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Geological investigation of the Mangalore to Lower Dysart water supply pipeline

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INTRODUCTION

The geological investigation of the proposed Mangalore to Lower Dysart water supply pipeline is the most recent of a series of similar investigations carried out by the Department at the request of the Hobart Regional Water Board.

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

(1) The nature and range of subsurface materials likely to be encountered on the route to a depth of 2 to 3 m (average excavation depth).

(2) The rippability or ease of excavation of the materials.

(3) The soil corrosivity along the entire route.

(4) Foundation conditions for a proposed second reservoir at Dysart.

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

SURVEY DETAILS

Seismic refraction

A total of 13 spreads were fired at locations selected on the results of the geological mapping and resistivity survey. These spreads 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 with spread lengths of 24.0 m and 2.0 m geophone spacings was used. 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. The traversing was done using the constant electrode spacing Wenner configuration with 4.0 m electrode spacings.

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 routes. 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 only as a guide to the conditions likely to be encountered and judgements made accordingly following a field inspection, preferably backed up with trial test pits.

ROUTE GEOLOGY

The distribution of the major geological rock types is shown in Figure 1. The proposed route is underlain mainly by a Triassic sandstone-mudstone sequence and Jurassic dolerite, with these rocks being covered in places by Quaternary-aged alluvial and slope deposit materials.

Outcrop along the proposed route was sporadic and mapping was based mainly on surface soil information and exposures observed in nearby roadside cuttings and disused borrow pits.

The geology of the route map differs in places from the published 1:50 000 scale Brighton geological map sheet (Leaman, 1975), especially in the area to the south of Blackport Road where the bedrock geology is obscured by slope deposit materials. The difference in interpretation is of no real significance with respect to the pipeline proposal.

The alluvial deposits, where indicated on the route map, have obscured the underlying bedrock. It is considered that dolerite underlies the alluvium in the vicinity of Halls Lane and Gangles Road, whilst the remaining alluvial flat areas are underlain by the Triassic sandstone sequence.

EXCAVATION CONDITIONS

The mapping and seismic refraction survey results (Table 1) suggest that the excavation phase of the project will, over the vast majority of the route, involve the removal of weathered materials overlying bedrock. These materials will consist mainly of unconsolidated sand, clay and highly weathered rock, although some sections of slightly weathered to fresh jointed bedrock will be encountered.

The two major rock types, dolerite and sandstone, have different origins and physical characteristics; it follows that the degree and depth of weathering of these rocks can also be expected to differ.

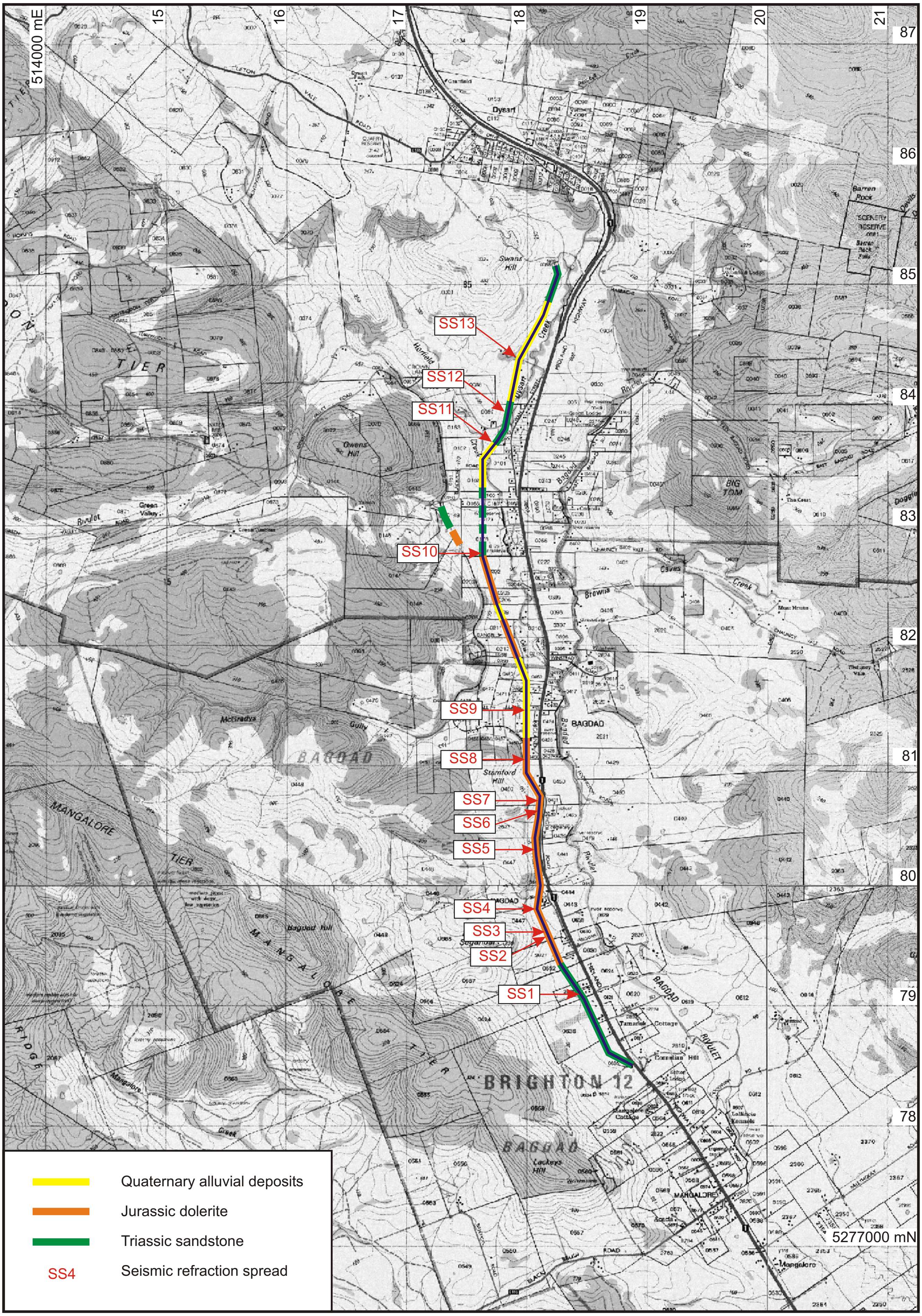

Figure 1

Geology of route and location of seismic spreads

The Triassic sandstone/mudstone sequence characteristically shows a gradational weathering profile that produces sandy clay soils (SC–CH) grading down into a highly weathered low strength rock. These weathering profiles are commonly of the order of several metres in depth (refer SS1 and SS12; Table 1).

Irregular weathering is characteristic of the dolerite, both in depth and lateral extent. This is typically demonstrated by comparing the differences in SS6 and SS7 (Table 1) . These two spreads were fired adjacent to each other, having a common central shot point. Dolerite tends to produce brown and black high plasticity clay soils (CH) overlying bedrock which varies from being highly to slightly weathered.

Velocities in excess of about 2500 m/s (dolerite) and 3000 m/s (sandstone) are considered to represent material that may require blasting. Whilst these velocities were seen (refer Table 1) they were, with the possible exception of spreads 2 and 7, well below the general excavation limit.

There are numerous roadside cuttings and borrow pit excavations 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 (fresh, high strength rock) should be sufficiently closely fractured and open jointed at the 2 to 3 m excavation depth to be worked with a large traxcavator employing a hydraulic impact rock breaker to loosen the material.

The resistivity traverse results (fig. 2–5) tend to show a broad correlation between high resistivity values and either rock outcrop or areas of float. These results may be used, with caution, to indicate areas of possible bedrock close to the surface. However one should not draw the conclusion that areas of low resistivity necessarily preclude hard rock conditions.

From all the information obtained, 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 restricted to zones within the dolerite. 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) resulting from the resistivity survey are essentially self explanatory and need little comment.

Based on a set of figures supplied by the Board relating soil corrosivity to resistivity, the plots suggest that the Triassic sandstone derived soils and alluvial deposits lie on the corrosive to moderately corrosive (500–2000 ohm-cm) range whereas the doleritic material is basically only 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

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

The most variable and therefore unpredictable conditions will be associated with the dolerite; the depth and degree of weathering both laterally and in profile can vary rapidly. This makes for uncertainty in estimating excavation conditions in rocky terrain. The investigation has indicated that most of the hard rock encountered should be sufficiently well jointed and weathered to allow the material to be loosened with the aid of an hydraulic impact rock breaker. Minor blasting may still be required over isolated short sections.

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

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 corrosive to mildly corrosive soils.

Contractors should view the results of the investigation as a guide only to the anticipated excavation conditions. It is recommended that contractors take the time to view some of the exposures along the route and follow up with a series of trial test pits to confirm and, if necessary, modify the above findings and predictions.

REFERENCE

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

[18 May 1989]

TABLE 1

Seismic refraction survey

Spread No.	Rock type	Velocity (m/s)	Layer depth (m)	Thickness (m)	Geological interpretation
1	Sandstone (Triassic)	V_1:500–530	2.9–3.6	2.9–3.6	Unconsolidated sandy clay (SC–CH)
		V_2: 880 (S)	4.4	1.5	Residual clay (unsaturated) overlying bedrock
		V_3:1650	–	–	EW–HW bedrock — open joints, some clay filled
2	Dolerite (Jurassic)	V_1: 350–550	0.8–1.3	0.8–1.3	Unconsolidated surface clay (CH)
		V_2: 1850–2250	5.1(+)	4.3(+)	MW–SW bedrock; joints open to tight, closely spaced
		V_3: 3000 (N)	–	–	FR rock, joints tight
3	Dolerite (Jurassic)	V_1: 450	0.7–0.9	0.7–0.9	Unconsolidated surface clay (CH)
		V_2: 1330	2.4–2.5	1.5–1.8	Residual clay grading into EW rock
		V_3:1850–2100 (steps to 4000)	–	–	MW–SW rock; joints both open and tight, closely spaced
4	Dolerite (Jurassic)	V_1: 300–310	0.7–0.8	0.7–0.8	Unconsolidated surface clay (CH)
		V_2:1350–1700	5.6–6.9	4.9–6.1	HW–MW rock; closely jointed
		V_3: 2400–3000	–	–	SW–FR rock; joints tight
5	Dolerite (Jurassic)	V_1: 330–500	1.4–1.6	1.4–1.6	Unconsolidated surface clay (CH)
		V_2: 1650–1800	8.5†	7.0†	HW–MW rock, joints generally open
6	Dolerite (Jurassic)	V_1: 350–360	0.8–1.6	0.8–1.6	Unconsolidated surface clay (CH)
		V_2: 1150–1350	9.9†	8.3†	Residual clay grading into EW–HW rock
7	Dolerite (Jurassic)	V_1: 315–380	1.3–1.5	1.3–1.5	Unconsolidated surface clay (CH)
		V_2: 2150–2400	11.0 (+)	9.6 (+)	Steps to 3000 m/s. SW rock, joints generally tight
		V_3: 3500 (N)	–	–	FR rock, tightly jointed to massive
8	Dolerite (Jurassic)	V_1: 320–340	1.6–2.3	1.6–2.3	Unconsolidated surface clay (CH)
		V_2: 1300–1600	7.8 (+)	6.2 (+)	Residual clay grading into HW rock, open joints
		V_3: 2650 (S)	–	–	SW rock, joints generally tight
9	Alluvial deposits (Quaternary)	V_1: 330	2.2–2.4	2.2–2.4	Unconsolidated surface clay (CH)
		V_2: 800–900	5.1–6.2	2.9–3.8	Poorly consolidated sand, clay & gravel deposits
		V_3: 1450 (W)	–	–	EW–HW bedrock; probably dolerite
		V_4: 2150 (E)	–	–	SW bedrock; probably dolerite
10	Slope deposits over sandstone?	V_1: 380–410	1.2–1.7	1.2–1.7	Unconsolidated clayey sand and silt (SC–SM)
		V_2: 700–850	10.2†	9.0†	Poorly consolidated materials similar to above
11	Sandstone (Triassic)	V_1: 450–500	0.7–0.8	0.7–0.8	Unconsolidated clayey sand (SC)
		V_2: 2000	6.5–7.6	5.8–6.8	HW–SW rock; joints open to tight
		V_3: 4000 (+)	–	–	FR rock; massive to tightly jointed
12	Sandstone (Triassic)	V_1: 350–650	0.6–0.7	0.6–0.7	Unconsolidated clayey sand (SC)
		V_2: 1050–1250	6.1–7.2	5.5–6.5	Residual clay grading to EW rock
		V_3: 2650–4000	–	–	SW–FR rock; massive to tightly jointed
13	Alluvial deposits over sandstone	V_1: 310–320	1.2–1.8	1.2–1.8	Unconsolidated sandy clay (CH)
		V_2: 570–640	3.5–4.0	1.7–2.8	Poorly consolidated sand, clay, gravel deposits
		V_3: 1000–1330	5.4–8.7	1.9–4.7	Similar to above — unsaturated
		V_4: 1820–2500	–	–	HW–SW rock, joints open to tight

† minimum layer depth assuming V_3 = 3500 m/s

N: Velocity recorded from one end only (direction indicated)

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

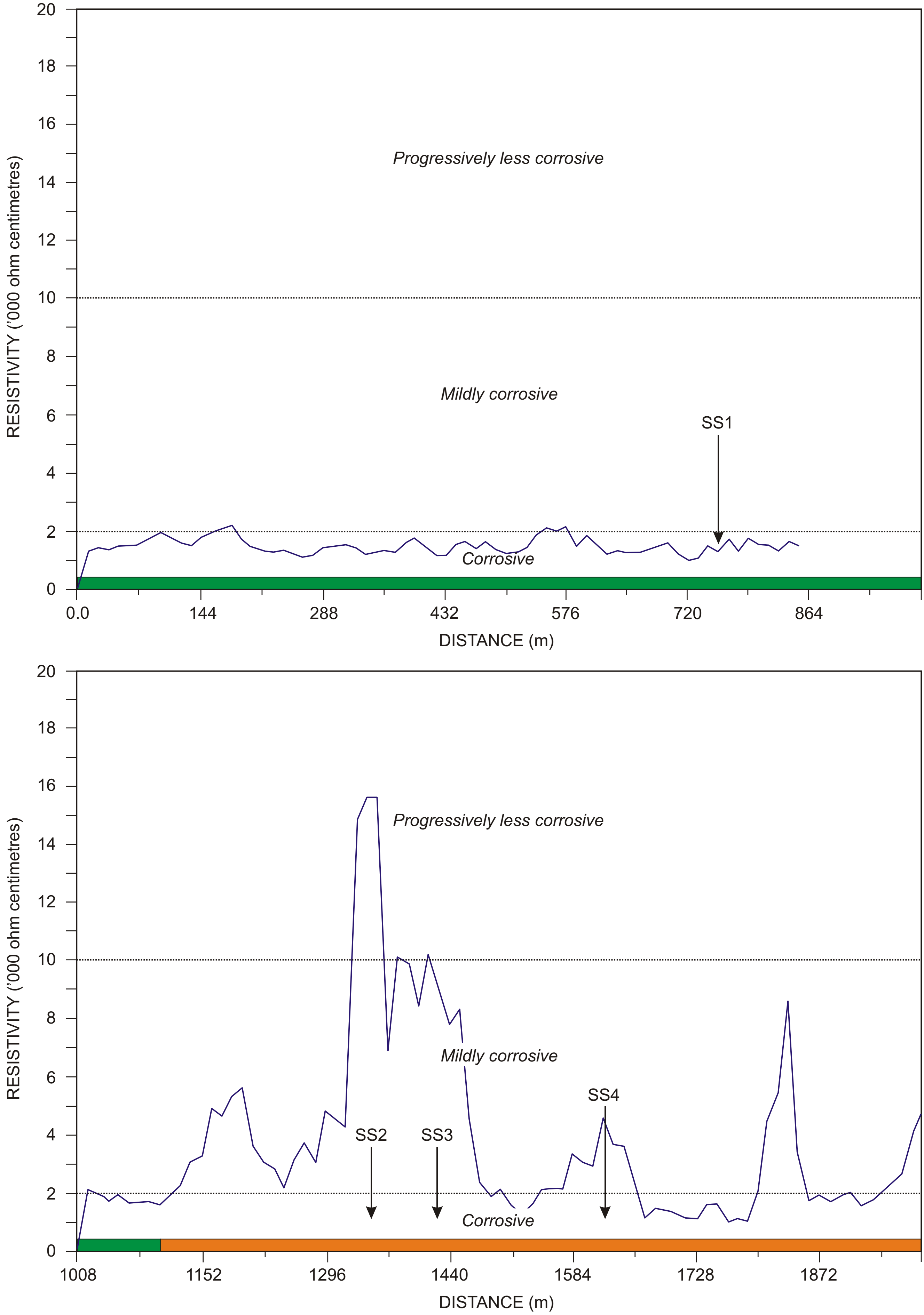

Figure 2. *Resistivity survey, 0 to 2000 metres*

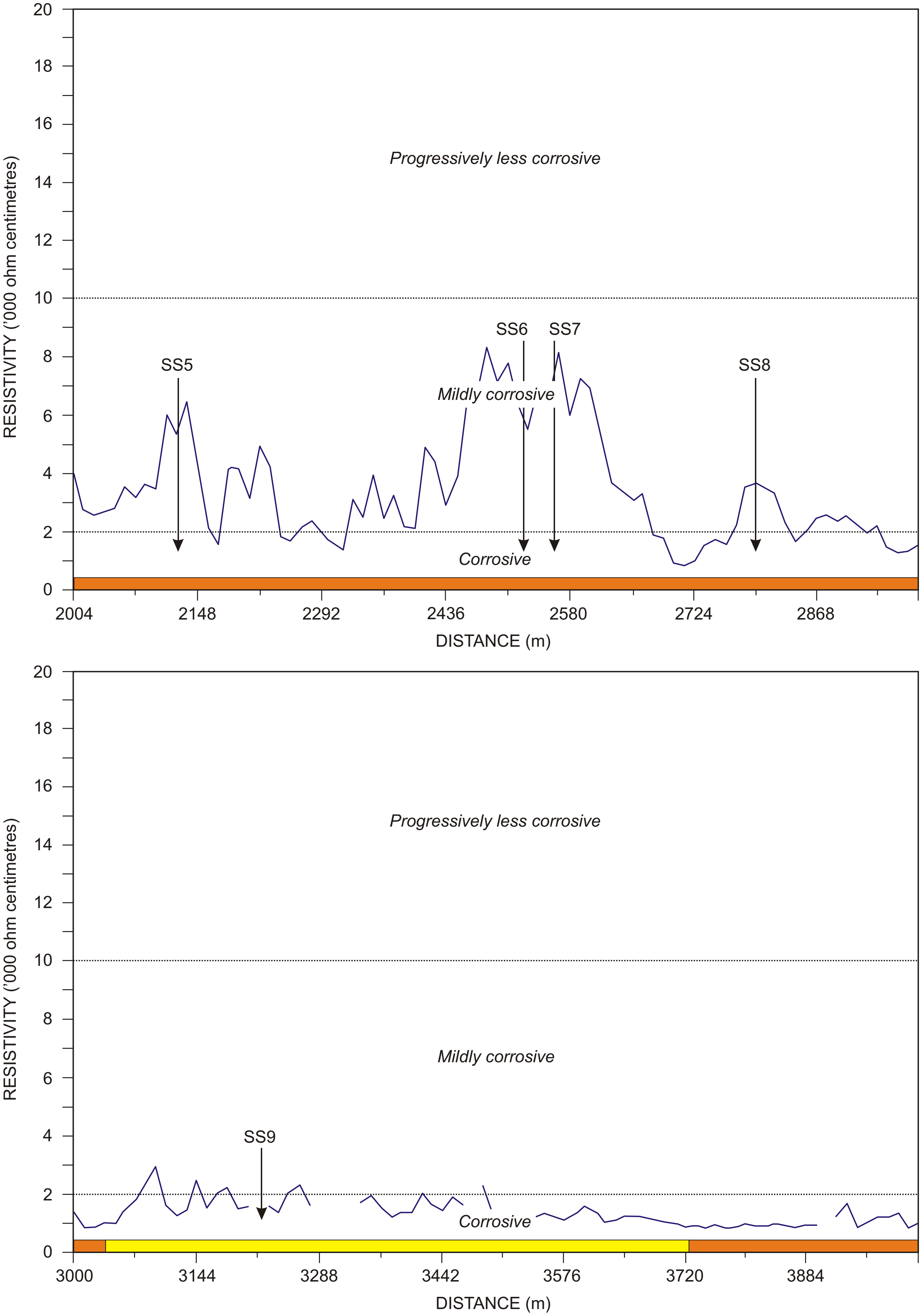

Figure 3. *Resistivity survey, 2000 to 4000 metres*

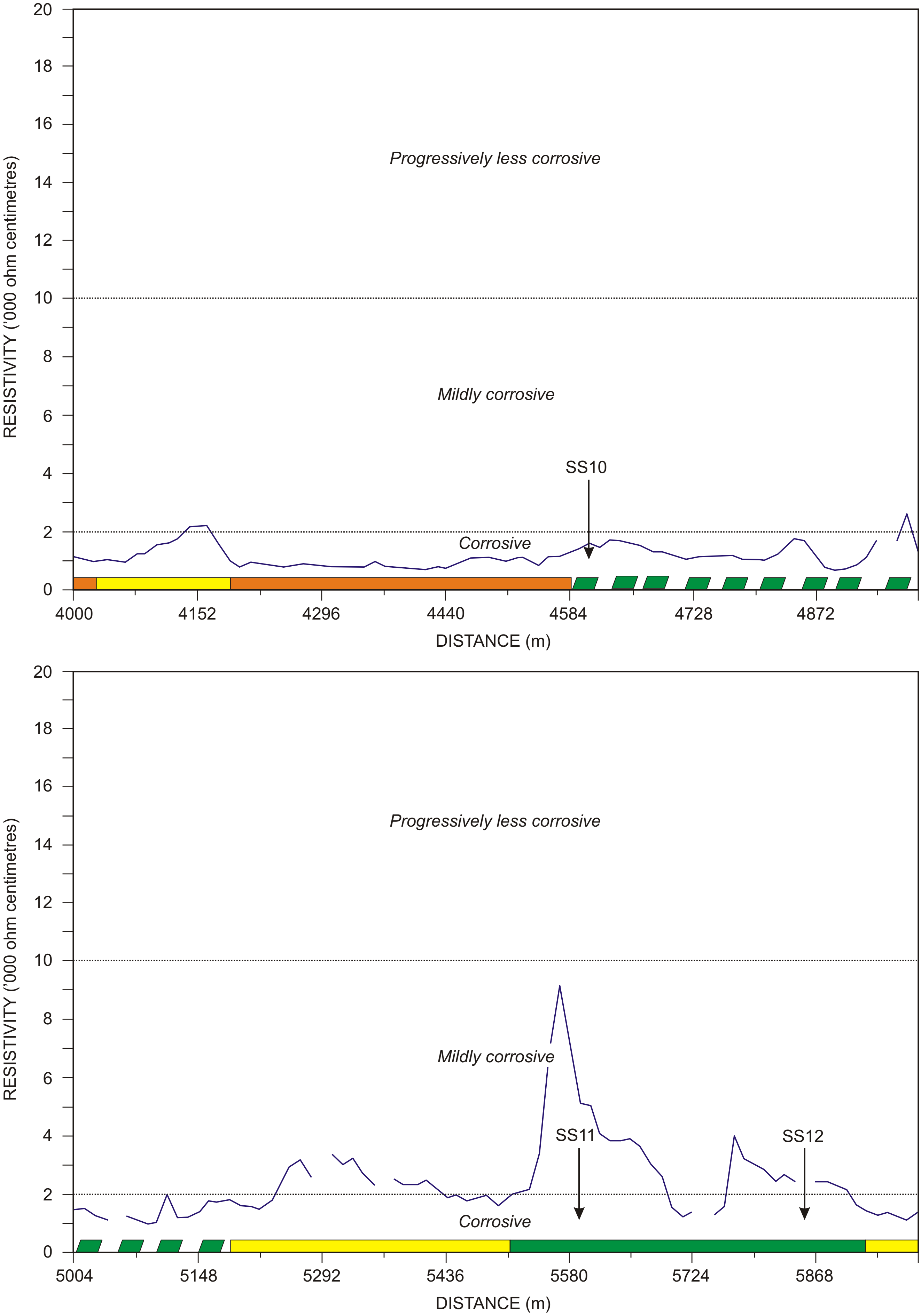

Figure 4. *Resistivity survey, 4000 to 6000 metres*

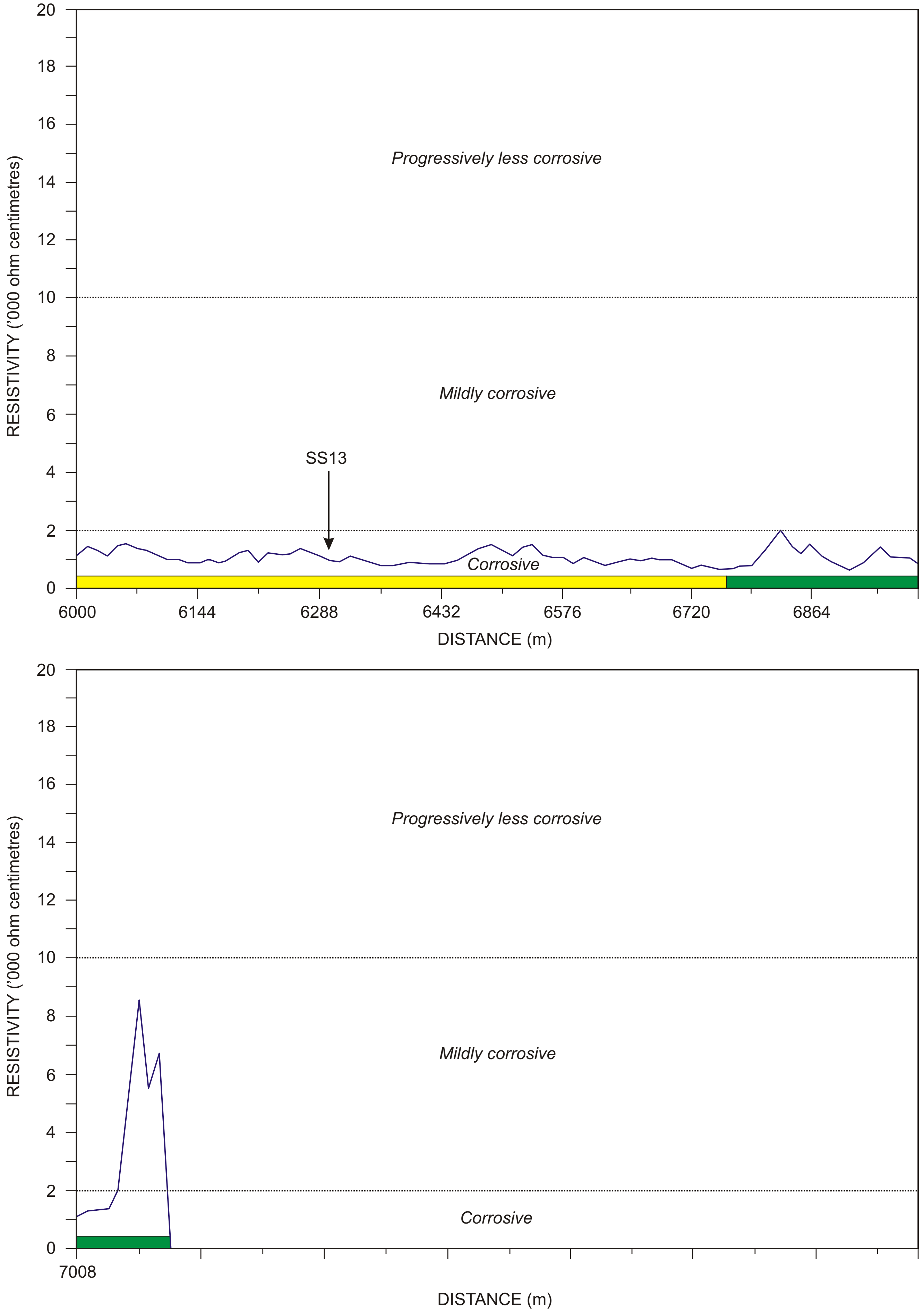

Figure 5. *Resistivity survey, 6000 to 7000 metres*