1981/16. Revised interpretation : Gravity survey of the Henry Jones Building, Old Wharf, Hobart

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Abstract

A review of new test pit data and nineteenth-century survey maps of Hobart Town suggests that commonly held deductions on the location of Hunter Island(s) are in error. The original gravity interpretation, though consistent with all currently available information, has been re-examined by filter analysis in order to better define the most likely sites for Hunter Island(s). The revised interpretation confirms that the most likely position is at the south-eastern end of the building complex but connected to the mainland by a sand-covered rock spine at variable depth.

INTRODUCTION

A detailed gravity survey of the Henry Jones Building was described by Richardson (1981). Figure 1, reproduced from that report, shows total Bouguer anomalies. Hunter Island(s), or at least low water shoreline, was considered to correspond roughly with the 3.75 $\mu m/s^2$ contour. This interpretation was consistent with limited test data then available.

Subsequent test pits have yielded a confusing picture. Their location is shown in Figure 2 from information provided by consultants to the project (Smith, Sale and Burbury). Also shown in Figure 2 is a presumed position for Hunter Island (refer Smith, Sale and Burbury, plan 51, project 80231, 20 March 81).

Consideration of the above data reveals a number of inconsistencies and peculiarities.

Consequently, the gravity data has been re-examined in an effort to extract more information, to resolve many of the uncertainties, and to provide a guide to critical drilling target locations. None of the test pit data conflicts significantly with the original interpretation.

THE PROBLEMS

(a) Only one pit (I1) encountered probable bedrock. It was identified as basalt, but the description is also compatible with dolerite. Either is possible in this area. Dolerite is the regional material and is exposed on both sides of Sullivans Cove, and basalt has been recorded in the city and central port area. Gravel and boulder descriptions from many pits are consistent with the local material, dolerite. Sandstone is most unlikely to form any natural shingle or gravel deposit. Sandstone cannot be excluded as the bedrock on Hunter Island(s) since the dolerite-sandstone rock boundary crosses the cove in a most erratic way (see also Leaman, 1971).

(b) Only one pit encountered rock near sea level or above (I1 above). This is curious since the (three) island(s) are shown in old drawings to have some prominence. Thus if the islands were levelled either to the height of wharf decking, or sea level, and the material back-filled, there should remain sizeable areas covered only by man-made debris above sea level. These have not been found.

(c) Sediments around the site are consistent with shoreline and bar-back deposits. Materials at the north-west of the site are consistent with reducing marsh deposits, while those to the east suggest beach deposits and more water working. The former are not consistent with an exposed island; certainly not one in the position suggested in Figure 2. However, the outline shown in Figure 2 may well represent part of the sand spit, elevated above marsh level. Certainly levels in the pits imply natural sand deposits above sea level.

(d) The pit data do not support, either by exposure or section content, the island-exposure outlines implied in Figure 2. Consideration of pile and footing type arrangements is more consistent with thick sediments along the Evans Street side of the complex, a beach/marsh spit to the north-west corner, and possible bedrock to the south-east. Thus "Hunters Island" (as shown in Figure 2) is more likely a sand spit. It must be noted, however, that many pits are shallow and reveal only beach deposits, not rock islands.

(e) Lands Department Surveys for 1829 and 1845, as discussed by Solomon (1967), suggest that Hunter Island had not been accreted into Old Wharf by 1829 but was part of the complex in 1845. This may be deduced from the fact that the lack of land bridge access precluded inclusion in the survey. The shape of at least one island is still evident in the 1845 plan. The orientation is NE-SW.

If the survey scales are calibrated against known road intersections (one scale is in error - 1845), the position of this island can be estimated. It lies east of pit Q1 and possibly east of B1. Another island is presumed north-east of this and a further island could occur to the south-east. It is possible that the third island is shown in the 1845 plan, which would imply that the second was already concealed. The first could still be untouched but unshown to the north-east. The records for the period 1829-1845 also show that the Hunter Street region was a marshy, swampy sand spit.

Thus historical and test pit data have not unambiguously defined the Hunter Island complex. But the evidence suggests that the interpretation shown in Figure 2 is incorrect. The original gravity interpretation identified an anomalous region at the south-east end of the complex with a westward trending spine. Such an interpretation is consistent with an island at the end of a sand-covered rock bar of variable but relatively shallow depth below sea level.

However, the interpretation based on a contour value of 3.75 $\mu m/s^2$ is unable to resolve the problem.

REVISED GRAVITY ANALYSIS

The basic observations, as presented in Figure 1, have been passed through two grid filters with apertures of 25 and 50 m. This has the effect of removing high frequency components in the recorded gravity field. A 25 m filter removes the effect of sources above a depth of 5-8 m and the 50 m filter above 10-15 m. The filtered observations are derived by grid averaging the data, and the results are then contoured and smoothed. When the filtered version (regional), which reflects the effect of geology around the site, is subtracted from the total anomalies (fig. 1) only the residual shallow-source effects remain. Figure 3 shows the residual Bouguer anomalies for the 50 m filter and thus has an effective interpretive depth range of 10-15 m. Because of filter matrix losses the contours are only reliable within the confines of the building.

The treatment exposed two positive anomalies. The most prominent lies at the south-east end of the complex.

Quantitative interpretation is difficult due to lack of control and the great range of densities provided by the various natural and man-made fills. But, as noted in Richardson (1981), clear relative positive anomalies correlate with zones in which the depth to rock is less.

Thus, if the highest positive (+1 $\mu m/s^2$) represents an island with rock at or above low water mark, the other positives cannot represent similar features since values of 0 to +0.5 $\mu m/s^2$ are typical. This interpretation is consistent with the 1829/1845 survey mapping and the general data relating to footing types and spit location. NE-SW orientation of the anomaly agrees precisely with that shown on the 1845 plan.

However information from pits A1 and A7 and the above deduction are not wholly consistent, with A7 being a piled site. This may reflect partial levelling of, or an erratic shape for, Hunter Island. It is apparent from a review of Figure 3 that key portions of the building have not been adequately tested - between pits B1, Y1, Q1 and B1, A7, B3, B2.

Quantitative estimates may be based on the residual anomalies using the following table of density and Bouguer contrasts:

dolerite	+0.70 t/m^3	+0.293 $\mu m/s^2/m$
sandstone	+0.15	+0.063
sand	-0.43	-0.180
clay	-0.23	-0.096
organic debris	-0.73	-0.306
air	-2.20	-0.922

All values are relative to a Bouguer reduction density of 2.20 t/m^3 and presume a reasonably uniform thickness of surface concrete.

The following set of mini-sections indicates the types of ambiguity problems which may arise, while also establishing clear limits for certain anomaly types. The base level for all models is twelve metres below the surface (filter mid range).

Thickness (m)

Section	A	B*	C	D	E	F	
organic/fill	-	0.5	1	-	1	1	
sand	-	1	1	2	2	3	
clay	-	-	-	1	1	3	
rock	12	10.5	10	9	8	5	
Attraction $\mu m/s^2$	3.52	2.75	2.44	2.18	1.57	0.33	} dolerite
adjusted	1.57	0.80	0.49	0.23	-0.38	-1.62	} bedrock
Attraction $\mu m/s^2$	0.76	0.33	0.14	0.11	-0.27	-0.83	} mudstone
adjusted	1.23	0.80	0.61	0.58	0.20	-0.36	} bedrock

For either type of bedrock the resultant is obtained in the following manner:

organics	1 m	=	-0.31
sand	2 m	=	-0.36
clay	1 m	=	-0.10
dolerite	8 m	=	+2.34
			1.57 $\mu m/s^2$ (attraction)

Each range of attractions is absolute, but the residual values shown on Figure 3 are relative, due to the processing. Thus to relate them, each has been adjusted by a constant amount referenced to section B. The value of 0.80 $\mu m/s^2$ suggested for B is representative of anomaly maxima.

The tables show that if the section at B is valid and resonable, then rock is unlikely to protrude more than a metre above sea level. It must also be noted that the density values quoted are assumptive for sand, clay, and debris. Even given the coarse assumptions made about the densities of the materials present, there is some overlap of section content possible. This is not easily resolved without firm control, but the examples A to F do show the range of possible interactions. Strong negatives are possible with dolerite and moderate cover, or sandstone and very thick cover. Thus the negative anomalies at the south-east end of the site clearly indicate the end of any bar-island system. Moderate negative anomalies can be produced by thick fills on shallow rock or combinations of less dense natural materials overlying rock at varying depths. As the density contrast between materials decreases so the interpreted thickness increases. Thus values of -0.25 to -0.75 $\mu m/s^2$ (fig. 3) around the site, especially near Evans Street, imply a natural channel with a possibly deep bedrock when the type of recovered material is considered. Values toward the northern corner of the site are also more consistent with a sandstone bedrock, whereas those elsewhere suggest a dolerite bedrock.

Ambiguities remain and only fully controlled sections with properly determined density values can resolve them. However, the interpretation and its set of assumptions can be tested at test pit sites 5 and I1. This is possible as the interpretation presumes that the most likely site for the island is as shown in Figure 3 and referenced the peak gravity anomalies on this basis.

	Hole *TP5*		Hole *I1*	
Fill	0.3 m	= -0.1	1.0 m	= -0.31
Sand/silt	2.1 m	= -0.38		
Rock	9.6 m	= 2.81/0.60	11.0	= 3.22/0.69 dolerite/sandstone
		2.33/0.12 $\mu m/s^2$		2.91/0.38 $\mu m/s^2$
adjusted				
(dolerite)		0.38 $\mu m/s^2$		0.96 $\mu m/s^2$
(sandstone)		0.59 $\mu m/s^2$		0.85 $\mu m/s^2$
observed value		0.60 $\mu m/s^2$		0.25 $\mu m/s^2$

There is good agreement for TP5 and poor for I1. Although rock condition or type is unknown at TP5, either material is possible and the section roughly satisfies two dimensional assumptions (see Richardson, 1981). However at I1, the rock is either dolerite or basalt, probably the former, and a much higher value could have been expected on Figure 3. There are two possible explanations.

(a) observation cover and filter reliability are reduced in this part of Hunter Street and as a consequence, the positive anomaly has not been properly scaled across the wall line. The residual value is probably too low.

(b) the rock observed in I1 is very weathered and offers an irregular interface. Thus the thickness of fill is variable and not reliably estimated for the dimensional assumption. The effect has probably been to increase the calculated attraction. But, more likely, is the use of an incorrect rock density. If the rock is deeply weathered it might well have a near-surface density of 2.2-2.4 t/m^3. The profile could be:

Fill	1 m	= -0.31
Weathered dolerite	3 m	= +0.19 (2.35 t/m^3)
dolerite	8 m	= +2.34
		+2.22 μm/s^2
		or +0.27 μm/s^2 adjusted

This calculation serves to show how important the density-section assumptions are. But it also suggests that the basis for the interpretation is reasonably sound. Allowance for weathering/density variations, which are applicable to dolerite bedrock only, supports the conclusions shown in Figure 3.

CONCLUSIONS

At least one island has been located under the Henry Jones building complex. It is near the south-east end and was linked by a sand spit to the mainland. The location of the spit was probably controlled in part by a localised rock spine which possibly stood a little clear of both sand and water in a few places. Such a spine could have formed a low island, with its sand cover. The bedrock of both spine and island is probably dolerite.

The suggested positions of Hunters Island and an 'extent of exposed rock', as shown in Figure 2 and adjacent to Victoria Dock, are not supported by survey plans, geology as shown in pit sections, or the gravity survey. It certainly seems likely that the Old Wharf followed the spit/rock spine out into the cove and then was filled out to encompass Hunter Island; the last prominence being at the eastern end of the current complex.

REFERENCES

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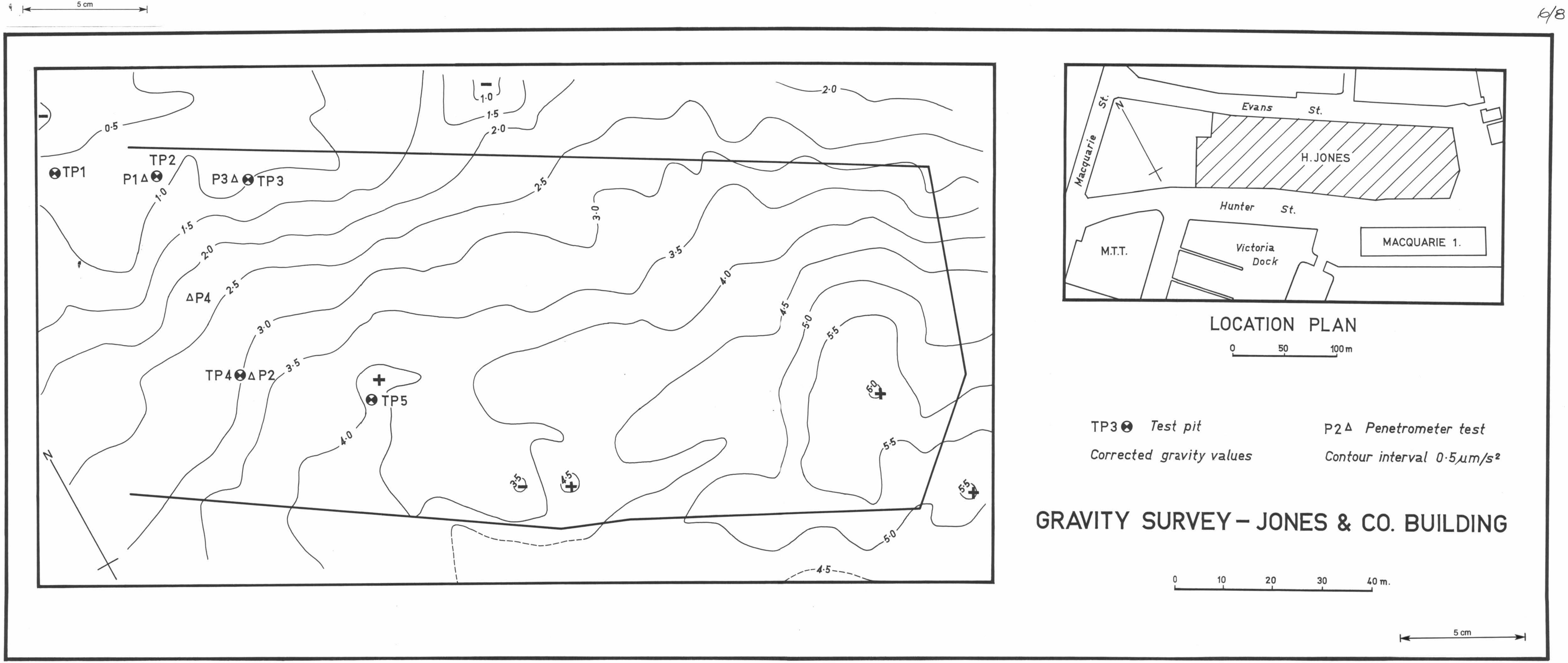
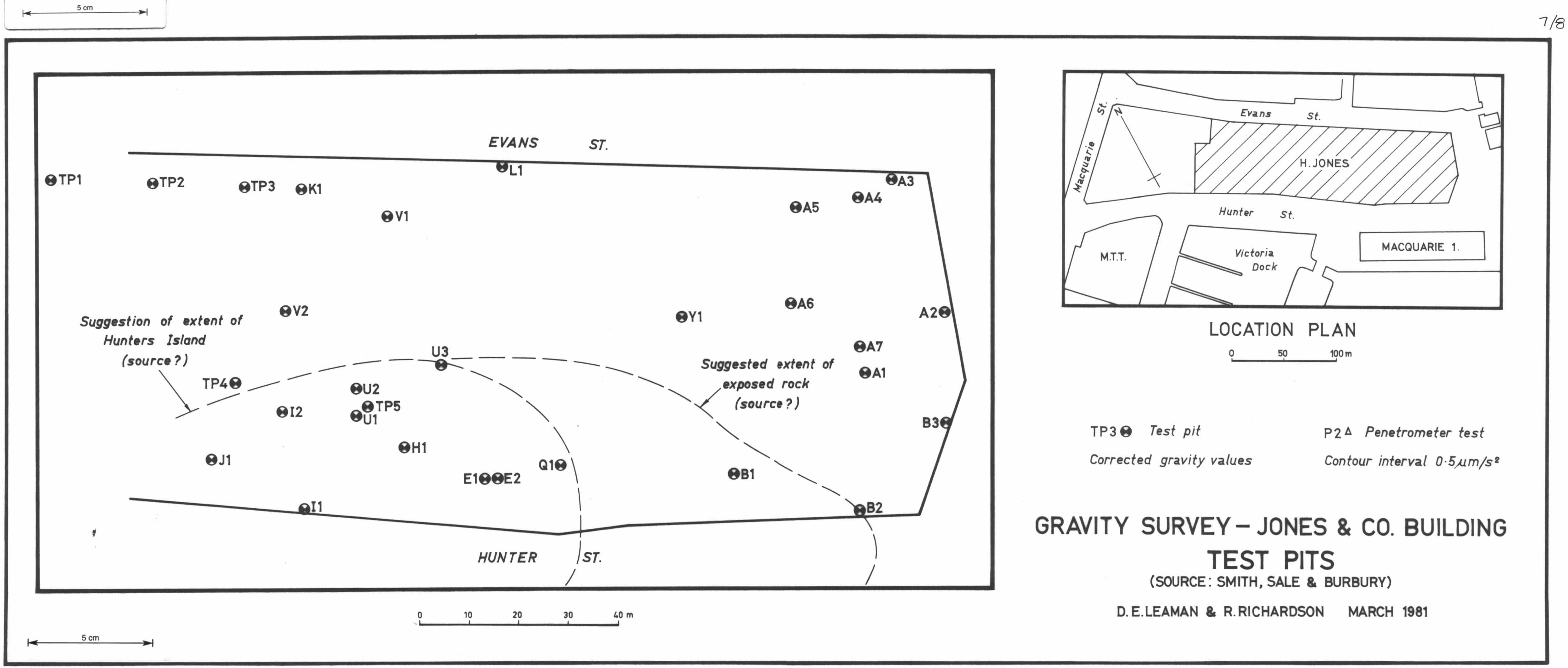

5 cm
TP1
TP2
P1
P3
TP3
P4
TP4
P2
TP5
N
0·5
1·0
1·5
2·0
2·5
3·0
3·5
4·0
4·5
5·0
5·5
Evans St.
Macquarie St.
N
H. JONES
Hunter St.
M.T.T.
Victoria Dock
MACQUARIE 1.
LOCATION PLAN
0 50 100 m
TP3 Test pit
P2 Penetrometer test
Corrected gravity values
Contour interval 0·5 µm/s²
GRAVITY SURVEY – JONES & CO. BUILDING
0 10 20 30 40 m.
5 cm

Fig. 1



GRAVITY SURVEY – JONES & CO. BUILDING
TEST PITS
(SOURCE: SMITH, SALE & BURBURY)

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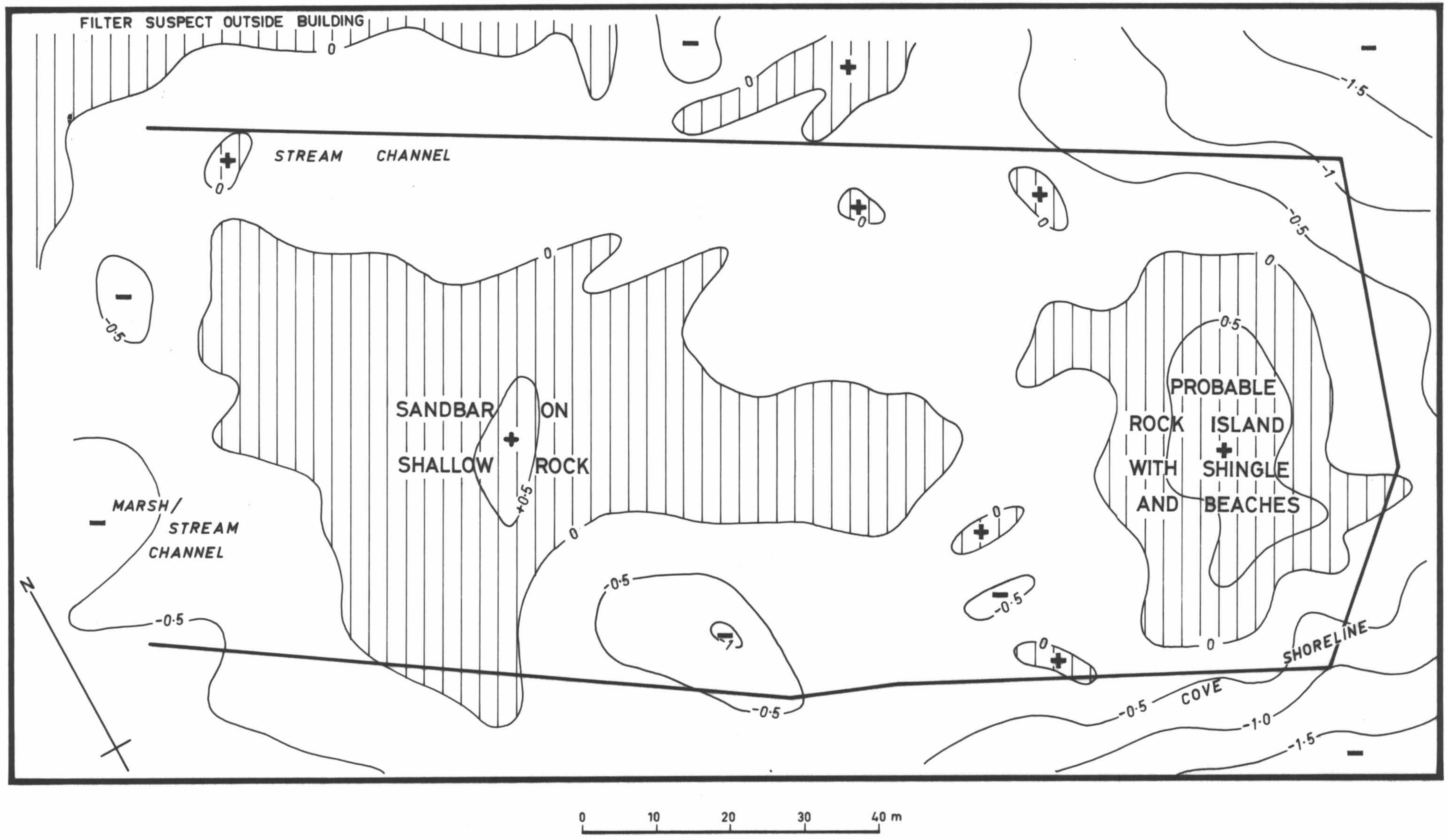
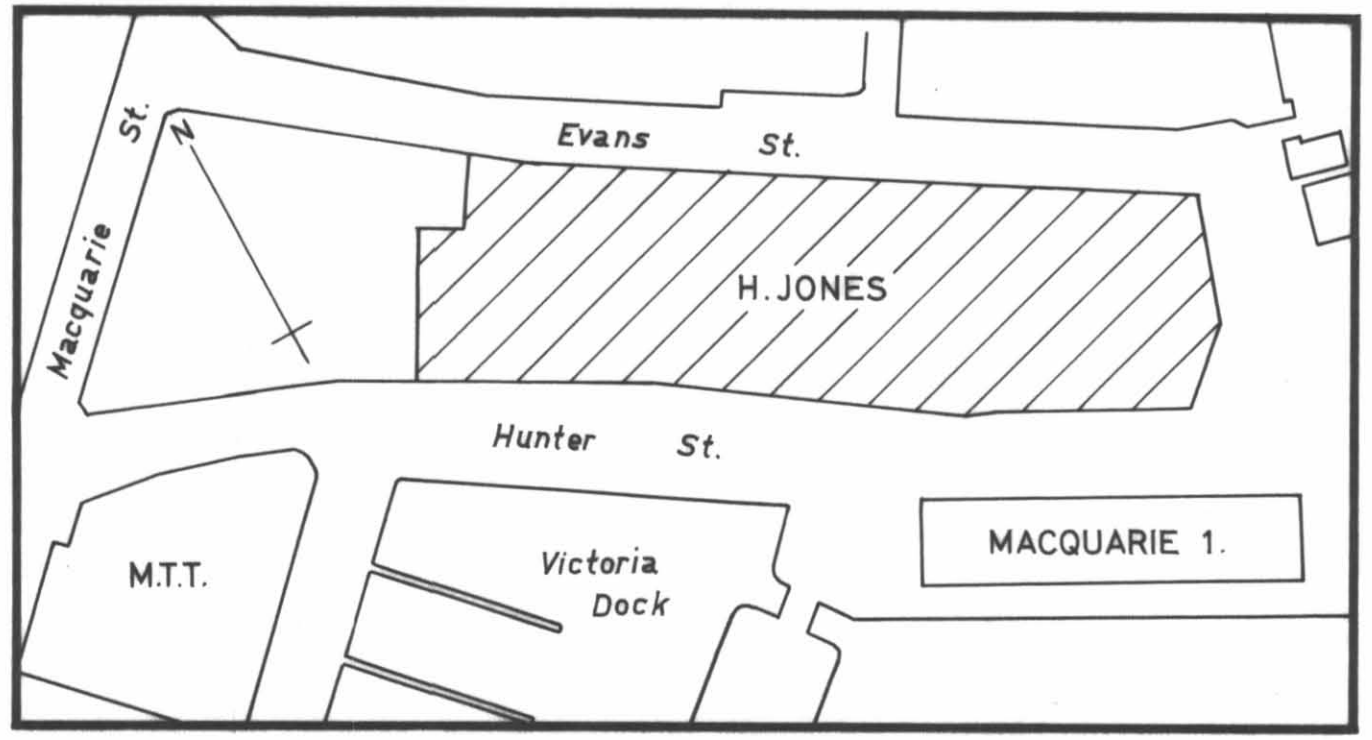
Fig. 2





LOCATION PLAN

0 50 100 m

TP3 ⊗ *Test pit*

Corrected gravity values

P2 △ *Penetrometer test*

Contour interval 0·5 µm/s²

GRAVITY SURVEY – JONES & CO. BUILDING
RESIDUAL BOUGUER ANOMALIES

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Fig. 3