1988/08. Tasmania gravity interpretation: Revised mantle model.

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INTRODUCTION

Various attempts have been made to define the Moho within the Tasmanian part of the Australian continental plate. The first consolidated study using a regular statewide gravity grid was reported by Leaman *et al.* (1980). All previous work using more limited gravity data, and seismic lines, has been referenced by Leaman *et al.* (1980) and Richardson (1980). The interpretation by Leaman *et al.* (1980) was greatly influenced by the then recent reflection-refraction study from Savage River to St Helens by Richardson (1980).

The result of the 1980 model study, reproduced from Figure 7 of Leaman *et al.* (1980), is given in Figure 1.

A REVISION NECESSARY?

A revision has become necessary, as subsequent work has exposed imperfections in procedures, coverage, corrections and model.

1. There has been considerable improvement in gravity coverage since 1975; the compilation date for the 1980 study. Also, all stations have now been reviewed for reliability and fully and uniformly corrected. While perfection is not claimed for the TASGRAV data base, many incorrect, non-reproducible stations have been identified and removed. All BMR stations and many other isolated surveys not observed by the Department of Mines have required terrain correction. Single station changes of up to 30 mGal were effected. Such changes set against a nominal station spacing of 7 km do introduce a very different appearance in contour maps.

2. The systematic application of corrections and improvements in coverage, especially in western Tasmania (previous Mt Read Volcanics Project phases), has shown that some apparently crustal source wavelengths were generated by large, relatively shallow sources. The Tor Granite, south of Cradle Mountain, provides an example of massive distortion of the gravity field where crustal effects are critical.

3. The original model was based on a mantle contrast of 0.6 t/m^3 and a crustal base density of 2.74 t/m^3. These values were set against sea water at 1.03 t/m^3. Recent studies of the primary crystalline basement in north-west, central and southern Tasmania suggest a density not in excess of 2.7 and probably very close to the Bouguer density of 2.67 t/m^3 (2.65 - 2.68). These changes indicate that some variations in crustal slope interpretation are warranted.

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*Leaman Geophysics. Report prepared for Mt Read Volvanics Project, Tasmania Department of Mines, January 1988.

4. Some unpublished regional analyses by the writer since 1980 in central and southern Tasmania, and more recently in west and noth-west Tasmania, have demonstrated that not only were the base assumptions of the 1980 model suspect (3 above) but issues such as (2) were also significant. The criteria which would allow evaluation and resolution of such problems, and permit generation of a revision, have evolved with such analyses. These criteria include curve matching a random array of profiles at a fixed arithmetic shift relationship between calculated and observed data.

   The use of regional separations has been avoided even though the alternative requires modelling of the entire crust. In the absence of clear cut, identifiable, unambiguous and continuous regional trends on any line array, the shift differential method becomes the only practicable path. The lack of any assumptions about long wavelength trends, or use of filters, avoids any risk of frequency content loss. When comparable values are calculated irrespective of line content, length or orientation, and the same structures in differing aspects yield the same density contrast pattern, the solution becomes acceptable. It is not necessarily unique but is tending so for the given control information.

RELATIONSHIP TO SEISMIC DATA

The work of Richardson (1980) superseded all previous work and all earlier studies were reviewed by him. The gravity model of Leaman *et al.* (1980) incorporated the crustal profile based on revised reflection-refraction observations across northern Tasmania. A crustal depression was implied in the Tamar region.

More recent gravity work showed that if the gravity model was based on the seismic depth range implied seismically near Savage River then the Tamar depression is unlikely. It must be noted here that gravity methods alone cannot define the mantle interface depth, they can describe its shape. The inferred depth is an approximation which depends on the density assumptions used. Seismic data at Savage River can reliably anchor the integrated gravity form. When this is done the seismic model is supportable as far east as Sheffield-Deloraine (80-100 km from Savage River). But why not further?

The geological interpretation of the gravity line models offers a solution. Massive granites occupy virtually half the crustal thickness from St Helens to west of Scottsdale and from Savage River to Beulah. If it is assumed that the granites raise the local crustal velocity, then the interpreted depression near the Tamar axis simply represents normal, lower velocity crust (free of granites) which has generated a relative time delay. A centre shot on the spread would resolve the issue absolutely.

Given that gravity data can only provide a surface shape, it is impressive that the new gravity and seismic interpretations from Savage River to Beulah are within one kilometre of each other in depth terms. Thus, where Richardson (1980) estimates about 24 km at Savage River, the basic gravity model implies about 25 km. The relativity is sustained for 100 km. Line array intersection misclosures within the gravity models amount to possible deviations of about 500 m, and the two solutions are effectively indistinguishable. The revised model presented in Figure 2 uses the gravity results and has not been tied to seismic absolute terms. The difference is not significant for any upper crustal appraisal of the gravity data.

REVISED MODEL

The revised model is shown in Figure 2. Most of the present changes are in NW Tasmania, which has been the focus for major gravity evaluations for the Mt Read Volcanics Project. The direct modelled revision is shown by heavy lines while an interpolation based on the original 1980 model constrained by the new modelling is suggested by broken lines.

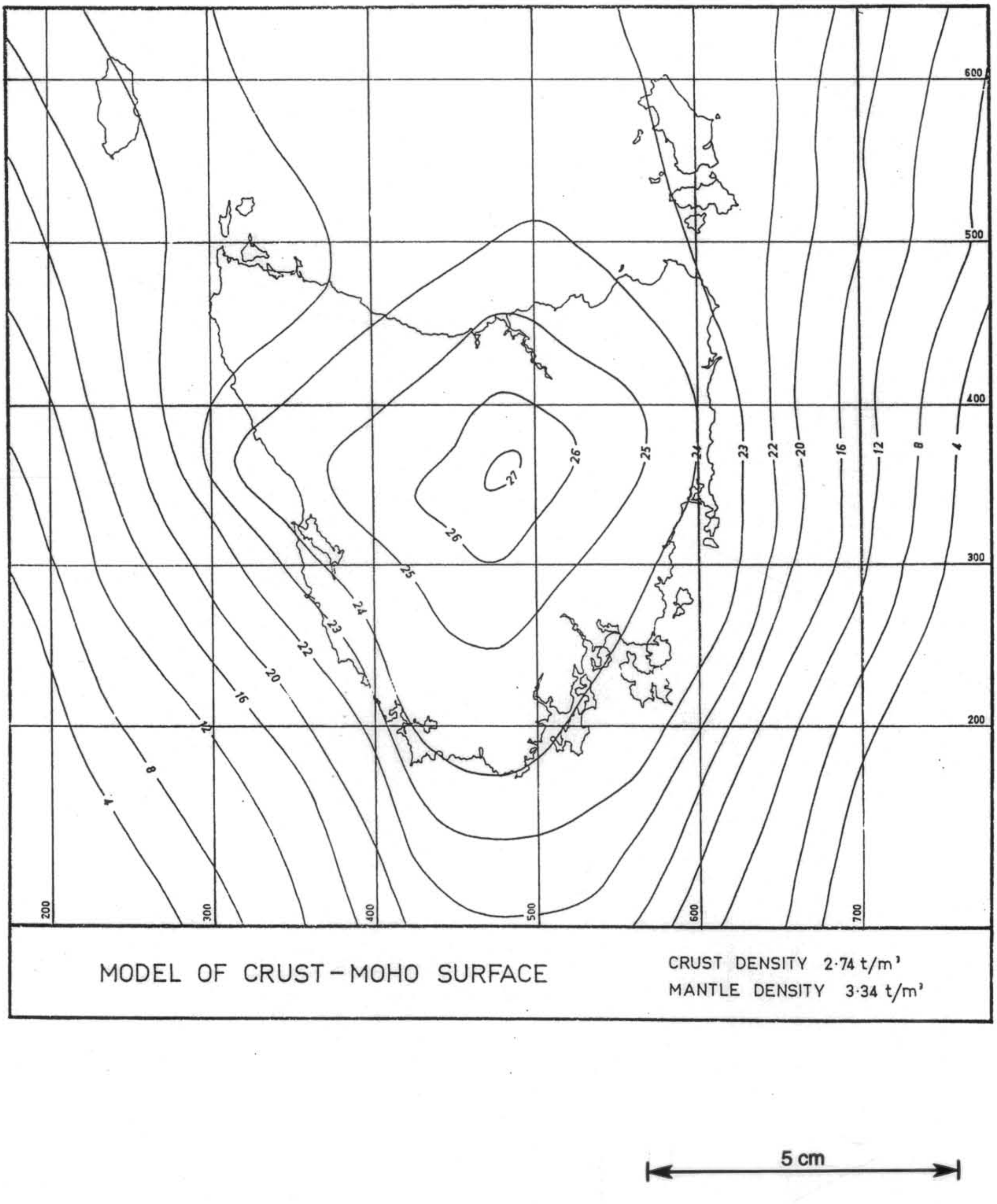
This model should be used to define 'regional' effects for large scale surveys until more extensive coverage and modelling permits further upgrading.

REFERENCES

LEAMAN, D. E.; RICHARDSON, R. G.; SHIRLEY, J. E. 1980. Tasmania - the gravity field and its interpretation. *Unpub. Rep. Dep. Mines Tasm.* 1980/36.

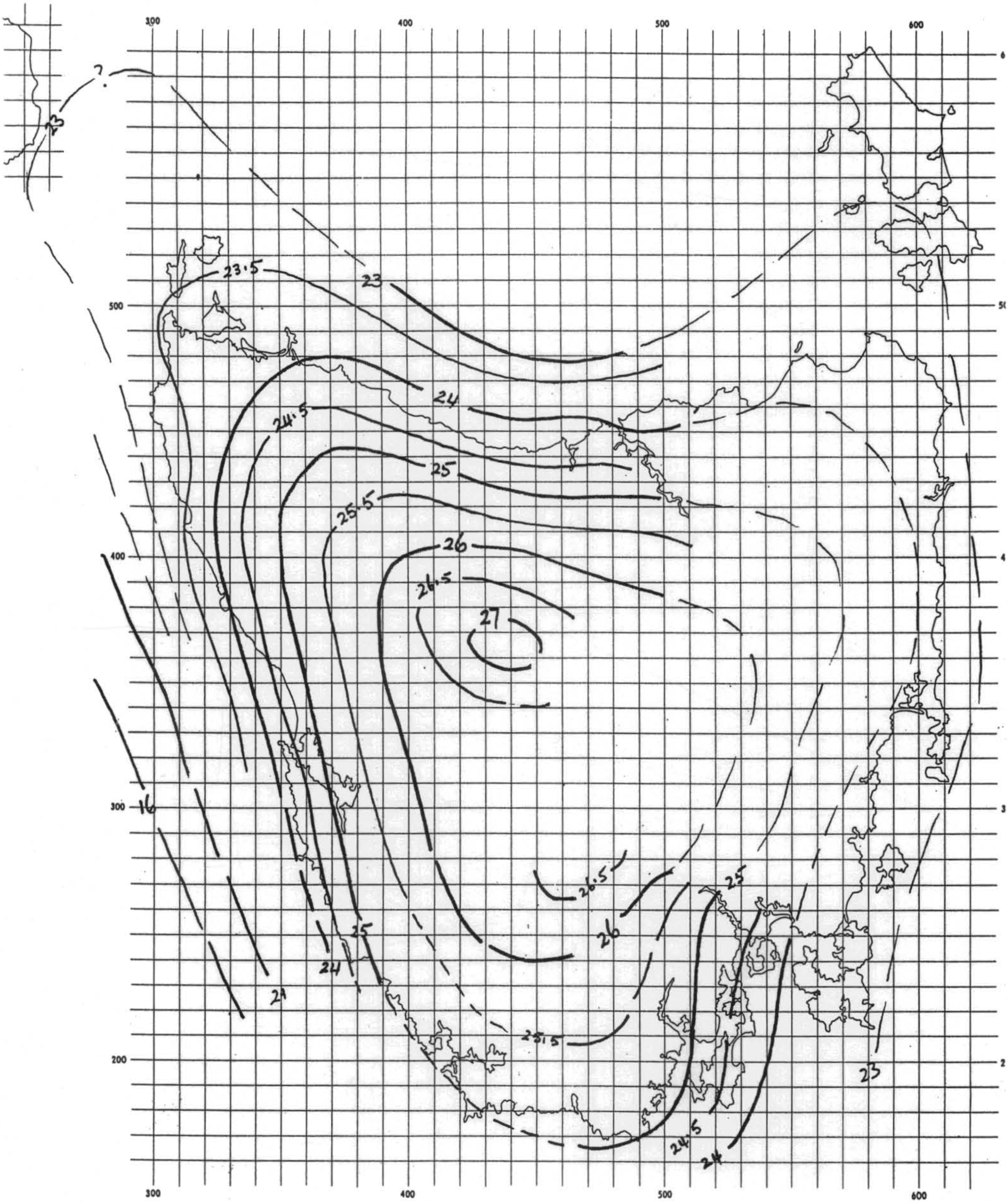
RICHARDSON, R. G. 1980. *Crustal seismology.* Ph.D. thesis, University of Tasmania : Hobart.

[30 March 1988]



1980 MODEL OF CRUST - MANTLE SURFACE
(from Leaman et al, 1980; Fig 7)

FIGURE 1



1988 MODEL OF CRUST - MANTLE SURFACE
(gravity solution shown, seismic implication 1 km shallower)

FIGURE 2

5 cm