UR1977_26

1977/26. Gravity survey of north-eastern Tasmania. Analysis of pluton margins

D.E. Leaman

Regional mapping of the Ringarooma and Boobyalla Quadrangles has now been completed. This has led to the recognition of a band of metamorphosed country rocks adjacent to the various plutons. The mapping criterion used for identification of such rocks is spottiness, representing growth centres for thermal alteration. As mapped, there is some variation in the width of the band of spotted rocks. Near Mt Horror for example, it is over 5 km wide but typically it is about one kilometre. Since the mapping of a recognisable thermal boundary is relatively easy a possible corollary arises. Can the width of such a zone be used to estimate the dip of the pluton margin? In order to test whether such a hypothesis, which was suggested to the author by N.J. Turner, is valid a number of key structural profiles were selected and compared with the gravity profile derived from the regional gravity survey of north-eastern Tasmania (Leaman and Symonds, 1975).

LIMITATIONS OF ANALYSIS

Several problems will be immediately apparent.

(1) The gravity survey provides a regional coverage and the station distribution is not ideally suited to margin analysis. In many cases the density of coverage is variable or even patchy and it is often difficult to pinpoint the gradient maxima so crucial to such analysis. Furthermore the coverage is random and non linear - it was designed to locate and scale the major features which are all three dimensional. The station spacing often exceeds 1-1.5 km which is too coarse for good profile analysis.

(2) A number of key structural profiles include several anomalous features. Where station coverage is limited it is not possible to resolve the contribution of each feature in order to assess the attitude of the particular interface in question.

(3) The entire process presumes that the intruded rocks are sufficiently homogeneous as to behave consistently in the thermal stress environment and to possess similar average bulk densities overall. Metamorphism locally increases the bulk density (Leaman and Symonds, 1975) but the scale of this effect is uncertain.

(4) Owing to the scale of the structures generating the gravity anomalies profiles are 6-10 km long. Regional effects and uncertainties in specification can interfere with a reliable gradient assessment.

(5) For a proper assessment of a profile it must be possible to relate the surface position of the igneous contact and the maximum gradient.

(6) Density contrasts can affect the gradient as can the particular distribution of densities in the near-surface zone about the contact. The presence of a denser band of country rock - the thermally metamorphosed material - serves only to complicate this problem. An extension of these difficulties relates to the problem of precise specification of density. The values quoted for the granites or granodiorites are well established but those given for the intruded rocks are estimates based on many determinations of probably weathered or altered heterogeneous rocks.

Each of the above problems would appear to introduce sufficient ambiguity as to make any processing invalid. An improved, specific profile coverage directed at the particular question of margin dip might ease the

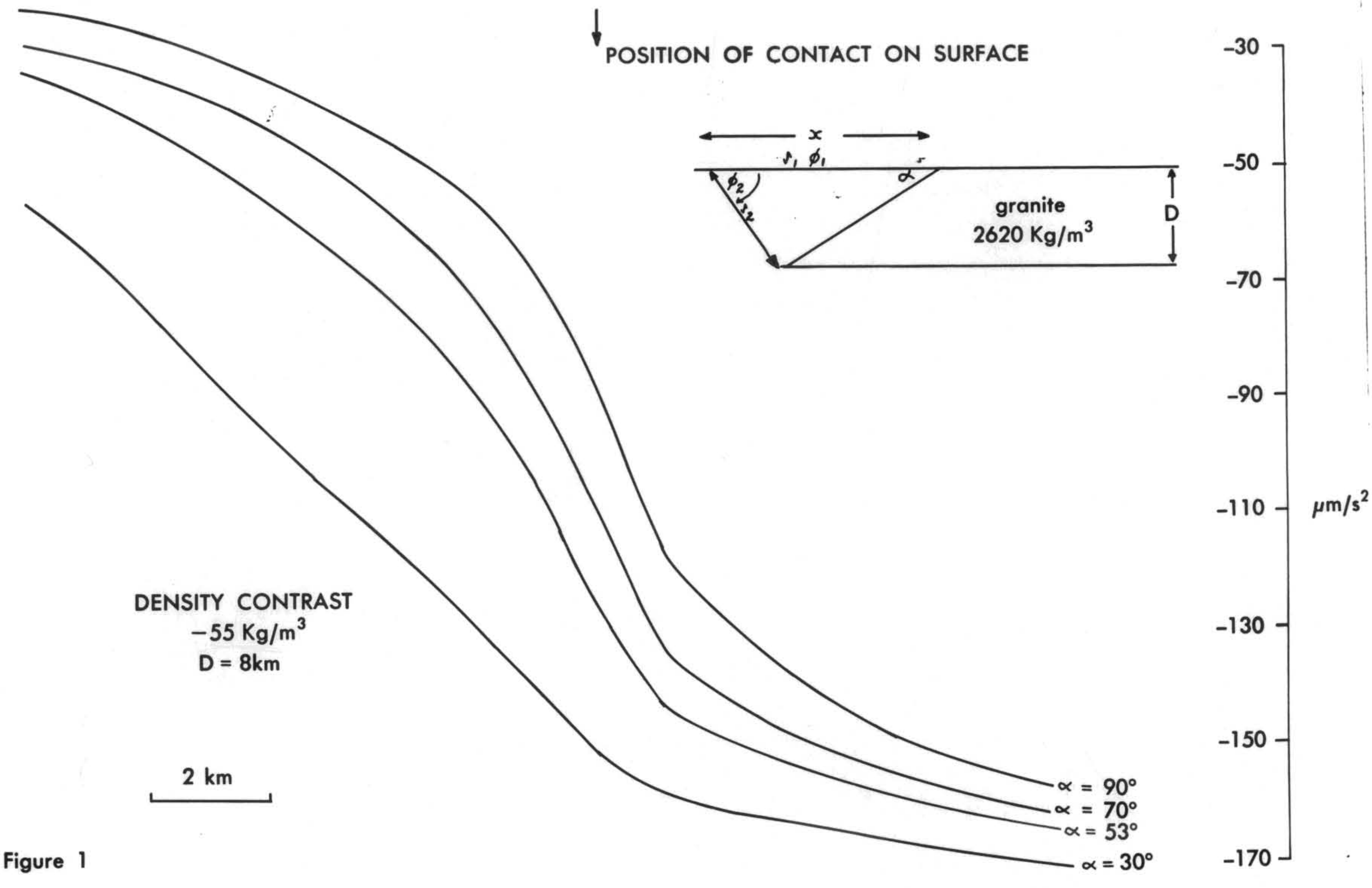
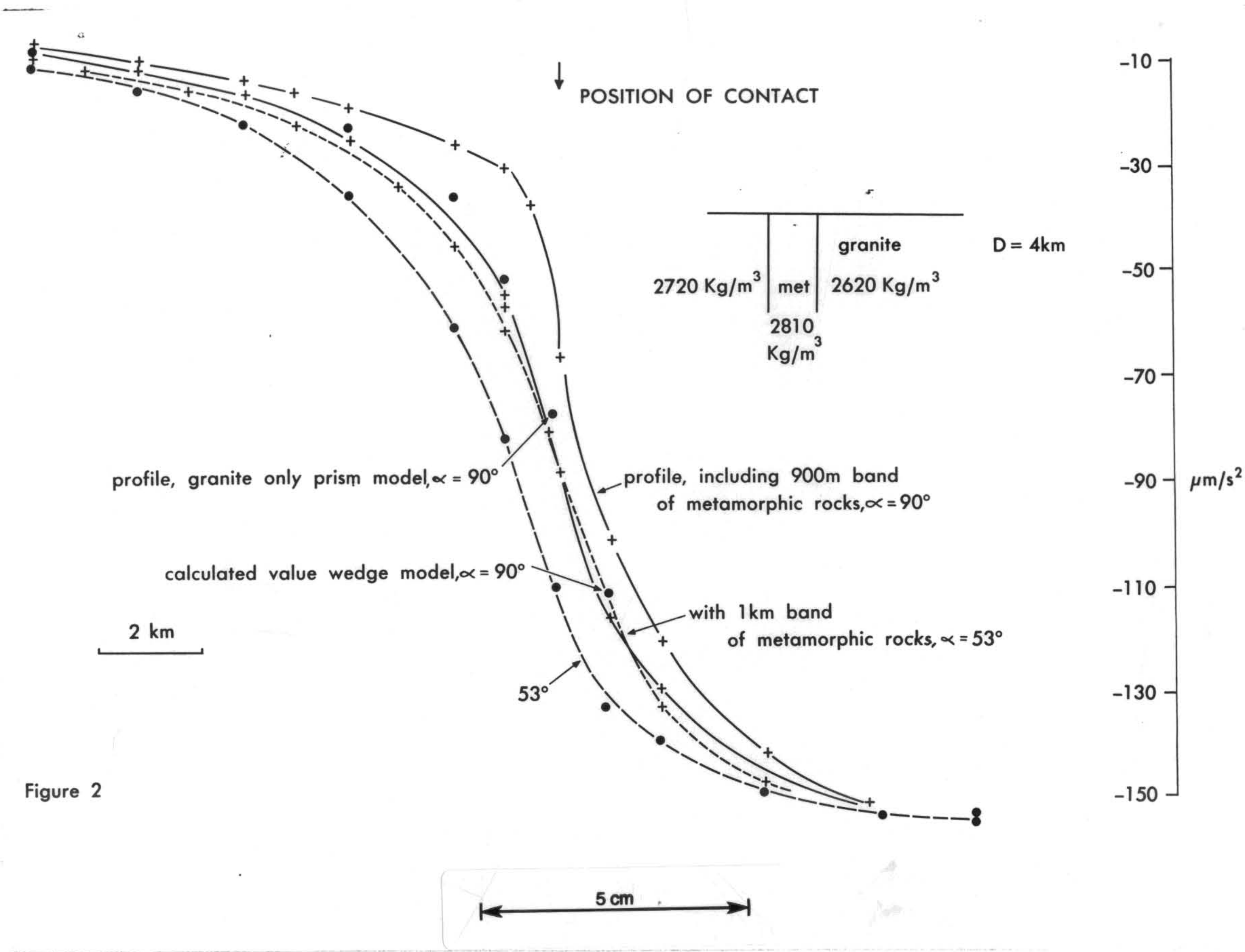

POSITION OF CONTACT ON SURFACE
x
ρ_1 ϕ_1
ϕ_2
ρ_2
α
granite
2620 Kg/m^3
D
-30
-50
-70
-90
-110
-130
-150
-170
μm/s^2
DENSITY CONTRAST
−55 Kg/m^3
D = 8km
2 km
α = 90°
α = 70°
α = 53°
α = 30°

Figure 1

5 cm



POSITION OF CONTACT
granite
D = 4km
2720 Kg/m3
met
2620 Kg/m3
2810 Kg/m3
-10
-30
-50
-70
-90
-110
-130
-150
μm/s2
profile, granite only prism model, ∝ = 90°
profile, including 900m band of metamorphic rocks, ∝ = 90°
calculated value wedge model, ∝ = 90°
with 1km band of metamorphic rocks, ∝ = 53°
53°
2 km
5 cm

Figure 2

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problems. Before this could be justified it is necessary to assess the problems listed above, estimate the scale and magnitude of anomalies to be expected and test criteria for resolution. The present coverage is adequate for such a basic evaluation although one profile was upgraded in order to assess possible improvements in interpretation.

Before considering the selected test profiles and their probable interpretation an inspection of the nature and scale of anticipated anomalies is necessary.

CALCULATED PROFILES

All calculated profiles are based on the two-dimensional step model with a sloping face.

For the case where the step face is exposed,

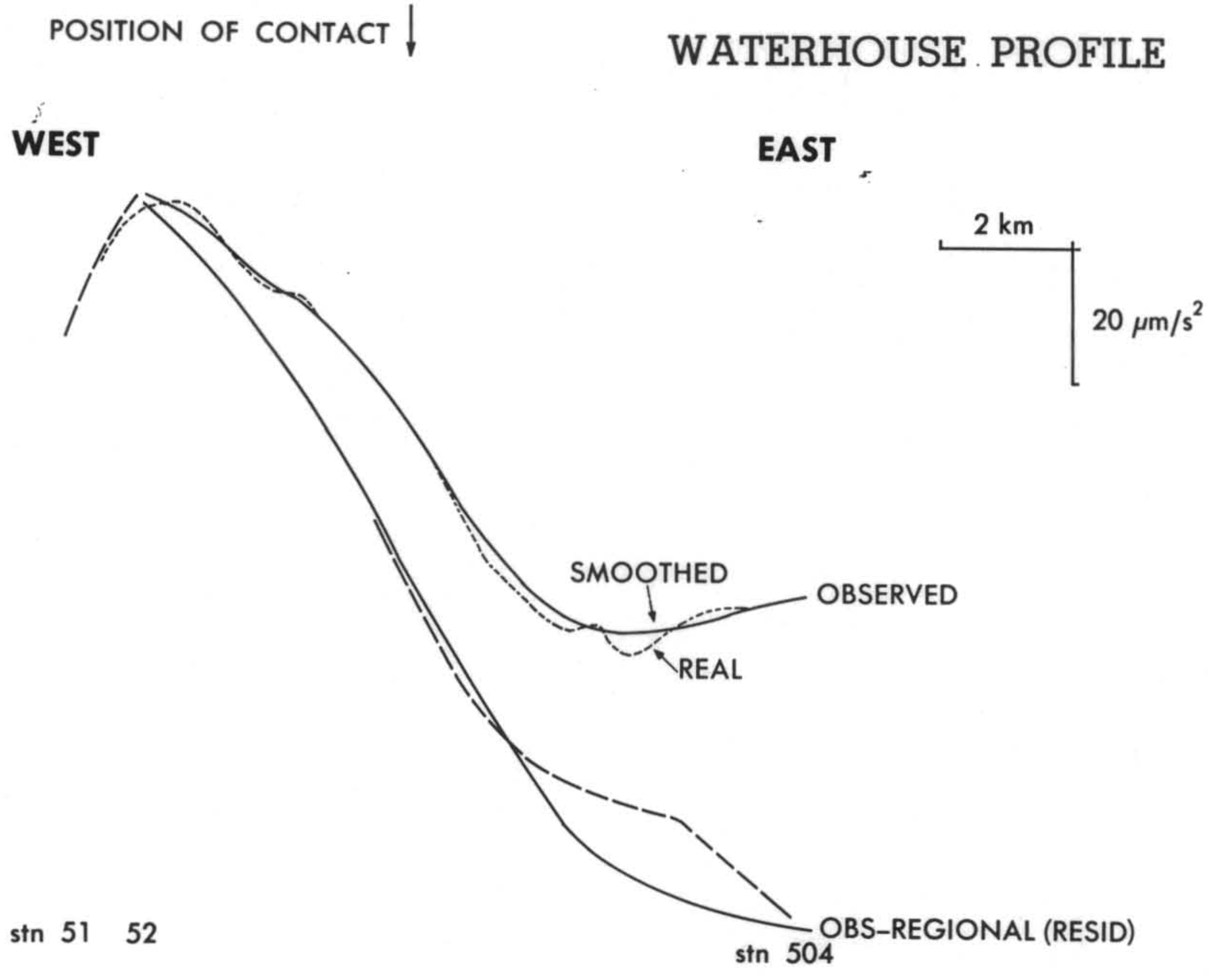
$$\Delta g = 2G\Delta\rho\,[D\phi_2 - x \sin\alpha(\sin\alpha \, ln \frac{r_2}{r_1} + \cos\alpha(\phi_2 - \phi_1)]$$

where G = the gravitational constant
$\Delta\rho$ = the density contrast
D = the thickness of the contrasting body (in this case the slab of granitic rock)
x = the distance from face of the calculation point
α = the dip of the face
ϕ_2, ϕ_1 = the angles subtended by the lower and upper edges of the face at the calculation point
r_2, r_1 = the distances from the calculation point to the lower and upper edges of the face.

A series of curves has been calculated for a granitic pluton 8 km thick (fig. 1). This is of the order of magnitude estimated by the regional coverage. Thickening to 10-12 km serves only to complicate the arguments related to the choice of density contrast and does not materially alter the gradients, whereas a reduction to 4 km is significant. The figure shows that the maximum gradient is directly related to the position of the contact when this is exposed and that the profile is moved outward from the pluton as the dip shallows. However, the degree of shift is slight for dips between 60 and 90° and is about 1-1.2 km. It will be immediately apparent from this observation that unless the regional survey contains an appropriate station coverage in the key areas it may not be possible to reliably estimate any high angles (>45°). It should be possible though, to state if the dip is high or low and estimate its value if less than 45°.

The figure also shows that profiles less than 6-8 km in length may not contain sufficient information to resolve the dip of the contact. Any profile must contain data across the contact and enough on at least one side to specify the overall shape and amplitude of the curve. This is necessary in order to provide a check on the realism of the profile using likely contrast values.

Information on two different aspects of this evaluation is given in Figure 2. First, the calculation is based on granite slabs 4 km thick. The contrast is such as to allow comparison with the 8 km model of Figure 1. Thus, given an anomaly of the same amplitude (approx. 160-170 $\mu m/s^2$) the gradients for the shallower feature (higher contrast corollary) are much steeper. Secondly, the model has been recalculated with the insertion of a band of denser metamorphic rocks along the contact zone. This results in a distortion in the profile of up to 20 $\mu m/s^2$ and a shift of the entire



POSITION OF CONTACT
WATERHOUSE PROFILE
WEST
EAST
2 km
20 μm/s²
SMOOTHED
OBSERVED
REAL
stn 51
52
OBS-REGIONAL (RESID)
stn 504

Figure 3

5 cm

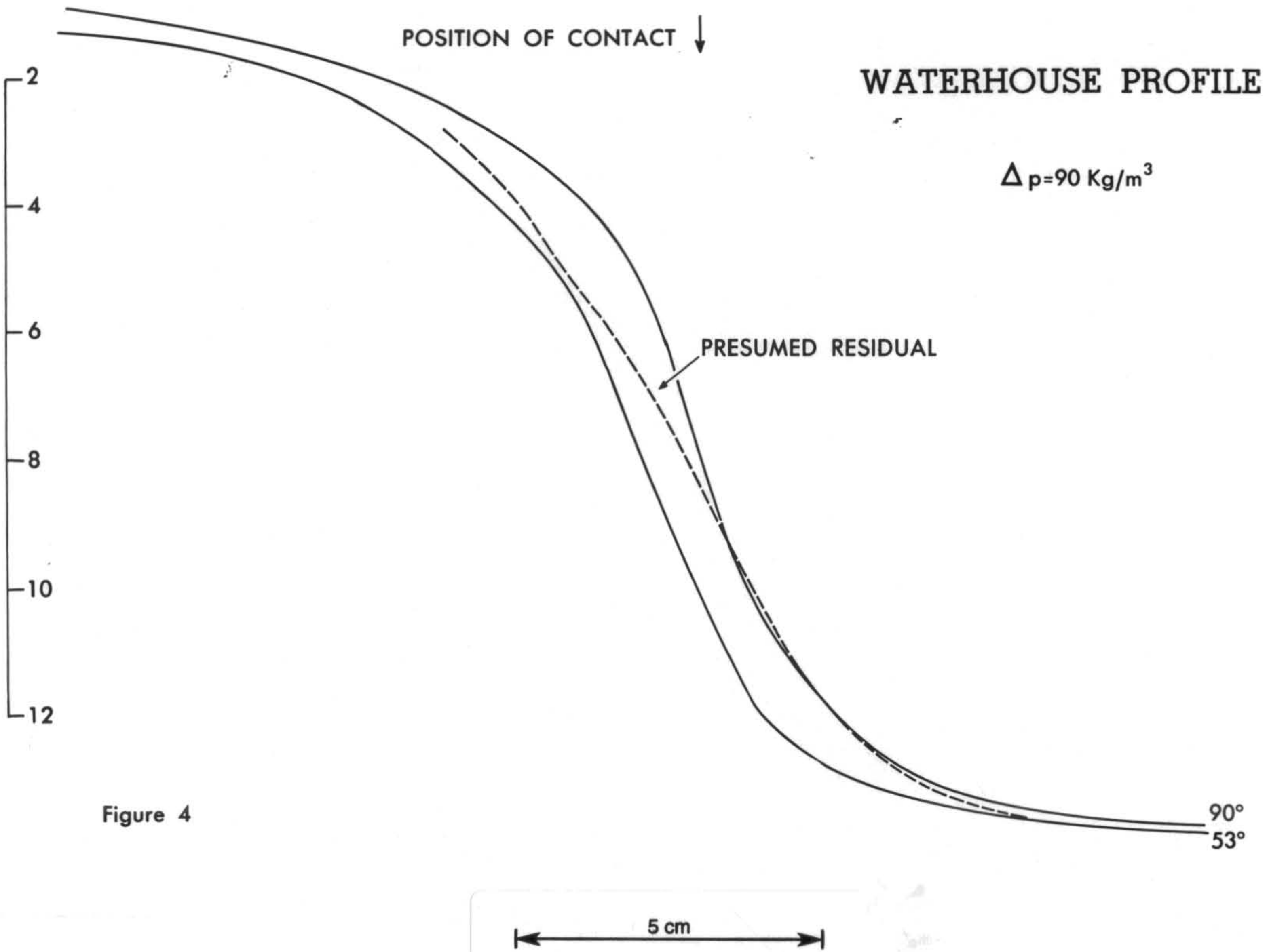
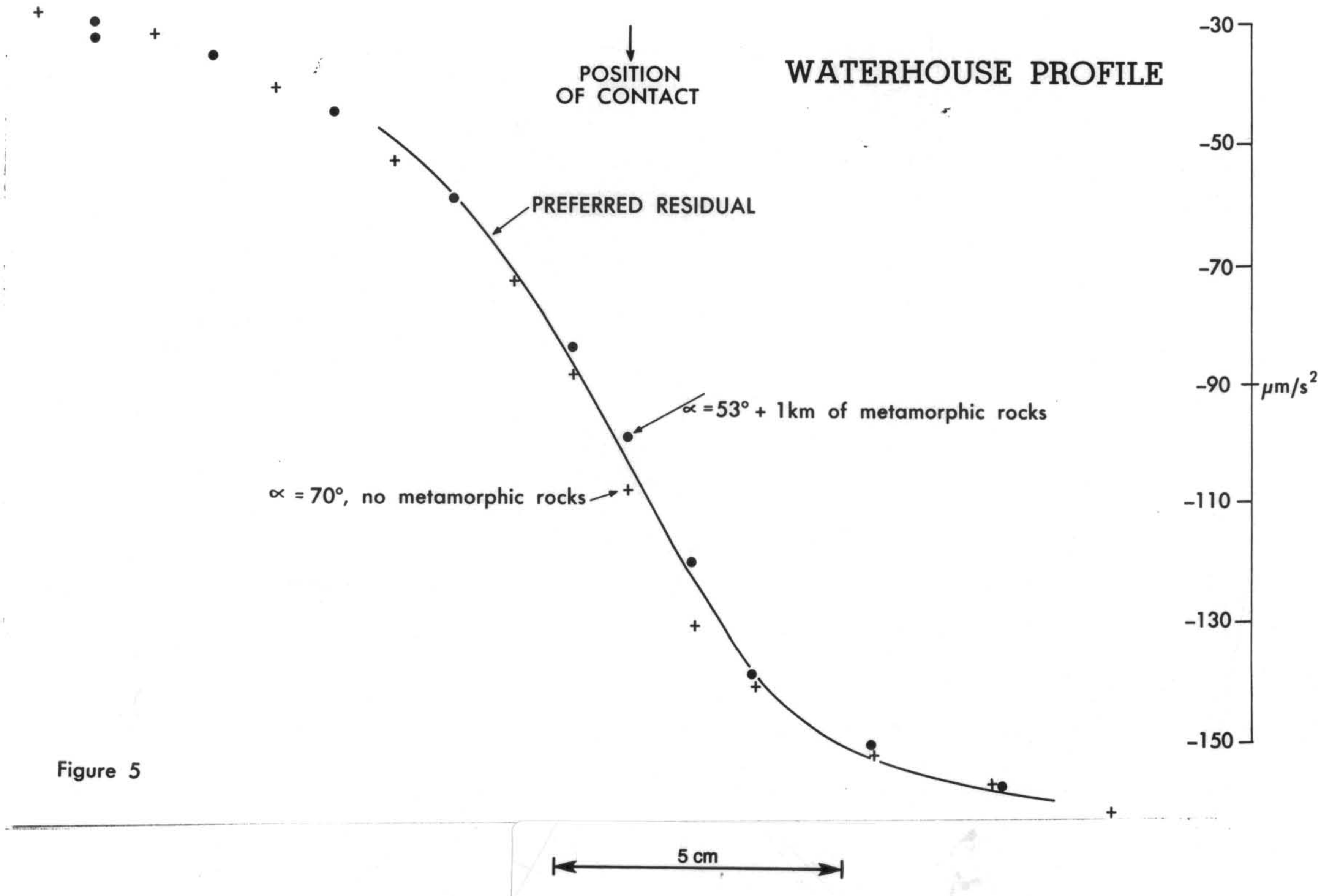

WATERHOUSE PROFILE
POSITION OF CONTACT
$\Delta p = 90$ Kg/m^3
PRESUMED RESIDUAL
2
4
6
8
10
12
90°
53°
5 cm

Figure 4



POSITION OF CONTACT
WATERHOUSE PROFILE
PREFERRED RESIDUAL
∝ =53° + 1km of metamorphic rocks
∝ = 70°, no metamorphic rocks
-30
-50
-70
-90
μm/s²
-110
-130
-150
5 cm

Figure 5

profile to the right. The shift, for the case $\alpha = 90°$, is 600 m but would vary for shallower dips.

Figure 2 also includes a profile calculated by the prism model. The slight deviation between the two profiles results from the miscellany of approximations made in the measurement of angles and distances in the wedge method whereas the specifications were wholly computerised in the prism method. Unfortunately the prism programme applies only to rectangular forms. Consequently similar slight inaccuracies may be present in the profiles of Figure 1.

EVALUATION OF PROFILES

Bridport-Gladstone Road, Waterhouse (fig. 3)

The Waterhouse profile is the best controlled section of the set selected for this evaluation. Sixteen stations lie on the profile. It will thus be used as a reference for the other more doubtful sections. The several real problems in this analysis are clearly indicated in Figure 3.

(1) The real observed profile is fairly smooth but contains small local anomalies of up to 6 $\mu m/s^2$. These can be directly related to variations in sand cover. Terrain effects do not contribute to these anomalies. The observed profile has been smoothed as indicated.

(2) The overall sweep of the curve reflects the granite-sediment contact contrast but is curiously distorted upward to the east and sharply downward to the west. The latter effect is due to the presence of Tertiary sediment and deep weathering basins in the Bridport granodiorite. The downturned section of the profile has thus been ignored but some real features may be concealed in the observed curve near station 52.

(3) Consideration of the regional gradients across the Waterhouse region (Leaman and Symonds, 1975, fig. 2) provides an explanation for the eastern upturn since there is a large regional component in this portion of the profile. It is not possible, however, to produce a wholly satisfactory residual profile as a result of the orientation of the traverse, the contact and the sweep of the regional contours. Figure 3 shows the range of possibilities and significant discrepancies arise only at the eastern end of the profile. The lower curve is that favoured by the author as being most realistic in view of the scale of the anomalous interfaces.

If Figure 3 is compared with the test Figures 1 and 2 several observations may be made (Figures 1 and 2 were scaled to match Figure 3 so that this discussion would be possible for the most reliable profile).

Compare Figures 2 and 3: Matching the contact position the gradient at Waterhouse is much less than that calculated for $D = 4$ km. The profile is shifted to the left when the lower tails are matched and had the profile been continued, and unaffected by light sediment to the west, it would have been about the right scale. On the basis of $D = 4$ km, $\Delta\rho = 100$ kg/m^3 the match is quite poor, the fit being fair to good east of the contact but poor elsewhere. A dip of 90° is implied east of the contact, but only about 45° west of it. Since the profile is incomplete it might be argued that the density contrast is not appropriate or that the curves used for comparison have an excessive amplitude. *Figure 4* presents the same curves (from (fig. 2) and the presumed residual profile but with a density contrast of

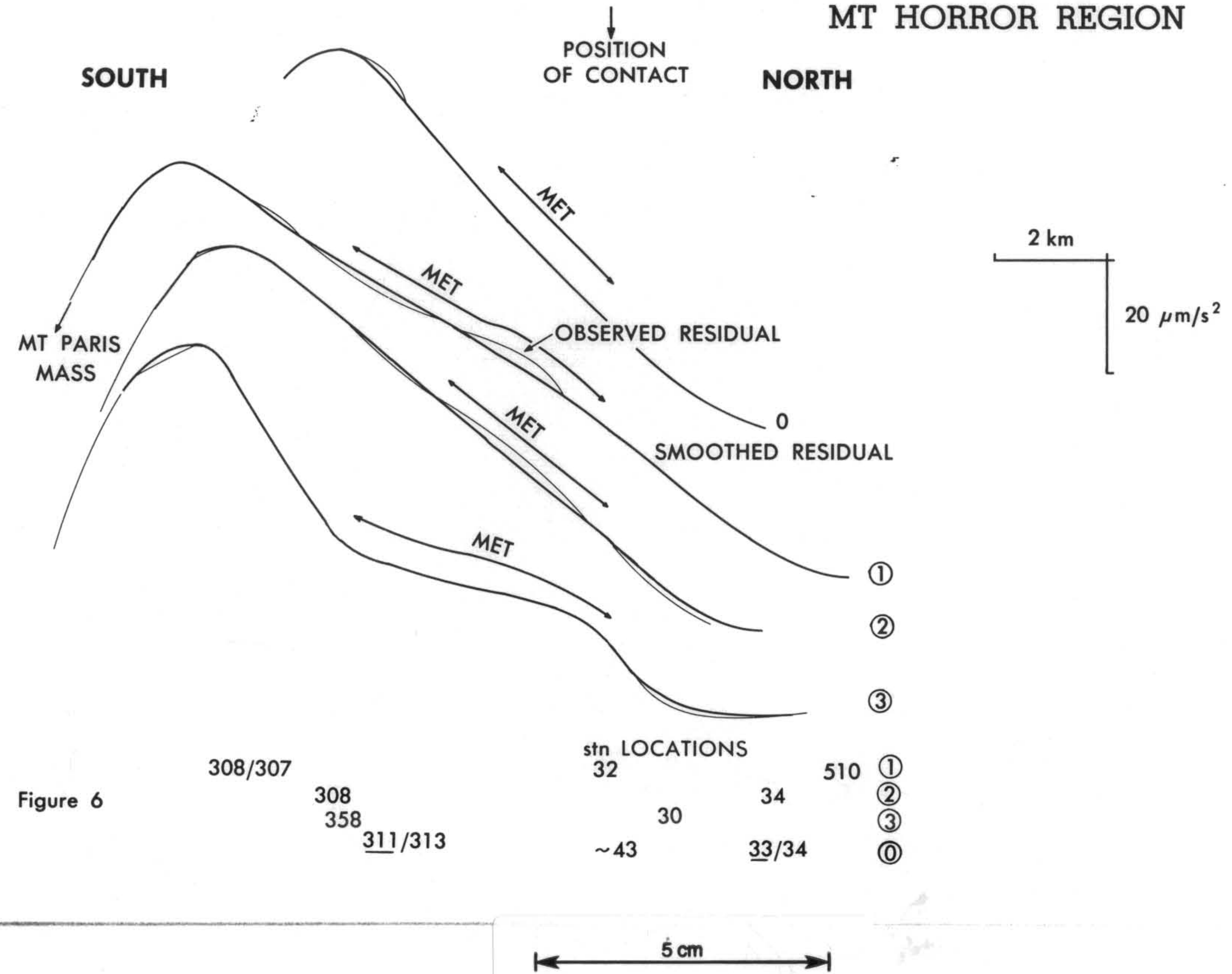

MT HORROR REGION
SOUTH
POSITION
OF CONTACT
NORTH
MET
MET
MET
MET
MT PARIS
MASS
OBSERVED RESIDUAL
SMOOTHED RESIDUAL
0
①
②
③
2 km
20 μm/s²
stn LOCATIONS
308/307
32
510 ①
308
34 ②
358
30 ③
311/313
~43
33/34 ⓪
5 cm

Figure 6

90 kg/m^3. The match is again quite poor, but clearly the dip implied is between 60 and 90°. It is not 90°, however, since the overall gradients are quite inadequate.

Compare Figures 1 and 3: Matching of the contact position results in an excellent fit with the 70° curve from station 52 to a point 2 km east of the contact. The upper tail and maximum gradient section match well, as does the extremity of the lower tail. Where Figure 3 indicates two possible residual profiles, the 70° curve is almost centred between them.

It is therefore implied that the contact extends for at least 8 km at an average dip of 70° and average contrast of 55 kg/m^3. However, this interpretation neglects the presence of a metamorphosed contact zone. Note that Figure 2 also indicates the effect of a dense skin of metamorphic rocks in the contact for dips of 53° and 90°. In the case of the lower dip the resultant curve is very similar to the uncomplicated 90° curve. In each case it is assumed that the increase in density contrast due to metamorphism is uniform and 90 kg/m^3. These assumptions may not be justified but can provide an indication of the maximum effect since the contrast is unlikely to exceed the value chosen overall.

Figure 5 provides a comparison for the above using Figure 1 as a base. Calculation points for the matching 70° curve and the 53° curve with metamorphic rocks are shown with the residual profile. The lower angle plus metamorphic rocks yields an improved result.

A narrow range of interpretations is thus possible depending on the precise impact of metamorphism on the intruded rocks.

(1) The dip of the contact cannot significantly exceed 70°.
(2) The dip of the contact cannot be less than 53° given the general approximate width of metamorphism and the extreme contrast used.
(3) Lesser contrasts or thinner zones imply that the dip would be nearer 70° than 53°.

Given the likely relative patchiness of the material and its bearing on the density assumptions the dip of the contact is probably 65 ±5°.

Mt Horror (fig. 6)

Four profiles have been extracted from the regional residual map and these are shown in Figure 6. Sufficient station numbers are provided to indicate the approximate position of the profiles. In view of the scatter of stations in the region and the variation in width of the metamorphic zone these profiles are as typical as possible. Profiles 1 and 3 are virtually north-south, profile 0 tends slightly west of south and profile 2 about NNW. Profiles 1 and 3 intersect the widest outcrops of thermally metamorphosed rocks and profile 0 the narrowest just west of Mt Horror. Profile 2 passes through Mt Horror.

Each profile indicates an anomaly amplitude of about 90 $\mu m/s^2$. In each case the anomaly is terminated to the south by the abrupt effect of the Mt Paris mass. It is quite clear from these profiles that the Mt Paris mass has a far steeper margin than the main pluton north of Mt Horror (see next section).

As the profiles are based on relatively sparse information the gradients indicated can only be approximate. As a result calculation or matching

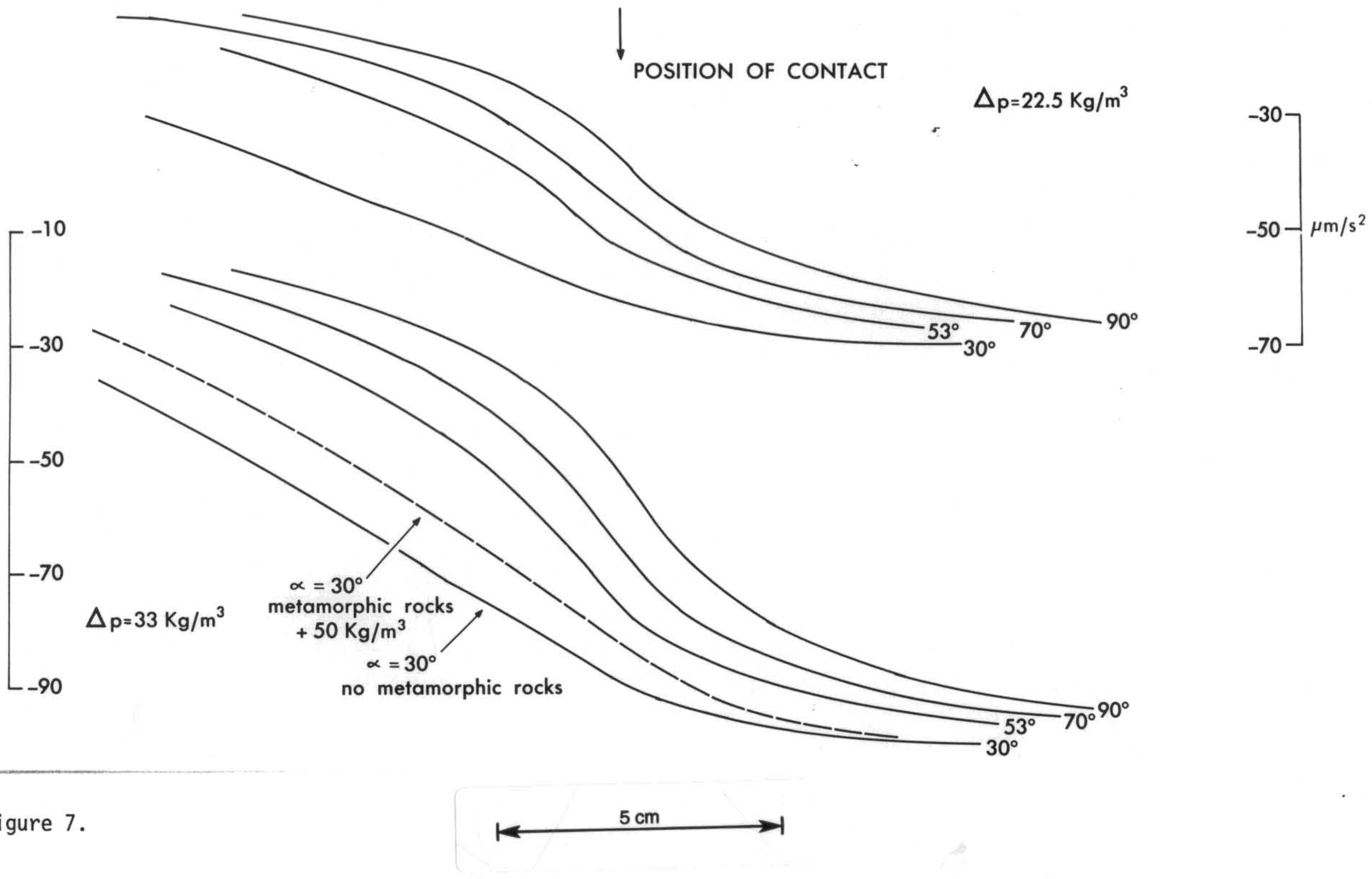


Figure 7.

26-11

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of these profiles is difficult and uncertain. Analysis by calculation and reference curves (fig. 1, 7) suggests that:

For line 0 the maximum possible dip is about 35°, $\Delta\rho$ >40 kg/m^3, D >8 km.

For line 1 the margin is compound with a shallow initial dip of more than 30°, and possibly as high as 70°, but with a substantial reduction to about 20° for at least 3-4 km. The ultimate dip is 25-30°. $\Delta\rho$ ∿40 kg/m^3.

For line 2 the margin is again compound with an initial dip of 35-40° reducing to about 30°, $\Delta\rho$ ∿40 kg/m^3.

For line 3 the margin is clearly compound. The initial dip may be as high as 50° for about 500 m and thereafter very low, 10-15° for about 3-3.5 km. The ultimate dip is at least 45°. $\Delta\rho$ >40 kg/m^3.

The above interpretations neglect the influence of near-surface denser thermally metamorphosed materials overlying such shallowly dipping interfaces. The values quoted should be considered maxima.

If allowance is made for a metamorphic zone the following limits may be imposed:

Line 0: minimum dip at maximum contrast, 30°.

Line 1: confused interpretation depending on options used. Minimum dip 20-30°. The interpretation including a metamorphic zone implies an overall dip of 25° but with a steeper and localised marginal dip.

Line 2: minimum initial dip: 30-35°. Minimum overall dip 25°.

Line 3: confused interpretation, likely minimum dips 40-45°, 10°, 45°.

The soundest interpretation is that given for line 0 and in order of decreasing confidence, line 2, line 1, line 3.

The width of the metamorphic zone has been marked on Figure 6 for each of the lines and there is fair correlation between the overall dip angles and the lineal width of the zone for each section:

Line 0: 30-35°, 8 km; zone 2 km. It is noted that line 0 is critically placed and is drawn through a locality in which the zone fans from 1.5 to more than 2.5 km.

Line 1: 30+° very restricted; 20-25°, 8 km; zone 4.5 km.

Line 2: ∿35° limited; 25-30°, 8 km; zone 3 km.

Line 3: >40° (∿500 m?); ∿10°, ∿3 km; >45°, 8 km; zone 4.8 km.

Obviously the extent of thermal metamorphism is partly governed by the scale of the steeper marginal effects where these are present.

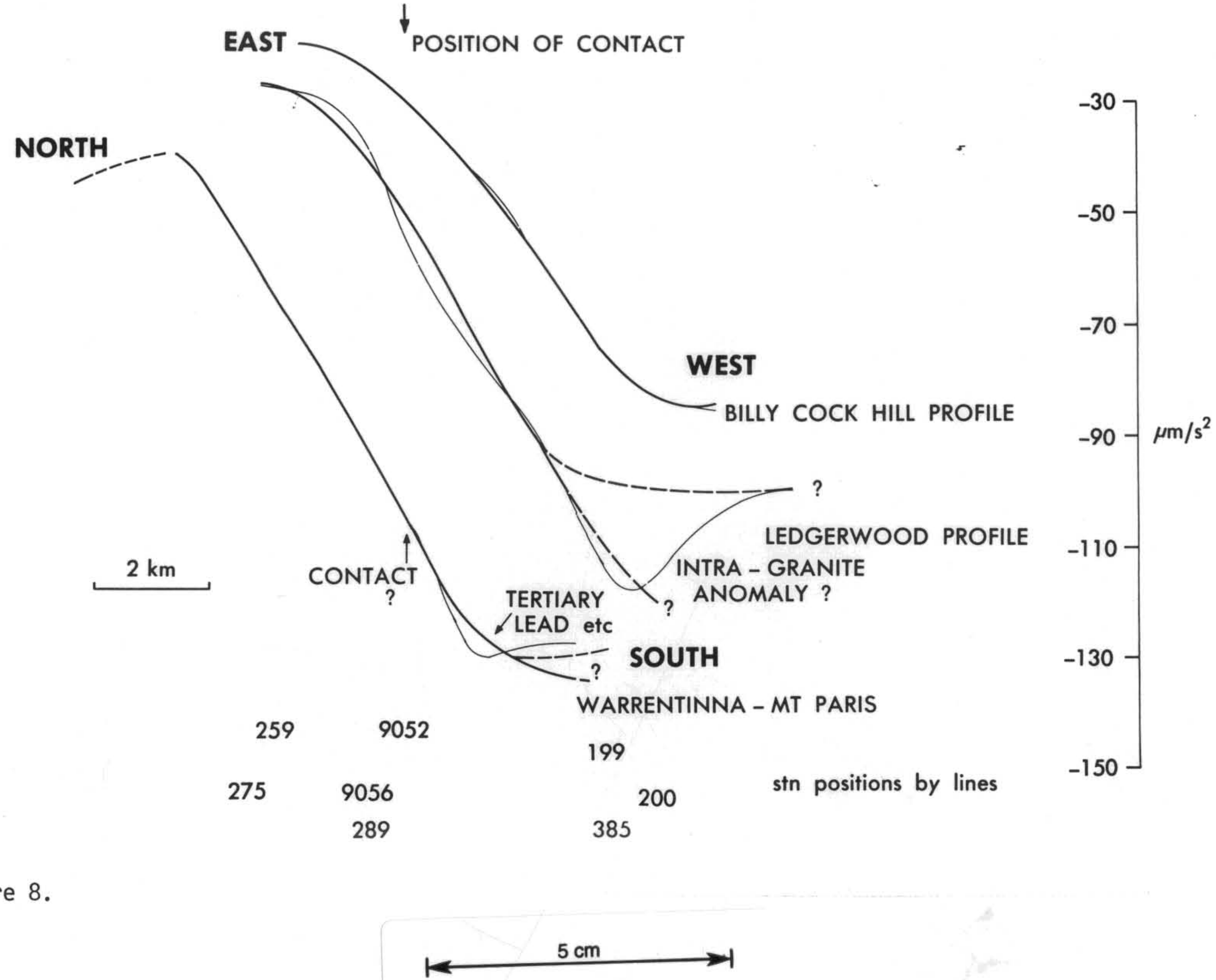
POSITION OF CONTACT
EAST
NORTH
WEST
BILLY COCK HILL PROFILE
?
LEDGERWOOD PROFILE
INTRA – GRANITE
ANOMALY ?
?
2 km
CONTACT
?
TERTIARY
LEAD etc
SOUTH
?
WARRENTINNA – MT PARIS
259
9052
199
275
9056
200
289
385
stn positions by lines
-30
-50
-70
-90
-110
-130
-150
μm/s²
5 cm

Figure 8.

Warrentinna-Mt Paris (fig. 8)

A single line has been drawn across Frasers Flats based on the regional coverage. The discussion relating to the Mt Horror region referred to the very strong negative gradients at the southern end of lines 1-3 as the Mt Paris mass is approached. The section offered in Figure 8 is considered representative of the anomalies on the northern side of this intrusive body.

The profile cannot be simply interpreted due to lack of adequate tails to the anomaly. Limitations on the absolute size of the Mt Paris mass mean that the anomalies noted over it contain substantial edge and side effects and do not obviously provide base level figures. Similarly, the termination of the anomaly near Warrentinna by the much shallower dipping main intrusion north of Mt Horror means that the amplitude of the entire anomaly is unknown. Thus only steepness of gradient can be reliably matched and the dip inferred presuming reasonable assumptions for contrast and metamorphic zone.

Given reasonable values for contrast the interface would extend in depth more than 4 km and the overall dip thus implied is less than 50° (compare fig. 2, 4, 8). Comparison of Figures 1, 4, 8 implies an overall contrast of about 80 kg/m^3. Analysis with such a contrast suggests a dip of 45-53° without a metamorphic zone and nearer 45° with such a zone (assumptions as for the Waterhouse profile).

An alternative profile drawn slightly to the west confirmed the above conclusion and implied that the maximum realistic value was no more than 50°.

A key difficulty with this entire interpretation is that the precise position of the contact is unknown. As marked in Figure 8 the contact is placed 100 m north of the Ringarooma River, an average position. However, small pockets of metamorphosed material occur on the south bank to the east of the section and it is possible that the contact lies as much as 200 m to the south of the river position in this section. Thus the contact position could be in error by 300 m toward the south. A similar error of 600 m is possible toward the north. These variations are crucial. In the former case the calculated dip would be reduced to 45° (maximum) and in the second case increased to 60-65° (maximum).

Legerwood (fig. 8)

Two parallel profiles have been drawn across the apparently narrow Legerwood contact zone; one near Billycock Hill and the other through Legerwood. Both are influenced by the Tertiary lead to the east and neither profile is complete. Consequently assumptions have been made concerning anomaly scale and contrast.

The Legerwood profile is complicated by the intra-pluton anomalies and it is difficult to assess a true base level for the anomaly on the Scottsdale Batholith and two versions are indicated in Figure 8. The upper suggestion is incompatible with a reasonable contrast and the observed gradient. Accepting a profile such as the lower suggestion and noting the position of the contact there can be no doubt that the dip of this margin exceeds 80-85° and that the offset of the gradient toward the granite is due to the presence of the, obviously, significantly altered contact zone. It is possible that this margin is vertical.

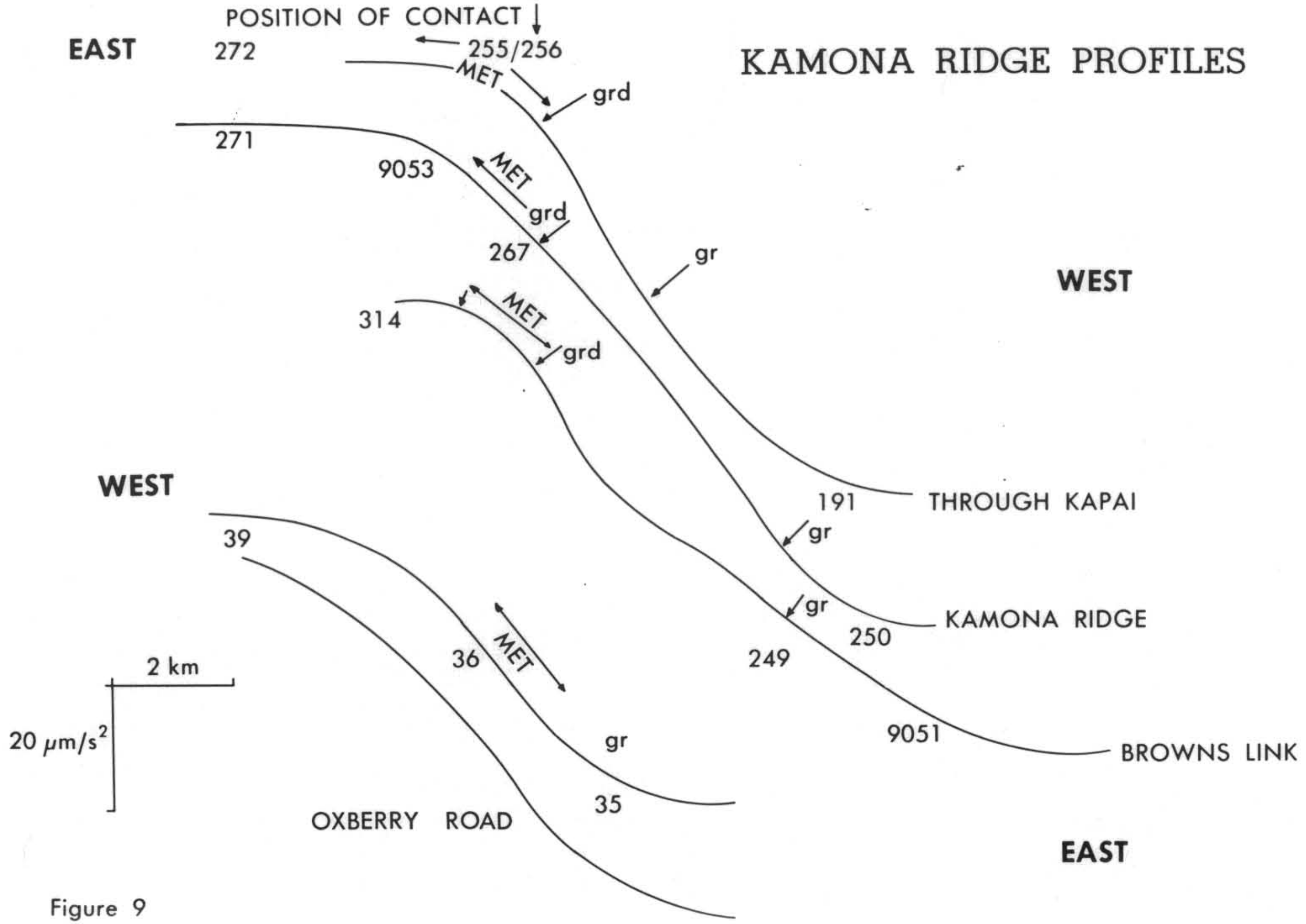

Figure 9

5 cm

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In the Billycock Hill region the metamorphosed rocks have a much greater apparent surface expression. The profile is well formed but not easy to fit. However, if the general contrast is about 33 kg/m^3 (see fig. 7) and the contact position is matched then the gradients imply a dip for the margin in excess of about 80° provided that the metamorphic rocks introduce a local contrast of about 80-90 kg/m^3. If the local contrast were lower (50-60 kg/m^3) then the margin could be nearly vertical. Any mismatches between an offset 90° curve (from fig. 7, for example) due to a contact zone effect and the observed profile as shown in the regional coverage, could be due to either inadequate specific cover or the nearness of the Kamona granodiorite. However external influences have affected this profile the anomaly amplitude, gradients and margin position all suggest a very steep dip.

Oxberry Road (fig. 9)

Two short profiles have been drawn across the contact exposed along the central portion of Oxberry Road. A further important contact has been mapped at the western end of the road near the Great Forester River but unfortunately exposure, station distribution and structural complexity make this very difficult to treat with the data available (compare structure with Kamona sections and related discussion).

The upper profile (fig. 9) is a simple step curve the amplitude of which reflects a contrast of about 20-25 kg/m^3. However, if the profile is matched with the curves of Figure 7 it will be noted that the tails match with the 53° curve but the match elsewhere is poor. The lower profile (fig. 9) implies a contrast of 30-35 kg/m^3. Comparative matching with Figure 7 indicates a good match at about 65-70°.

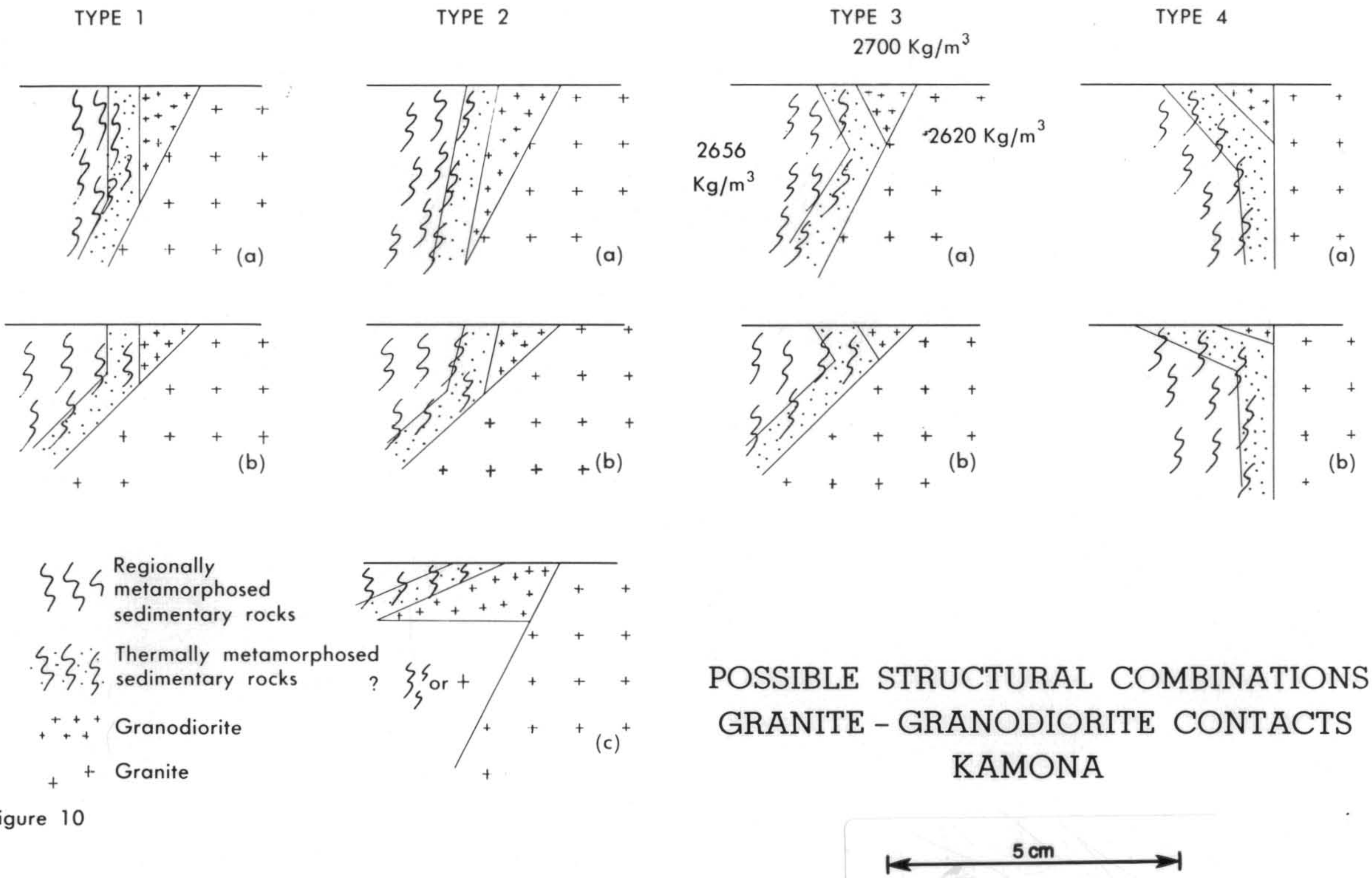
The profiles presented here are related and simply indicate extremes of gradient behaviour near Oxberry Road. Increased station coverage would of course resolve the variations indicated.

The first interpretations offered above (53-70°) are based on simple matching and ignore the effects of full contrast scaling and the metamorphosed contact rocks. Inclusion of the latter factor depresses the estimated angles to about 45-55° although the evaluation of the upper profile is quite uncertain in this respect. Although the station control is only fair the steepness of interpolated gradients does imply a dip in excess of 55°. The dip range is 45-70° but more probably 55-70°. These values are consistent with, if not as well controlled as those of profile 1 at Waterhouse across the same contact further north.

Kamona Ridge (fig. 9)

Three profiles have been drawn across the Kamona Ridge. Each reflects a compound structure. The overall anomaly is related to the granite-sediment boundary but a wedge of granodiorite is present near this boundary which modifies all gradients. Inspection of the regional map shows that the residual anomalies do not have the same form as the sketch geology given in Figure 3 of Leaman and Symonds (1975). Recent mapping has proved that the contact between granodiorite and sedimentary rocks is offset up to one kilometre to the east a little north of Kapai. The sweep of the contact directly parallels the form of the 30 $\mu m/s^2$ contour. In this zone the contact metamorphic zone is narrowed significantly.

The compound character of the profiles is most clearly seen for that across Browns Link but some of the effect may be due to uneven coverage.



POSSIBLE STRUCTURAL COMBINATIONS GRANITE – GRANODIORITE CONTACTS KAMONA

Figure 10

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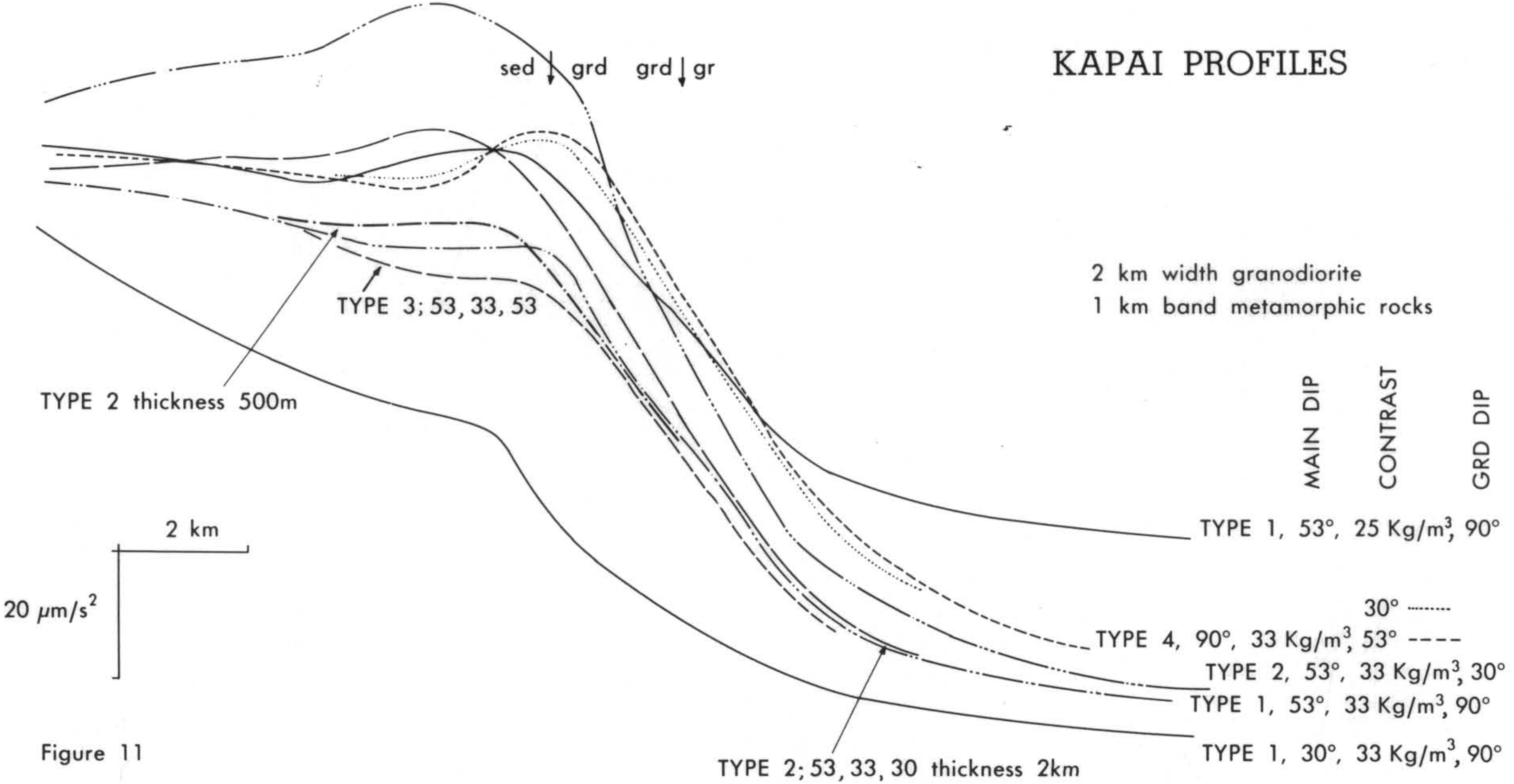

KAPAI PROFILES
sed grd
grd gr
2 km width granodiorite
1 km band metamorphic rocks
MAIN DIP
CONTRAST
GRD DIP
TYPE 3; 53, 33, 53
TYPE 2 thickness 500m
2 km
20 μm/s²
TYPE 1, 53°, 25 Kg/m³, 90°
30°
TYPE 4, 90°, 33 Kg/m³, 53°
TYPE 2, 53°, 33 Kg/m³, 30°
TYPE 1, 53°, 33 Kg/m³, 90°
TYPE 1, 30°, 33 Kg/m³, 90°
TYPE 2; 53, 33, 30 thickness 2km

Figure 11

The southern profile through Kapai appears more 'normal' and the amount of granodiorite exposed along the section is minimal.

Kapai profile

Several observations may be made directly. The overall contrast indicated given a deeply rooted granite is about 30 kg/m^3. The profile is oversteepened for this contrast and offset more than a kilometre to the west of the granodiorite-sedimentary rock contact. The exposed width of granodiorite is 2 km. Since the granodiorite is known to be denser than the granite by about 80 kg/m^3 it will distort the field in the same way as the band of denser metamorphosed contact rocks. Thus the gradients must reflect this effect. A further complication is introduced by the regional interpretation given by Leaman and Symonds (1975) which indicates a maximum thickness for the granodiorites of about 4 km. The contact problem thus evolves into the resolution of two dipping igneous interfaces.

Figure 10 presents in simplified form the four basic alternatives for the structure. The main granite body may be considered to have a margin which is either vertical or dips toward the intruded rocks whereas the granodiorite has been termed sheet-like and could dip either way. Further, since the margin under discussion involves a major intrusion, the Scottsdale batholith, it is likely from comparison with sections 1, 3, 4, 5 that the predominant dip will be more than 45-50°. By contrast the marginal dips associated with the granodiorite body could range from 10-90°. Consequently at least two variations have been considered for each model type in order to assess limits of effects. Most of these are shown in Figure 11.

Three type 1 profiles have been calculated. The first, using a contrast of 25 kg/m^3, has been included by way of comparison only since the anomaly scale at D = 8 km is inadequate (compare Kapai profile, fig. 9). A value of 33 kg/m^3 is more appropriate for models of the depth scale indicated. Both classes of type 1 are presented using dip angles of 30, 53° for the major contact. It will be noted that the plateau and bulge effects apparent in the observed profiles are generally reproduced. The type 4, 53° model can be considered a limiting type for this variation of structure. However, both type 4 models produce a greater contact bulge anomaly than is observed in any profile. Since the contrasts employed seem wholly compatible with known density distributions (*e.g.* granite, 2620 kg/m^3; sedimentary rocks, 2655 kg/m^3; granodiorite, 2700 kg/m^3; metamorphic rocks, 2700 kg/m^3) and could even be a little low for the last mentioned, it seems certain from the form of the profiles that type 4 structures do not occur. There are no bulges of the type calculated and the profiles are too far offset to the right (cf. fig. 9).

Of the type 2 structures only the third has been plotted since the first two differ only marginally in total mass distribution from type 1. It is quite apparent from this model that should the granodiorite have a shallowly dipping contact then the slab thickness cannot approach 4 km. The calculations for thicknesses of 2 km and 500 m are also offered. The 2 km profile may be considered as unsatisfactory as the type 4 profiles. However, the two type 3 profiles which produce very similar results, although only one curve is plotted in Figure 11, the type 1 53°, 90° curve and the type 2, 30°, 500 m slab all produce anomaly profiles which are quite compatible with that observed.

When the profile indicated in Figure 9 is matched with Figure 11 and the contact positions fitted, the observed profile agrees almost perfectly with the 500 m slab model as calculated. There is a very slight left offset

KAMONA RIDGE INTERPRETATIONS

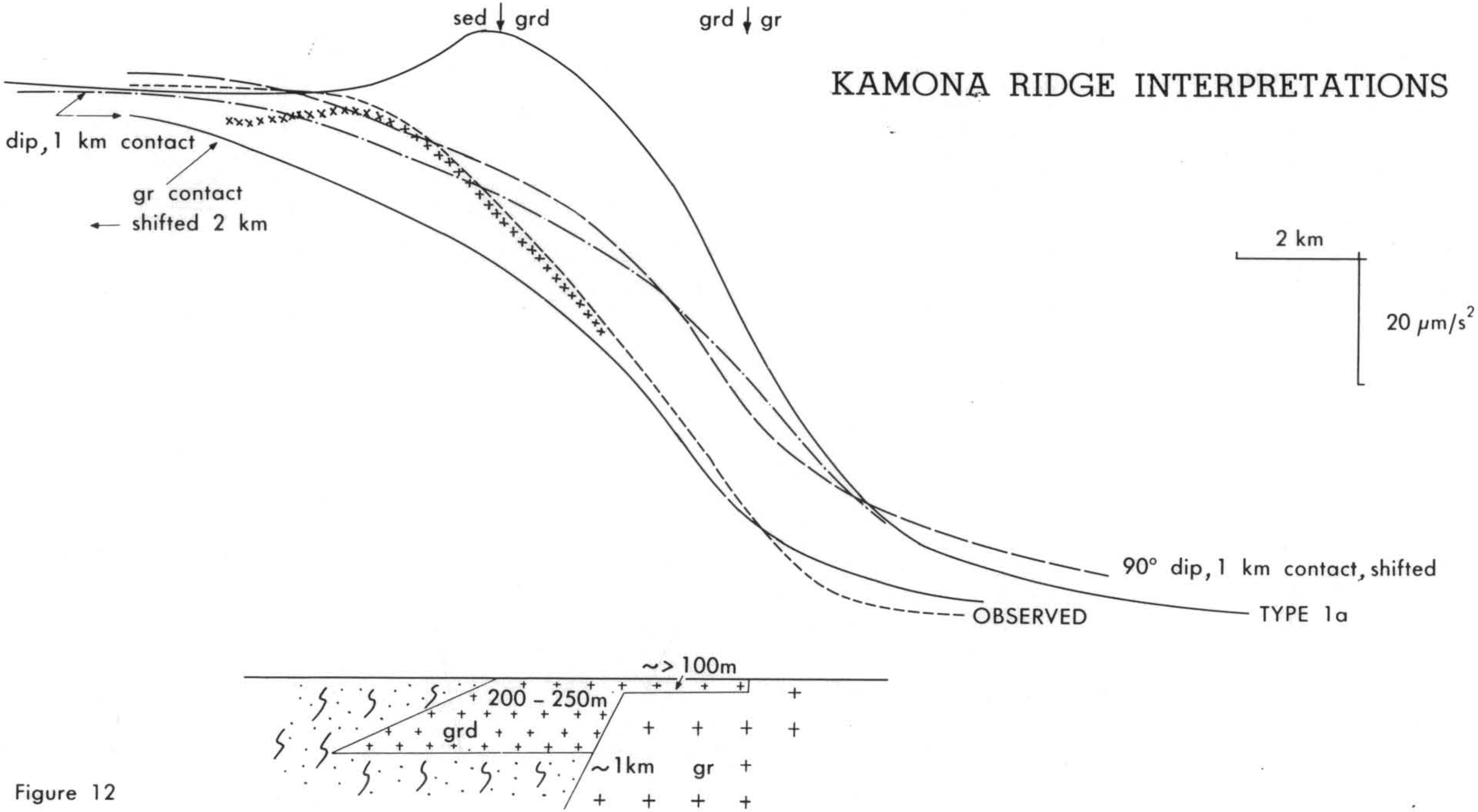
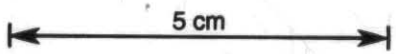


Figure 12



in the curve which suggests that the overall dip might be nearer 50°. Model types 1a, 2a, 2c - 500 m, 3 a could produce comparable anomaly distributions and the method cannot resolve them. However, it will be noted that a one kilometre band of contact rocks has been included in the models and since the exposure is far wider than this 2c is the likely solution. Should the contact rocks produce an insignificant effect the dip of the main contact could not exceed 70°. The dip range for the main contact is thus 50-70° but is most probably 50-55°. The granodiorite contacts cannot be better specified.

Kamona Ridge profile

The features of this profile are slightly more pronounced than for the Kapai profile due to the greater width of exposure of granodiorite but are mirrored in model types 1a, (2a), 2c, 3a of Figure 11. Thus only these structural types will be developed. The gradients observed in the profile can only be generated by dips in excess of 50° and so model types 1b, 2b, 3b may be excluded. If structure 1a is recalculated for a 4 km outcrop of granodiorite in a regional contrast of about 33 kg/m^3 then the anomaly amplitude is achieved as is an approach to maximum gradients but the entire profile is offset about 2 km to the east (fig. 12). This situation could only be improved by considering either a thin slab of granodiorite with a complex shelving mass of granite beneath or a development of model type 3a. Simple thinning of the granodiorite mass is not a solution as may be deduced by comparison of the observed profile and the basic 53° profile. No model of type 2a could reduce the deviation. No variation of any structure could resolve the negative deviation in the centre of the profile. For comparison and reference the 53° line has been redrawn in Figure 12 to ignore the outcrop expression of the granodiorite and displace the granite contact by 2 km. The improved match suggests that the granodiorite is very thin for most of its exposed width but thickens and dips eastward. Thus a compound structure between 2a and 2c is implied. A 90° reference line has also been added which clearly shows that the main contact dips at an angle of the order of 50-55°.

A possible structure for the granodiorite mass is indicated in Figure 12 but definite resolution of alternatives is not possible. It is clear that the mass dips shallowly (∿30° or less) to the east and the thin zone of metamorphism in the region may reflect either smaller heat capacity of the granodiorite or relatively small volume.

Browns link profile (fig. 9)

The gradients associated with this profile suggest a shallower dip for the main contact although part of the reduction may reflect a slight decrease on contrast. The profile also contains a definite bulge near the granodiorite-sedimentary contact. If the profile is matched with Figure 12, and assuming no hidden contact shift, then the main contact has an implied dip of about 45°. The section also suggests that the granodiorite is thin. The dip and bulge may be false features since an inspection of station coverage shows that control for this section is not good.

CONCLUSIONS

Given the variable character of the basic regional gravity data coverage, the limits of the method and the information available a considerable amount of structural information has been deduced. Some profiles could be improved with more data but more observations would not improve the resolution of others. The general density contrast ranges between 25 and 55 kg/m^3

and implies that the regional bulk density of the intruded rocks is not more than 2675 kg/m^3 if the granite density (overall) is 2620 kg/m^3. Thermal metamorphism has elevated the 2675 value to more than 2700-2720 kg/m^3 which is comparable with the density of the granodiorite. This fact compounds the problems of dip resolution.

In general the granite contact dips are very steep, except in the region of Mt Horror. Granodiorite contact dips are very uncertain since the bodies are thin and variable.

Waterhouse contact	:	65° ±5°
Around Mt Horror	:	W→E 30-35°
		>30°, 20-25° (stepping)
		35°, 25-30° (stepping)
		>40°, 10°, >45° (stepping)
Warrentinna-Mt Paris	:	45-65°
Legerwood	:	80-85°
Billycock Hill	:	>80°, ∿90°
Oxberry Road	:	45-70°, probably 55-70°
Kapai	:	50-70°, probably 50-55° toward granodiorite contact
Kamona Ridge	:	50-55° granodiorite $\lesssim$30°
Browns Link	:	∿45°

The upgrading of the Waterhouse profile did improve the quality of the interpretation but it is doubtful whether upgrading of any others outside the Kamona region would be worthwhile at this stage since the estimates are quite restrictive.

REFERENCE

LEAMAN, D.E.; SYMONDS, P.A. 1975. Gravity survey of north-eastern Tasmania. *Pap.geol.Surv.Tasm.* 2.

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