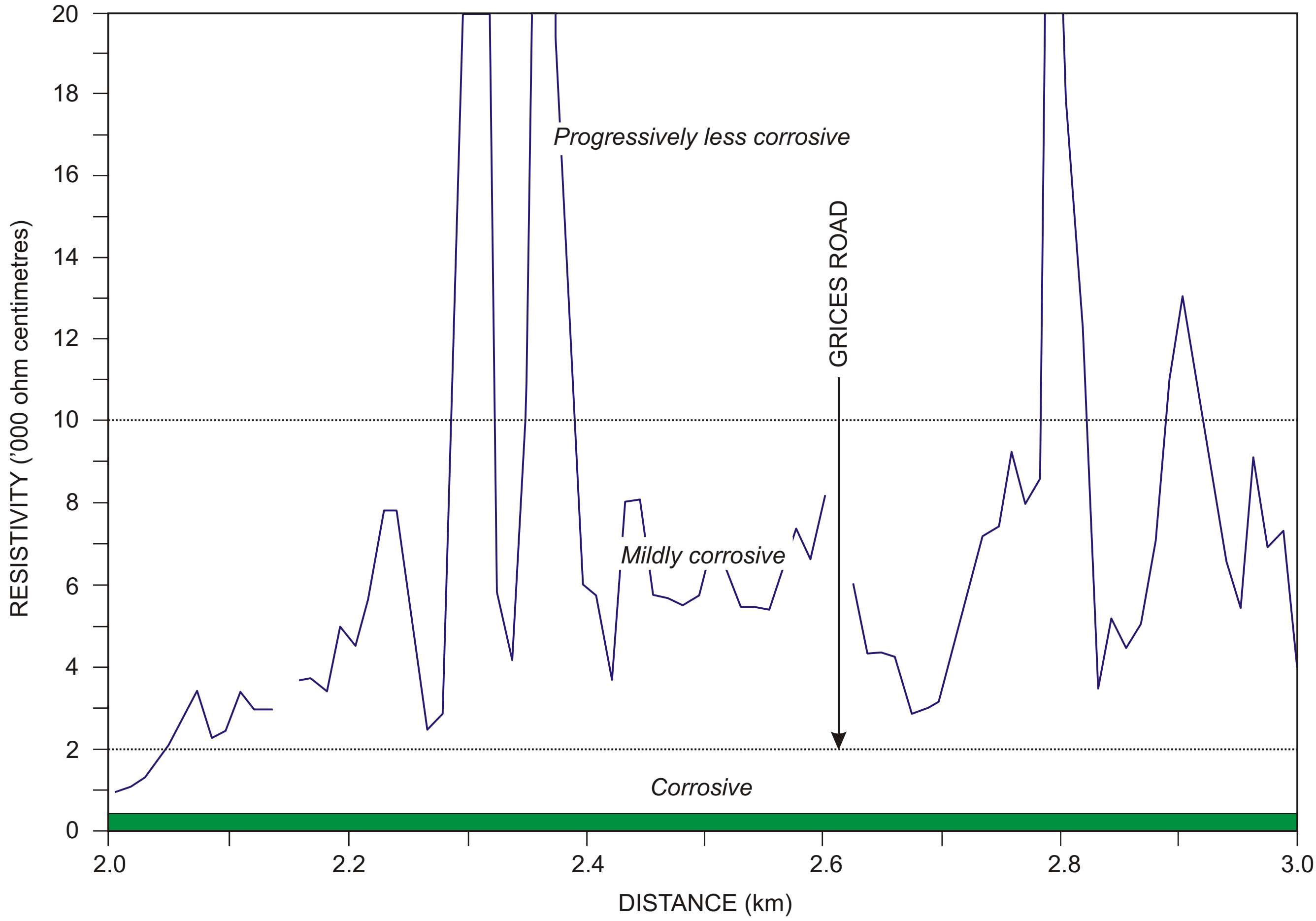


Figure 2. *Resistivity survey, Tea Tree–Campania pipeline*



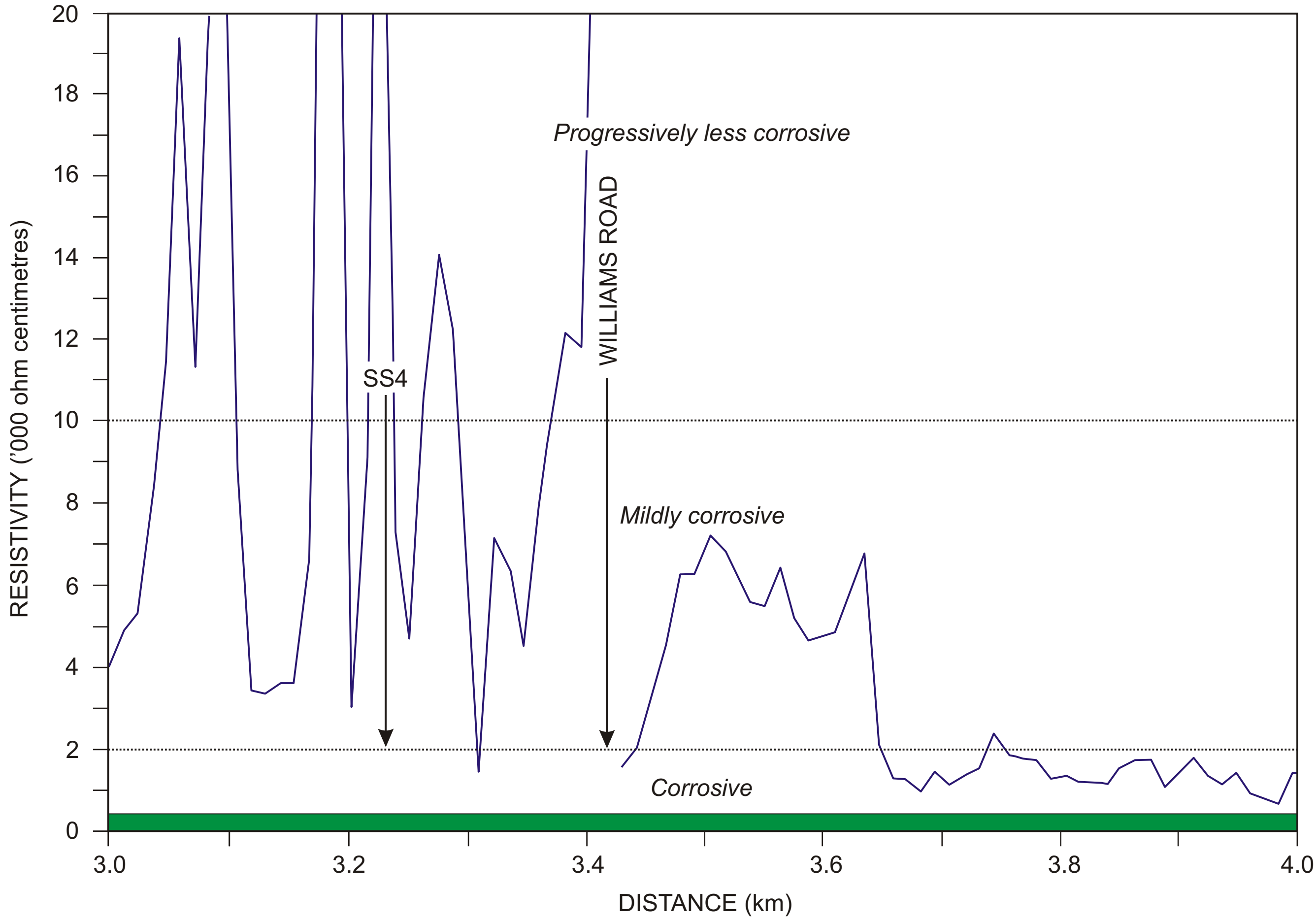
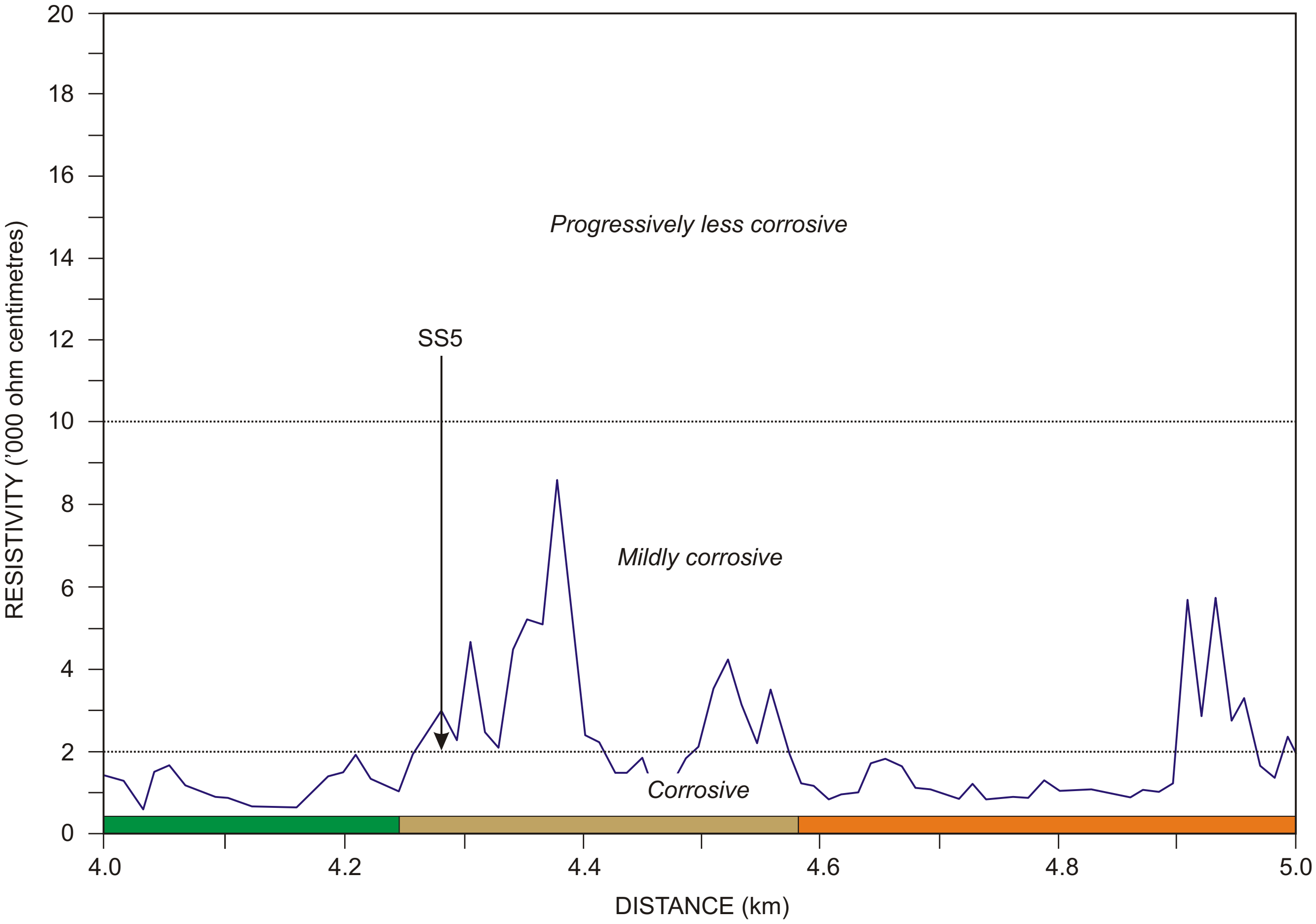


Figure 3. *Resistivity survey, Tea Tree–Campania pipeline*



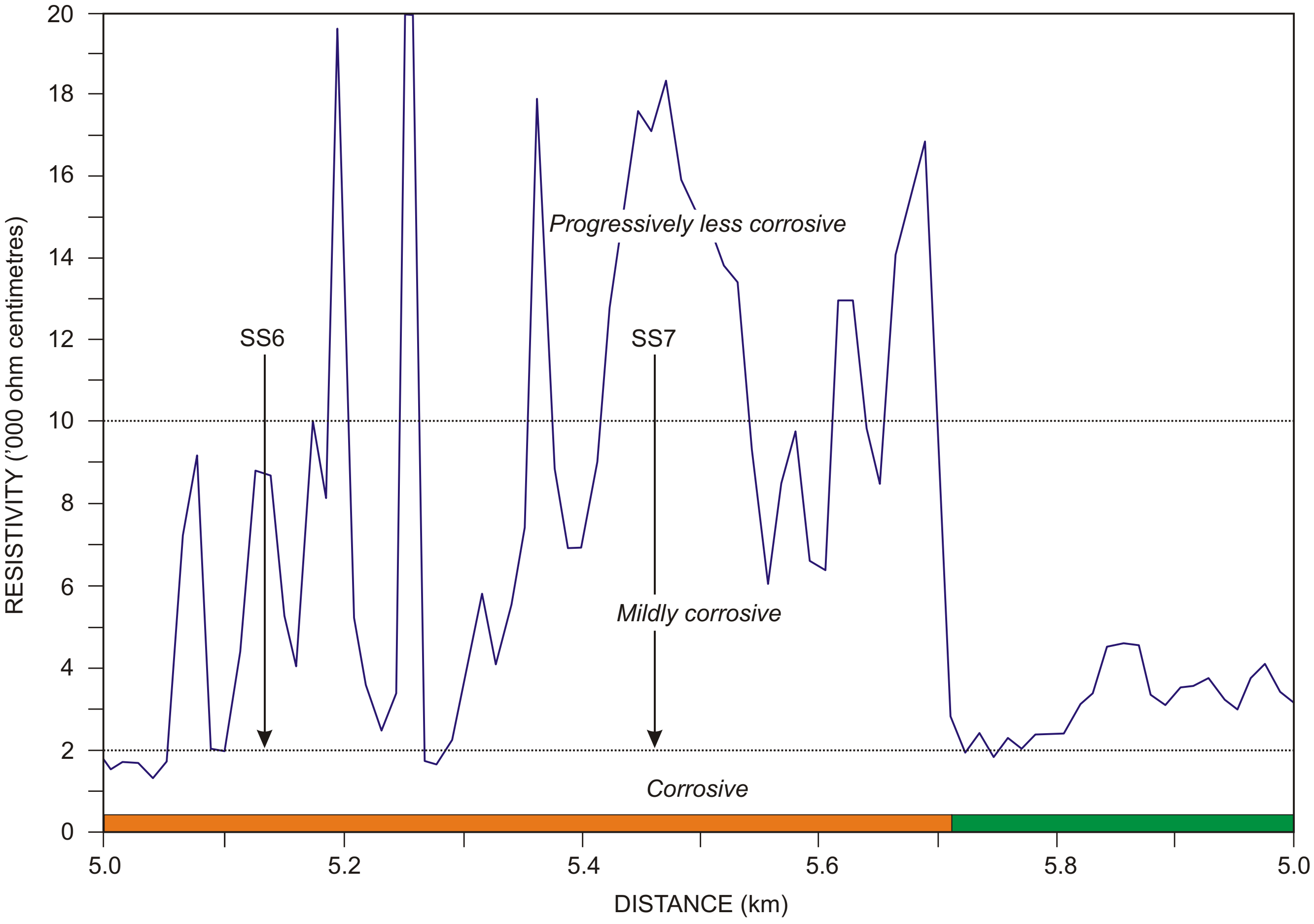


Figure 4. *Resistivity survey, Tea Tree–Campania pipeline*

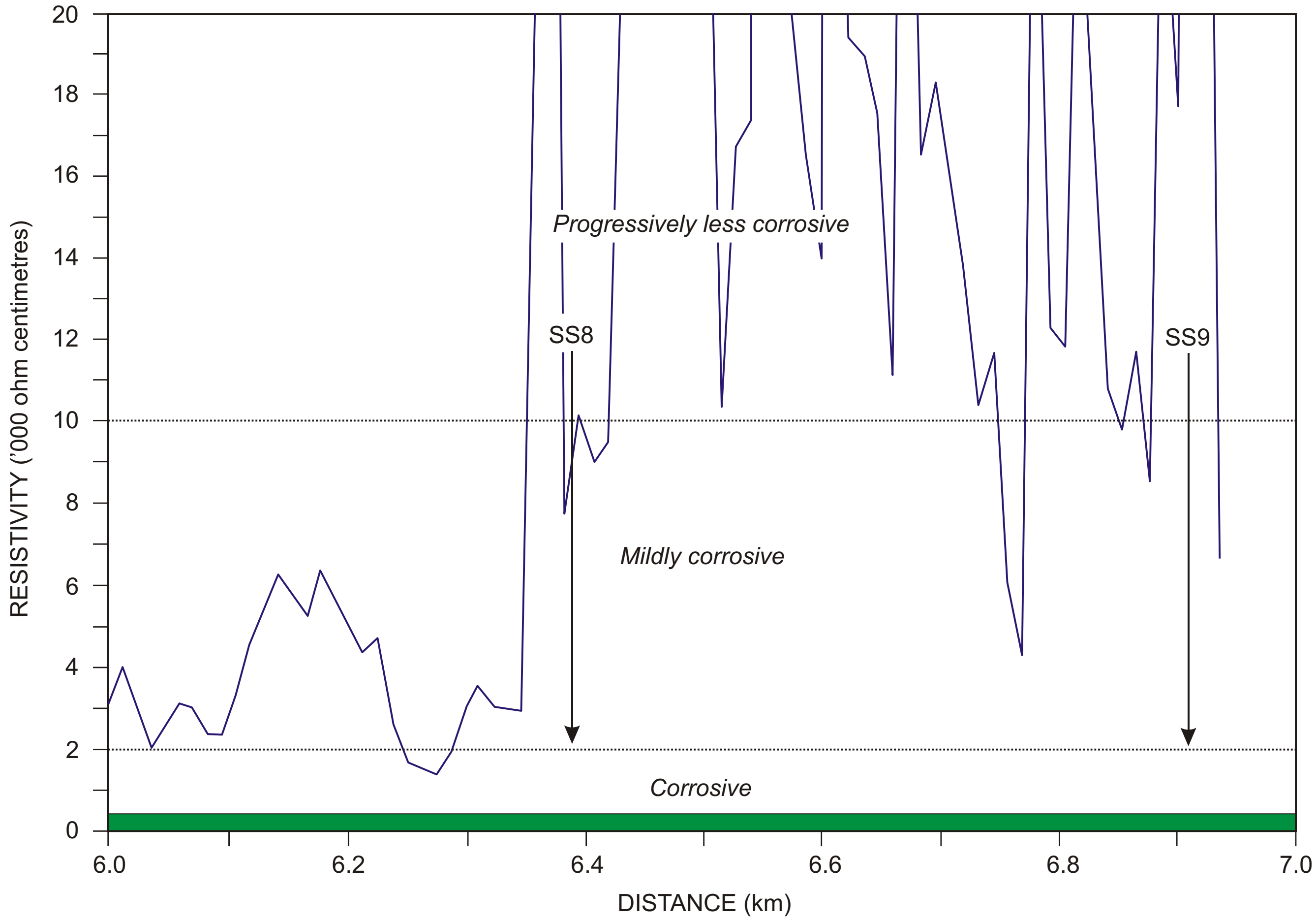


Figure 5. *Resistivity survey, Tea Tree–Campania pipeline*