Tasmania Department of Mines — Report 1989/45

Geological investigation of the Ridgeway Reservoir to Browns Hill water supply pipeline

by R. C. Donaldson

INTRODUCTION

The proposed duplication of the ageing water supply pipeline between the Ridgeway Reservoir, south of Hobart, and Browns Hill near Kingston is to be laid approximately four metres to the west of the existing route. The investigation of this 4.8 km section, including the 0.5 km Olinda Grove pump station branch line, sought to provide basic information on:

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

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

(3) Soil corrosivity along the entire route.

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

SURVEY DETAILS

Seismic refraction

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

Semi-continuous resistivity traversing was carried out along the entire route so that a guide to the soil corrosivity could be determined. 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 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

There is good exposure along much of the proposed route. Bedrock was seen either in outcrop or sub-outcrop in the numerous creeks and steep gullies that transect the pipeline and in the cuttings associated with various sections of the easement. The entire route is underlain by two rock types; dolerite and a siltstone/sandstone sequence.

Jurassic-aged dolerite is the dominant rock type present and underlies approximately 60% of the route (3.3 km) with the Permian-age siltstone/sandstone sequence making up the remaining 40% (2.0 km). The distribution of these rocks is shown in Figure 1.

The route map differs in places from the published 1:50 000 scale Hobart geological map sheet (Leaman, 1972), which does not indicate the presence of Permian sedimentary rocks between 1270 and 1600 m or the sedimentary rocks along the 150 m section of the Olinda Grove branch line from the junction (1122 m) to the Southern Outlet.

The dolerite throughout this area is essentially medium grained and displays highly variable weathering characteristics. This is particularly evident over the initial sections of the route where zones of fresh, hard, massive blue-grey dolerite are interspersed with zones of shattered weathered rock.

The Permian sedimentary rocks are comprised essentially of a coarse siltstone/fine sandstone including some fossiliferous mudstone. These rocks are gently dipping (<10°), well jointed, and subject to uniform and usually shallow weathering. In places they show signs of having been baked by the intruding dolerite body.

EXCAVATION CONDITIONS

The investigation indicates that substantial sections of the proposed 5.3 km pipeline route will encounter rock conditions during the excavation phase of the project. It is

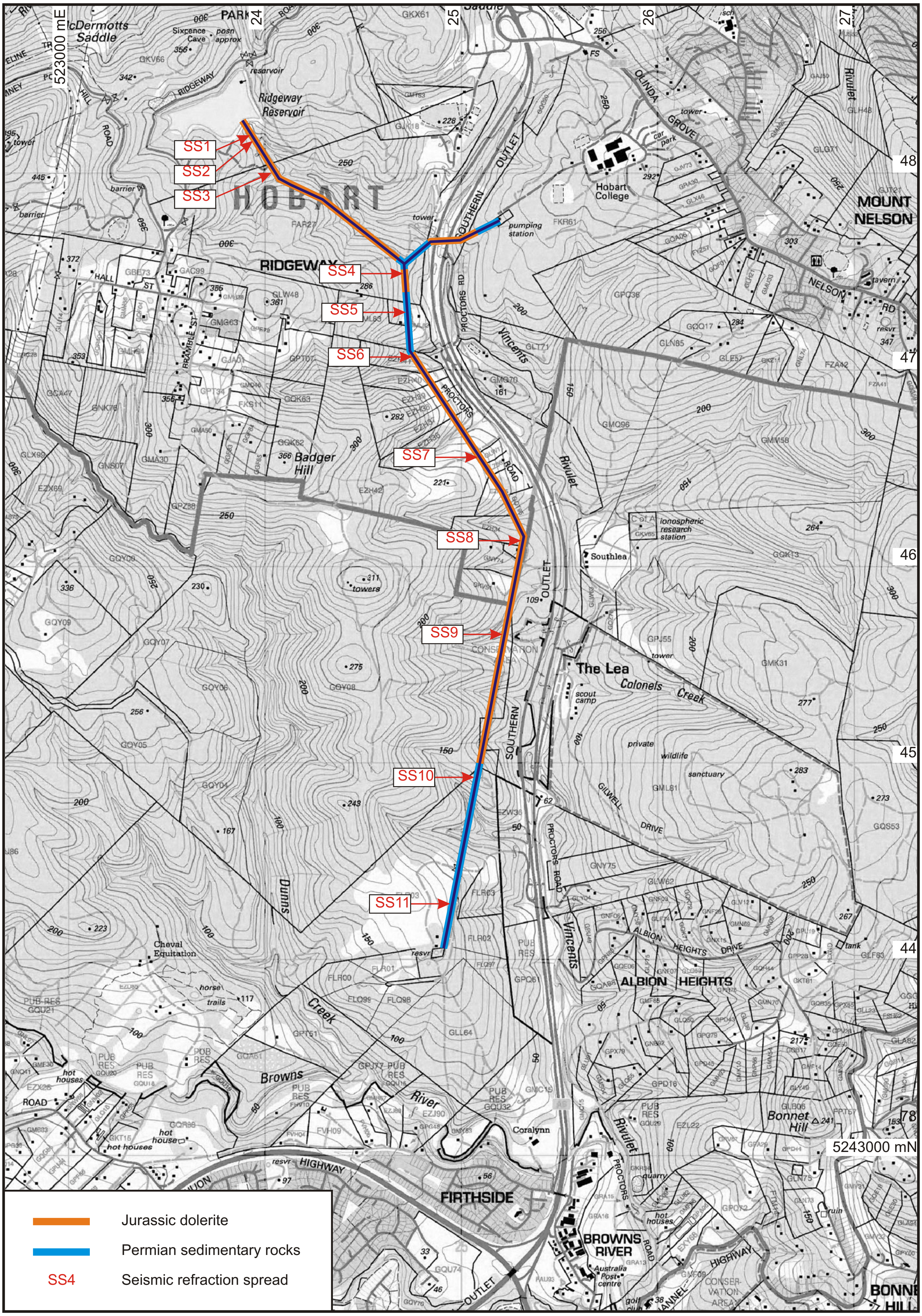


Figure 1

Geology of route and location of seismic spreads anticipated that a combination of blasting and/or hydraulic hammer or similar will be required to remove much of this material.

There are several sections along the route where dominantly soil conditions will be met but these are considered to be less extensive than the rock areas.

The Permian sedimentary rocks have minimal soil development and bedrock was seen in outcrop or sub-outcrop over a large section of the route where these rocks occur. The seismic velocities (Table 1) indicate generally open-jointed rock down to the average excavation depth in the case of spreads 5 and 10. This suggests that the materials could be successfully worked with the aid of a hydraulic impact rock breaker or similar. The relatively high V_2 velocities observed in spread 11 suggest that blasting, in combination with hammer, will probably be needed.

Overall, the Permian rocks tend to be brittle and well jointed and hence easily worked by explosives and/or hammer.

The dolerite, as observed along the route, has highly variable weathering characteristics which results in rapid changes in the nature and strength of the rock mass over short distances. Results of the seismic refraction survey (Table 1) clearly indicate the variability of conditions to be encountered within the dolerite along the route. As a general rule, velocities in excess of 2200–2500 m/s are considered to represent material that requires blasting. The uncharacteristically low velocity values recorded in spreads 1 and 2 relate to slightly weathered to fresh rock in which secondary fractures have developed through previous blasting to form the roadside cut. Despite the low velocities, this area will require blasting.

The resistivity survey results can be interpreted, in a qualitative manner, to indicate areas of substantial soil development as distinct from areas of probable bedrock close to the 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. It is stressed that these categories are, until further evaluation, only broad approximations. Nevertheless, it does give an indication to those areas where either soil or rock conditions are likely to be prevalent.

Based on this information, together with the results of the seismic refraction survey and mapping, it is anticipated a high percentage of the route is likely to encounter rock of some description, either fresh or highly weathered. The major soil areas roughly correspond to the broad spurs underlain by dolerite in the middle section of the route.

SOIL CORROSIVENESS

The series of plots relate soil corrosivity to resistivity. The plots indicate relatively high resistivity values of the order of 10 000 ohm-cm or greater for most of the route, independent of rock type. Values of this order correspond to a relatively low corrosive environment.

Those sections of the route regarded as mildly corrosive (2000–10 000 ohm-cm) correspond with the areas of soil development such as observed on the broad dolerite spurs.

No comment is made on the degree of protection required to ensure the longevity of the pipes.

SUMMARY

The 5.3 km route is underlain by Jurassic dolerite (60%) and a Permian siltstone/sandstone sequence (40%).

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.

The Permian sedimentary rocks were seen to outcrop or sub-outcrop over the majority of the section where they occur. These rocks tend to be brittle and well jointed.

The investigation has indicated that rock conditions will be encountered over a substantial section of the route requiring the extensive use of explosives and/or hammer techniques, depending upon the nature of the weathering and degree of fracturing.

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 excavations to confirm and, if necessary, modify the above findings and predictions.

REFERENCE

LEAMAN, D. E. 1972. *Geological Atlas 1:50 000 scale series. Sheet 82 (8312S). Hobart*. Department of Mines, Tasmania.

[22 June 1989]

TABLE 1

Seismic refraction survey results

Spread No.	Rock type	Velocity (m/s)	Layer depth (m)	Thickness (m)	Geological interpretation
1	Dolerite	V_1: 1000	0.3	0.3	Unconsolidated surface clay (CH) layer
(93–114)		V_2: 1430–1500	2.7–3.1	2.4–2.8	SW rock; joints open (results of previous blasting?)
		V_3: 4000–4500	–	–	FR rock; massive, tightly jointed
2	Dolerite	V_1: 600–700	0.8–1.0	0.8–1.0	Unconsolidated surface clay (CH) layer
(112–133)		V_2: 1500–1700(S)	3.7	2.9	MW–SW rock; joints open, shear zones
		V_3: 4000–4500	–	–	FR rock; massive, tightly jointed
3	Dolerite	V_1: 890(N)	0.9	0.9	Unconsolidated surface clay (CH) layer
(260–284)		V_2: 1200–1350	2.5–3.1	2.2–2.5	EW–HW rock; joints open, shear zones
		V_3: 2250–2650	–	–	Segments to 4000. SW–FR rock; joints generally tight
4	Dolerite	V_1: 670–800	0.9–1.1	0.9–1.1	Unconsolidated surface clay (CH) layer
(1200–1224)		V_2: 1250–1400	7.0–9.0†	6.1–7.9	EW–HW rock; joints open, some clay filled
5	Siltstone	V_1: 670 (N)	0.6	0.6	Unconsolidated surface silty clay (MH) layer
(1336–1360)		V_2: 1350–1650	4.8–6.4	4.2–6.4	MW–SW rock; closely jointed (3 distinct sets)
		V_3: 2000–2400	–	–	SW rock; joints open-tight
6	Dolerite	V_1: 450–500	0.7–0.8	0.7–0.8	Unconsolidated surface clay (CH) layer
(1692–1714)		V_2: 1700–2600	–	–	Mean 2000. MW–SW rock; joints open-tight
7	Dolerite	V_1: 350–400	0.7–0.8	0.7–0.8	Unconsolidated surface clay (CH) layer
(2214–2236)		V_2: 800–1000	2.7–3.4	2.0–2.6	Residual clay & boulders and/or EW–HW rock
		V_3: 1700–2000	–	–	MW–SW rock; joints open-tight
8	Dolerite	V_1: 400 (S)	0.7	0.7	Unconsolidated surface clay (CH) layer
(2766–2790)		V_2: 800–1000	2.2 –2.4	1.5–2.4	Residual clay and boulders and/or EW–HW rock
		V_3: 1500–1700	–	–	HW–MW rock, joints open
9	Dolerite	V_1: 570–670	0.7–0.9	0.7–0.9	Unconsolidated surface clay (CH) layer
(3090–3114)		V_2: 2200–2600	–	–	SW–FR rock; joints generally tight
10	Siltstone	V_1: 400–670	0.6–0.9	0.6–0.9	Unconsolidated surface silty clay (MH) layer
(3900–3924)		V_2: 1600–1700 (S)	3.6	3.0	MW–SW rock; closely jointed (open-tight)
		V_3: 2000–2700	–	–	SW–FR rock; joints generally tight
11	Siltstone	V_1: 570–1330	0.8–0.9	0.8–0.9	Unconsolidated surface silty clay (MH) layer
(4600–4624)		V_2: 2200–2500	–	–	Segments to 4000. SW–FR rock; joints generally tight

† : minimum layer depth assuming V_3 = 2500 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

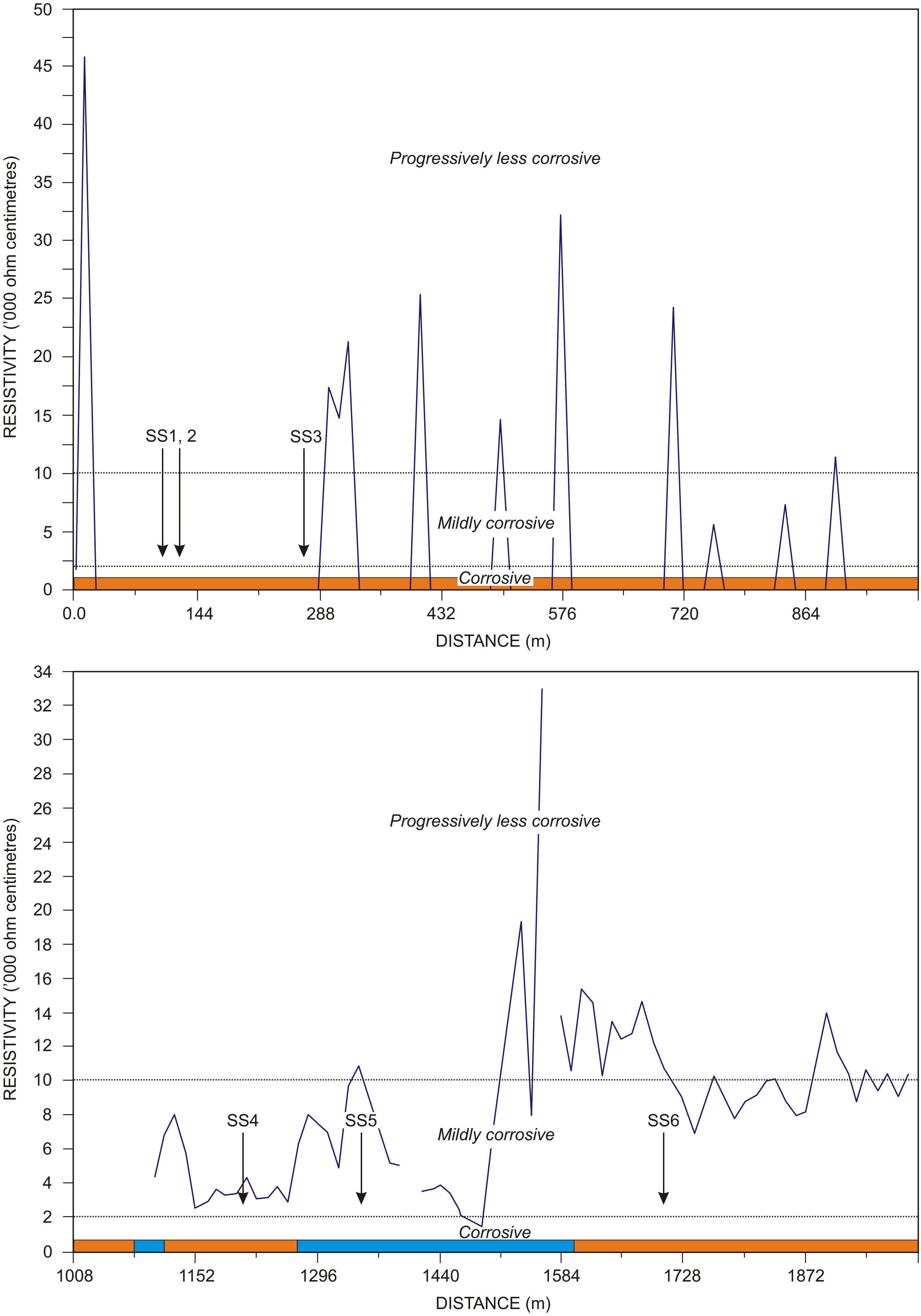
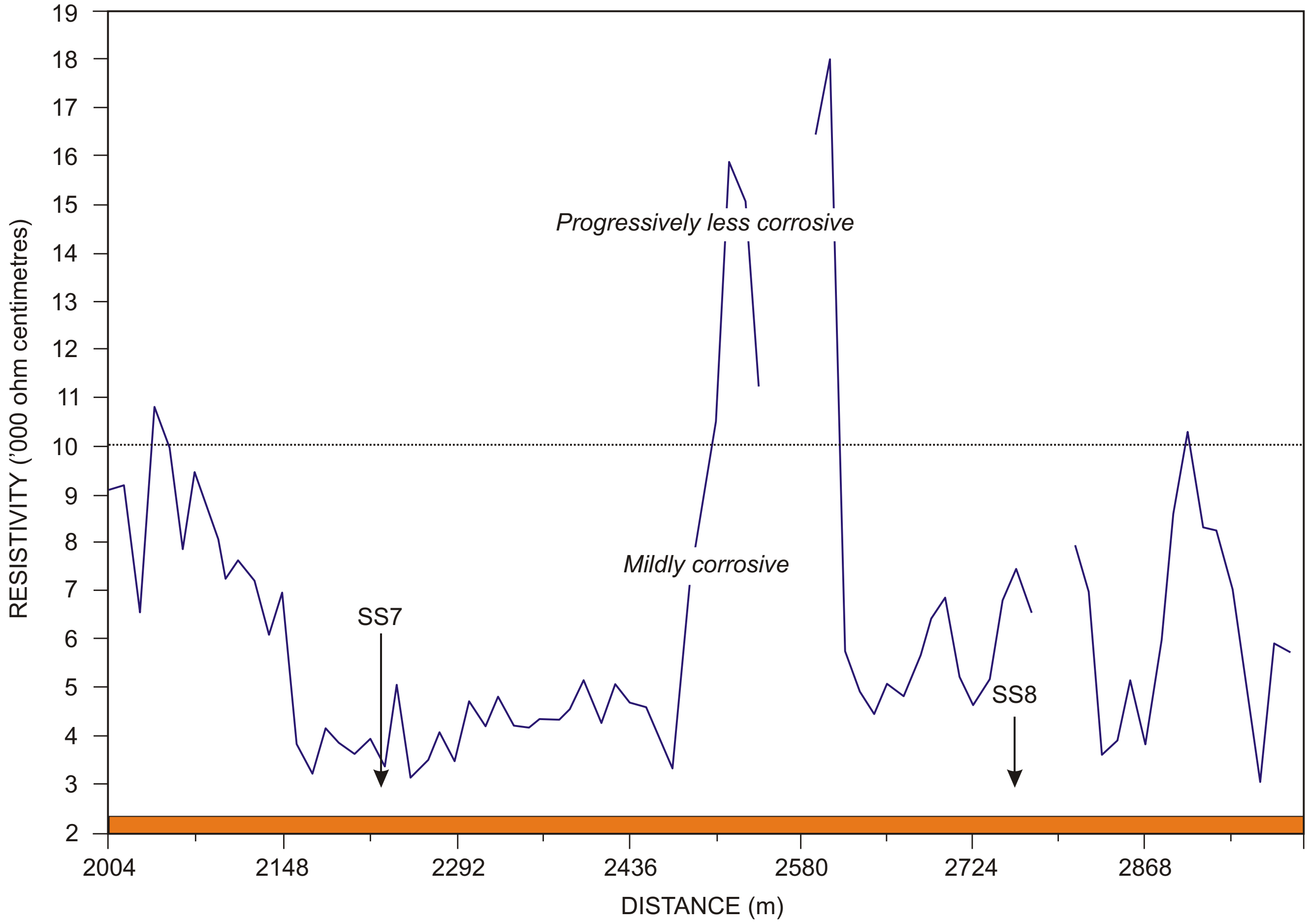


Figure 2. *Resistivity survey, 0 to 2000 metres*



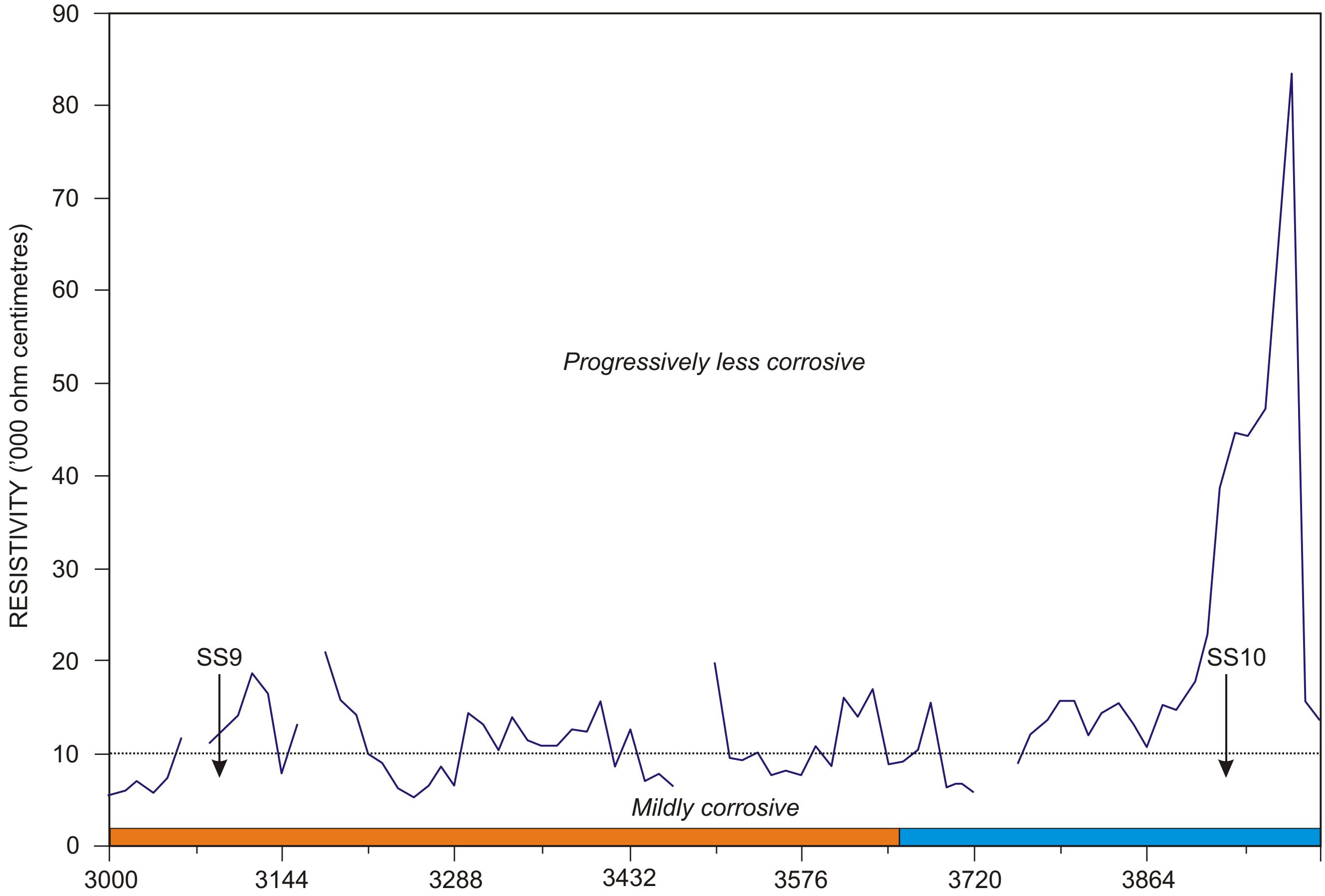


Figure 3. *Resistivity survey, 2000 to 4000 metres*

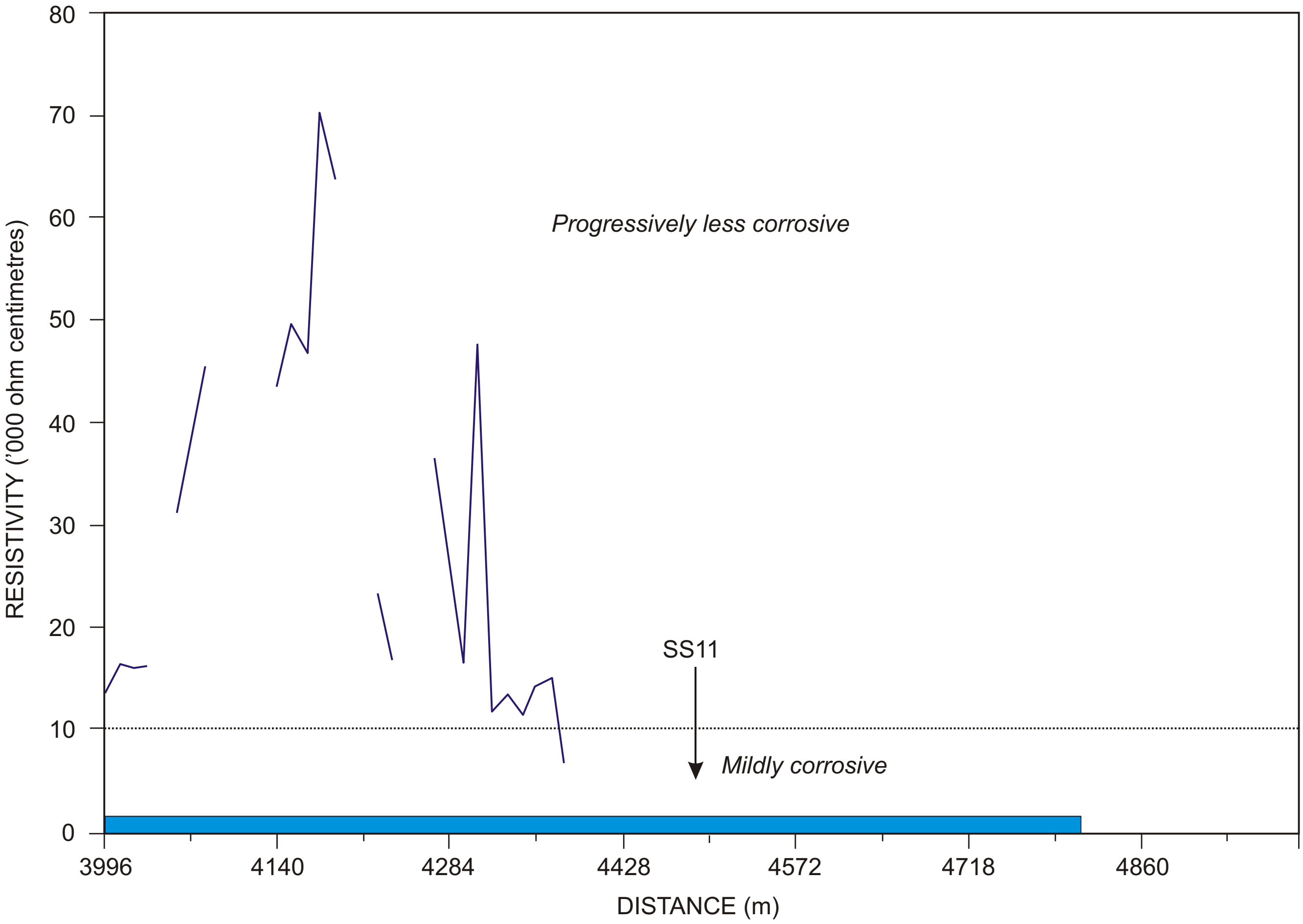


Figure 4. *Resistivity survey, 4000 to 4800 metres*