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DAFTAR ISI

INTERPRETATION OF GROUND MAGNETIC DATA OVER THE NORTHWEST OF Mt. MAUNGAONGAONGA, NORTH ISLAND, NEW ZEALAND

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Abstract

The Maungaongaonga area is located about 15 km SE of Rotorua. It is situated inside a large thermal zone covering the Waiotapu, Waimangu, Waikite geothermal fields which has the largest total area of surface thermal activity in the Taupo Volcanic Zone (TVZ). Topographic modelling of ground magnetic data over the north-western flank of Mt. Maungaongaonga (the Field Farm), however indicated that not all the rocks in this area have been affected by hydrothermal demagnetization. The interpretation of magnetic data suggests that near surface hydrothermal demagnetization in this area follows a zone trending about 50°-60°NE. The extent of this demagnetization zone is mostly consistent with the result of a previous shallow resistivity traversing.

Sari

Daerah Maungaongaonga terletak sekitar 15 km sebelah tenggara kota Rotorua di Pulau Utara, Selandia Baru. Daerah tersebut terdapat di dalam suatu sistem lapangan panas bumi dengan segala aktifitas dan manifestasi panas bumi dipermukaan yang meliputi kawasan Waiotapu, Waimangu dan Waikite disepanjang Zona Volkanik Taupo. Dari hasil pemodelan topografi berdasarkan data magnetik permukaan di daerah barat laut dari lereng Gunung Maungaongaonga (Field Farm), mengindikasikan bahwa tidak seluruh batuan di daerah tersebut terpengaruh oleh aktifitas demagnetisasi hidrotermal. Interpretasi data magnetik menunjukkan bahwa demagnetisasi hidrothermal dekat permukaan terdapat sepanjang zona yang berarah 50°-60°. Hasil interpretasi zona demagnetisasi tersebut mempelihatkan kesamaan dengan hasil lintasan geolistrik pada penelitian sebelumnya.

1. Introduction

I.1. The Geographical Setting of Study Area

The Maungaongaonga area is located about 15 km southest of Rotorua. The study area lies within the NZ Map grid coordinates 2802200 to 2803100 (Easting) and 6314850 to 6316650 (Northing) and included in the NZMS 1:50,000 series sheets U-16 Rotorua. Geomorphology of this area is generally characterized by a rather steep terrain (medium to high relief). The highest peak is that of Mt. Maungaongaonga which is about 825 m above sea level (a.s.l.)

The study area is situated within a large thermal region covering the Waiotapu, Waimangu and Waikite geothermal fields on the eastern side of Taupo Volcanic Zone (Figure 1). This thermal region is associated with an elongated resistivity low extending in the NE-SW direction, where a wide variety of surface thermal phenomena are more or less enclosed by 30 Ω-m contour of Schlumberger AB/2=1000 m apparent resistivity (Bibby, et. al, 1994).

The purpose of this magnetic study is to interpret the ground magnetic anomalies in terms of topographic effect and thermal alteration of rocks in the vicinity of Northwest of Maungaongaonga dacite dome. The interpretation of the ground magnetic anomalies (topographic modelling and 3-D modelling) was conducted along three NW-SE profiles over the NW of flank Mt. Maungaongaonga as shown in Figure 2.

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2. Interpretation of Ground Magnetic Data Over the Field Farm, Northwest of Maungaongaonga Geothermal Prospect Area, New Zealand

2.1. Review of Magnetic Methods Used in Geothermal Exploration

Airborne and ground magnetic methods have been applied as an exploration tool to investigate the structure of a number of geothermal prospects in New Zealand and elsewhere. The target of magnetic surveys for geothermal study is hydrothermally altered rocks at upper level of geothermal reservoir forming a demagnetized zone which normally has a significant magnetisation contrast with respect to the surrounding unaltered volcanic rocks. Over the Taupo Volcanic Zone (TVZ) the airborne magnetic data show an association between most of geothermal fields and magnetic lows (Soengkono and Hochstein, 1996). This phenomenon can be explained by a reduction in the intensity of magnetization of reservoir rocks by the action of hydrothermal fluid (i.e. hydrothermal demagnetization) which alters the primary minerals such as magnetite, titanomagnetite and other ferrimagnetite minerals to non-magnetic minerals such as hematite, pyrite, leucoxene and sphene causing the reservoir rock to become partially or totally demagnetized (Browne, 1982). The demagnetization causes a contrast in magnetic properties between rock within a geothermal reservoir and the surrounding unaltered volcanic rocks. This phenomena was observed, for example, over Mokai and Orakeikorako geothermal fields (Soengkono, 1985, 1993), Broadlands-Ohaaki field (Henrys and Van Dijck, 1987) and also at Rotokawa (Risk, 1985).

2.2. Interpretation of Ground Magnetic Data Over the Field Farm, Northwestof Maungaongaonga GeothermalProspect Area, New Zealand

A ground magnetic survey over the north-western flank of the Maungaongaonga dacite dome, in a farm owned by Mr. Richard Field (the Field Farm), was conducted by Vidanovich (1994). A preliminary 2-D interpretation of the ground magnetic data was conducted by Talebi (1996). No active thermal manifestation was found in this survey area. Furthermore, a shallow resistivity traversing across this area using Schlumberger array with AB/2 spacing of 25 m and 50 m has also been conducted in August 1996 and is reported by Eissa (1996).

2.3. Residual Magnetic Anomalies over the NW of Maungaongaonga

To obtain an appropriate "zero level" for residual anomalies, the average value of the observed total force magnetic field (54,700 nT) was used to estimate the regional field of the study area (Vidanovich, 1994). This value was reduced from the magnetic readings to produce residual anomalies shown in Figure 2. This figure shows that a positive anomaly (anomaly C) occurs at the center part of study area. There is a strong elongated negative anomaly (anomaly A) trending NNW-SSE direction lying to the NE of anomaly C and it is surrounded by several positive anomalies. Another negative anomaly (anomaly B) occur to the west of anomaly C.

2.4. Magnetic Modelling of Topography

Computation of theoretical topographic effects was made by using the MAGTOPO program. The topographic model was constructed by digitizing a topographic map of 1:2,500 scale using grid spacing of 50 metres (Figure 3). The base of the model was made horizontal at 415.6 m (RL) elevation. A constant magnetisation value of 1.7 A/m with declination of 0° and inclination of -62.5° was used to compute theoretical topograhic effects. The contour map of these theoretical magnetic effects over the study area is shown in Figure 4.

2.5. Interpretation of topographic effect

Figure 4 shows the contour map of theoretical magnetic effect of topography over the study area. This figure shows that there are some positive effects over the area to the S and SE of study area, indicating that the positive residual anomalies C and D in the south and south-eastern part of study area (Figure 2) are associated with topographic effects. A correlation is also shown between negative topographic effects at the center part of this area (west of BH-1 in Figure 4) and the strong negative residual anomaly A (Figure 2). Such correlations between theoretical topographic effects and observed residual magnetic anomalies suggest that the rocks forming topography in those areas are magnetic and, therefore, have not been affected by hydrothermal demagnetization.

However, there are other parts of the study area where positive theoretical topograhic effects were not recorded by the ground magnetic survey. Such a case is clearly shown by the magnetic profiles along line 1 (Figure 5; centred at above 6315440, 6315330 and 6315120), line 2 (Figure 6; between 6315100 and 6315350), and line 3 (Figure 7; to the SE of 6315300). It indicates that in these parts of the study area, the magnetization of rock forming the terrain is much lower than that used to compute the topographic effects (1.7 A/m); i.e. the rocks may have been affected by the hydrothermal demagnetization in the past. To obtain a better indication of lateral distribution of the inffered near surface hydrothermal demagnetization, the topographic effects were subtracted from the obeserved residual anomalies and the result is presented in Figure 8.

2.6. Result and Discussion

The inferred lateral extent of near surface hydrothermal demagnetization is drawn in Figure 8 not only by looking at strongly negative contours, but also by looking at the pattern of the observed residual anomalies (Figure 2).

The result of resistivity investigation which was conducted by Eissa (1996) over the NW of Maungaongaonga area provided some information about the possible shallow alteration zone along two traversing profiles (see Figures 8 and 9). These figures show that the lateral extent of near surface hydrothermal demagnetization inferred from this magnetic study is mostly consistent with shallow resistivity traversing result from Eissa (1996).

The lateral distribution of shallow hydrotermally alteration over the Field Farm inferred from a combination between result from previous resistivity investigation and 3-D topographic effect modelling of ground magnetic data is presented in Figure 9. It shows that shallow hydrothermal alteration appears to follow a zone trending about 50^0-60^0 NE.

3. Conclusion

Magnetic modelling of topography over Mt. Maungaongaonga indicates that a positive residual total force magnetic anomaly should have been observed if the rock forming this volcanic cone are still fresh and, therefore, magnetic. (Maximum anomaly of 350 nT, if the average total magnetisation of the rocks is 1.7 A/m).

Ground magnetic data indicate that not all the rocks in the NW flank of Mt. Maungaongaonga (the Field Farm) have been affected by hydrothermal demagnetization. The lateral extent of near surface hydrothermal demagnetization in this area was interpreted using 3-D topographic modelling of the ground magnetic data. The result is mostly consistent with result of previous shallow resistivity traversing.

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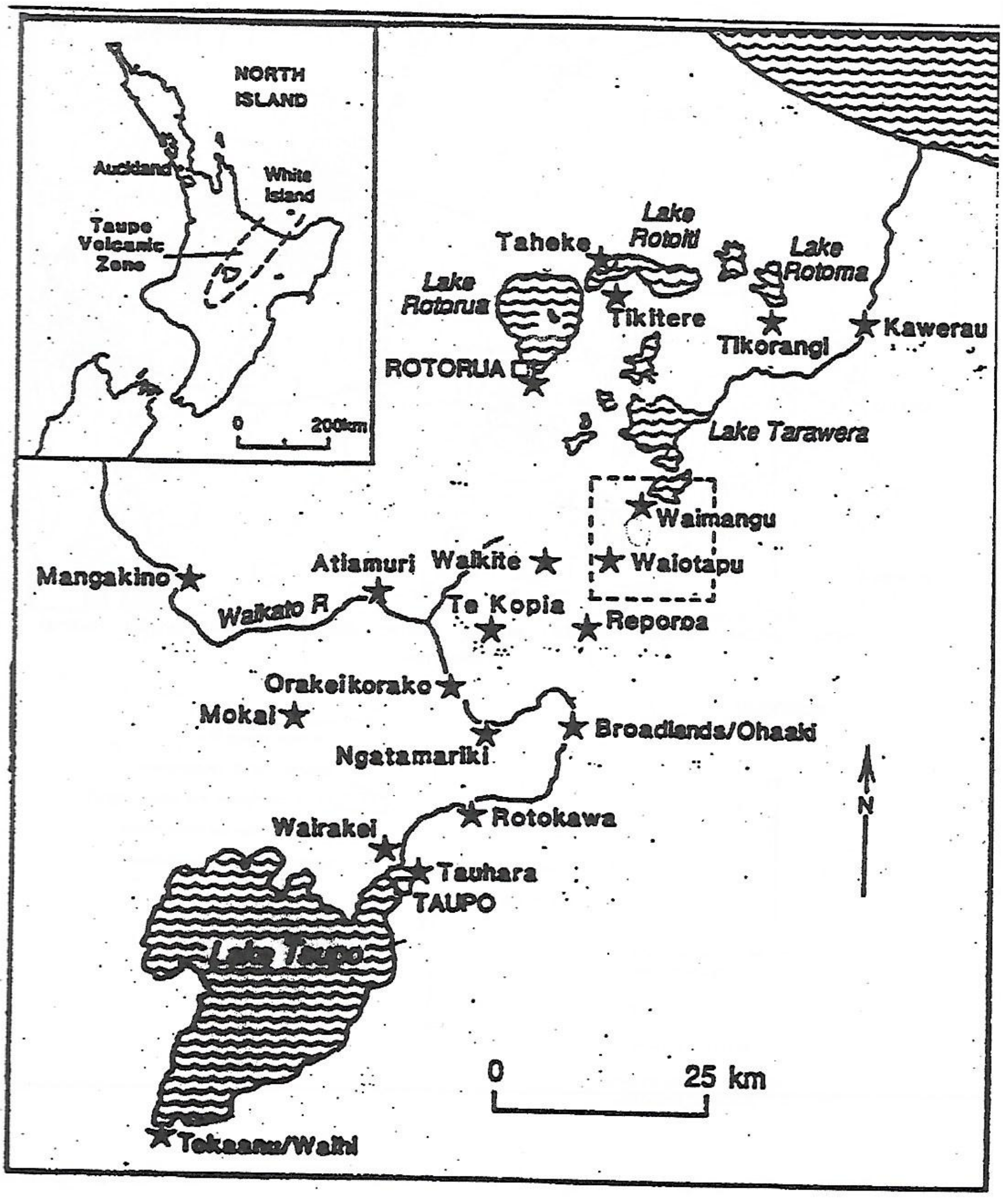

Figure 1: The Taupo Volcanic Zone showing the approximate distribution of geothermal system (shown by stars). The area of this study is outlined (from Bibby et.al, 1994)

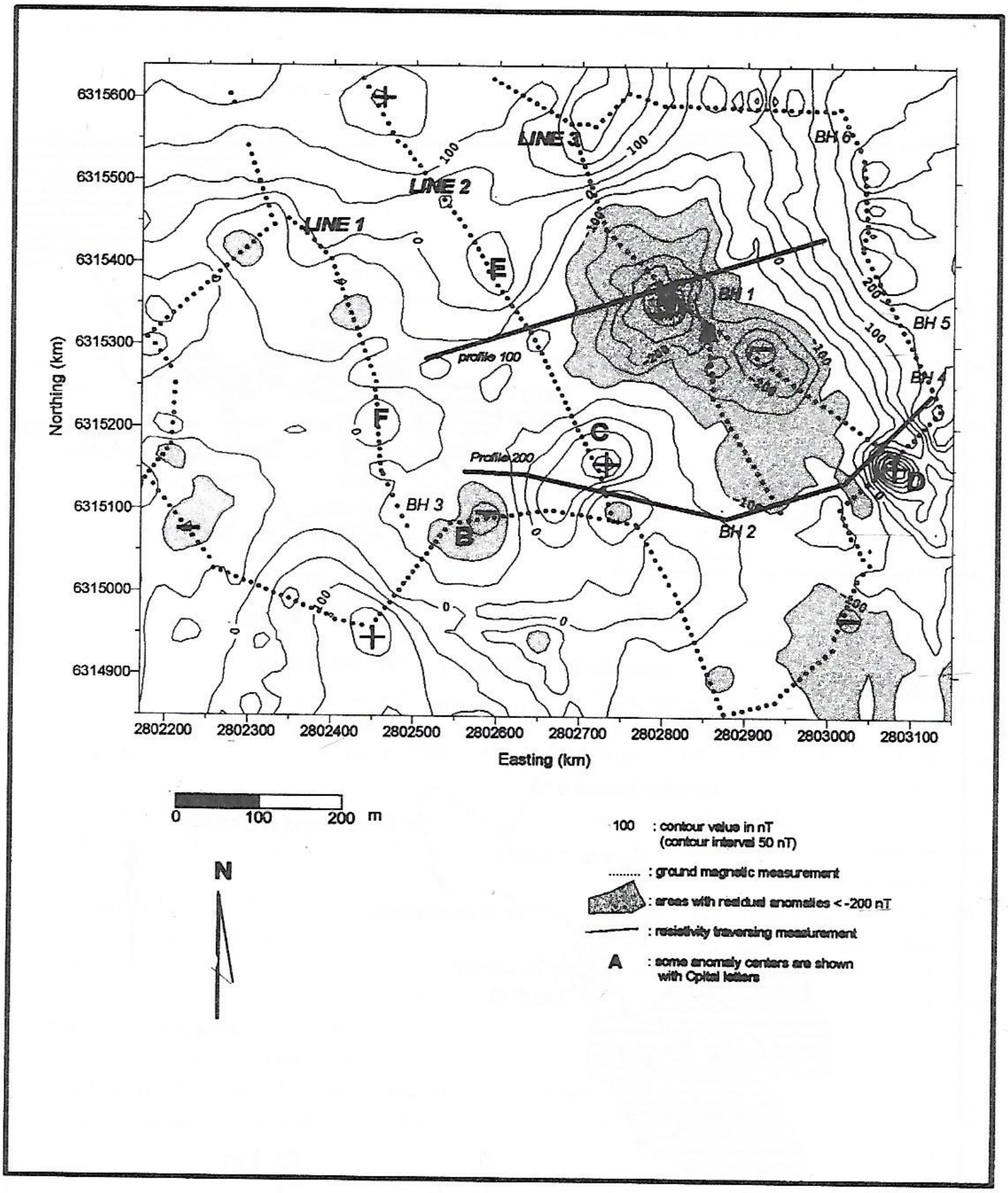

Figure 2: Observed residual ground magmatic anomalies over NW of Maungaongangonga area

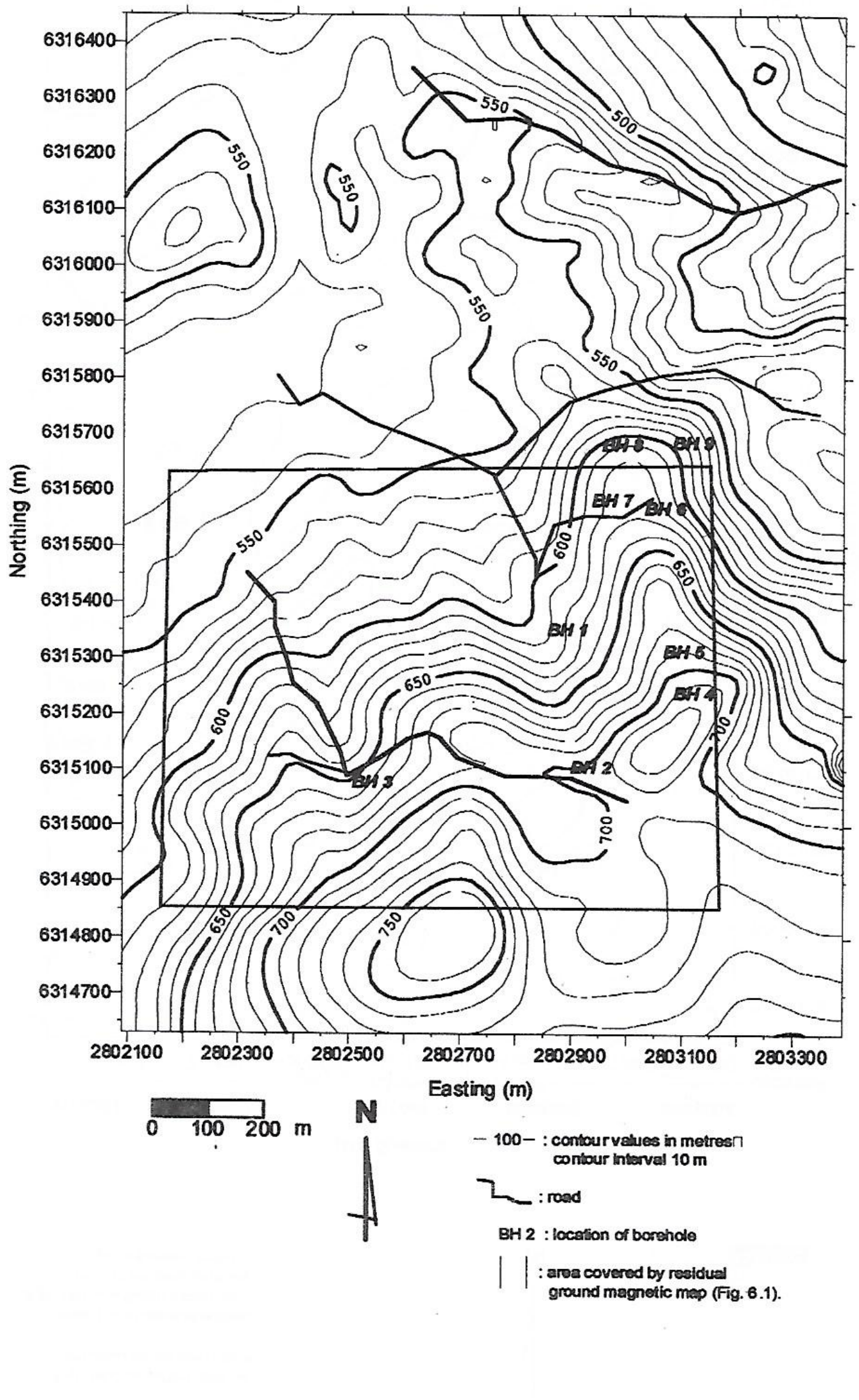

Figure 3: Digitalized topography of the NW Maungaongaonga area

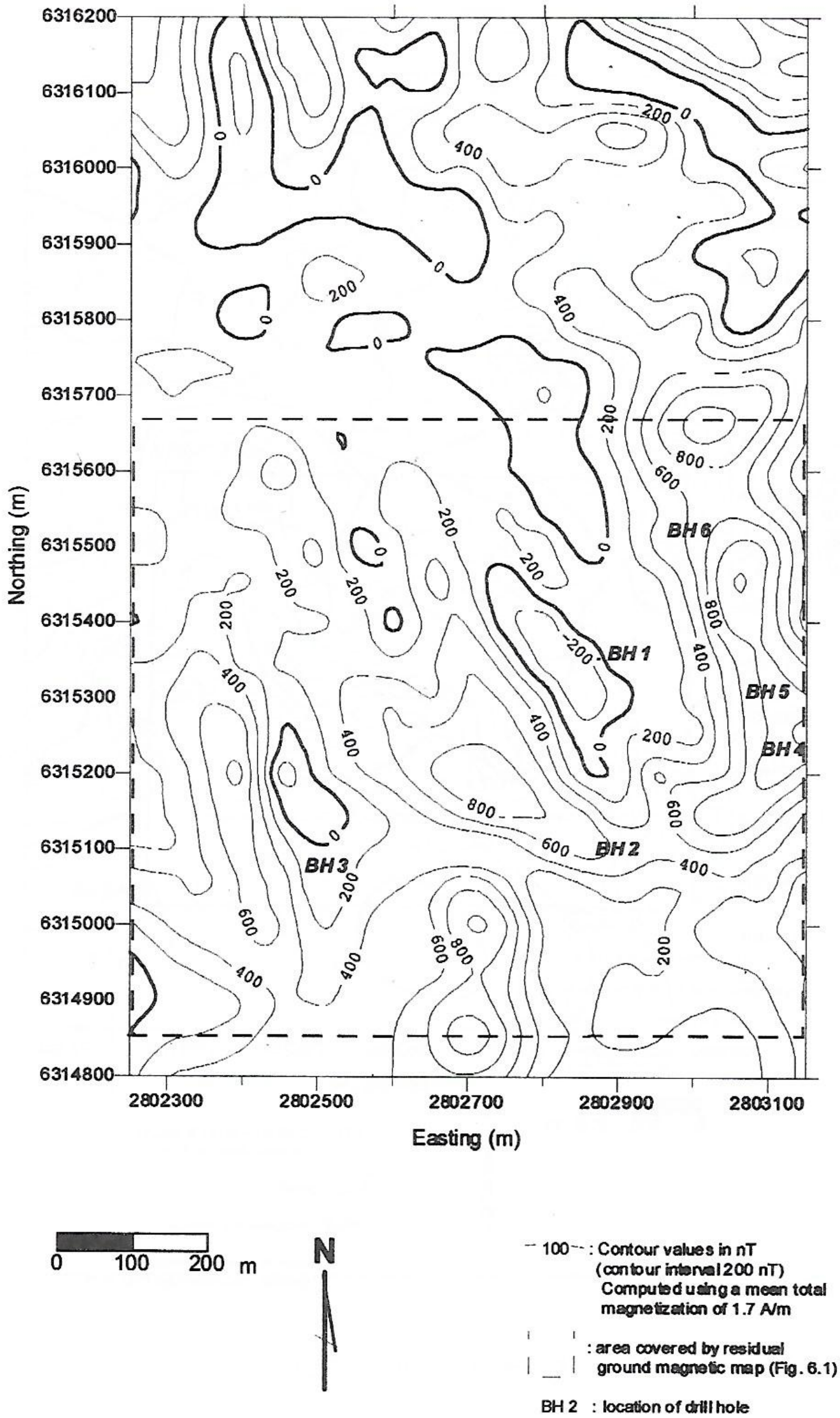

Figure 4: Magnetic effect of topography over the NW of Maungaongaonga

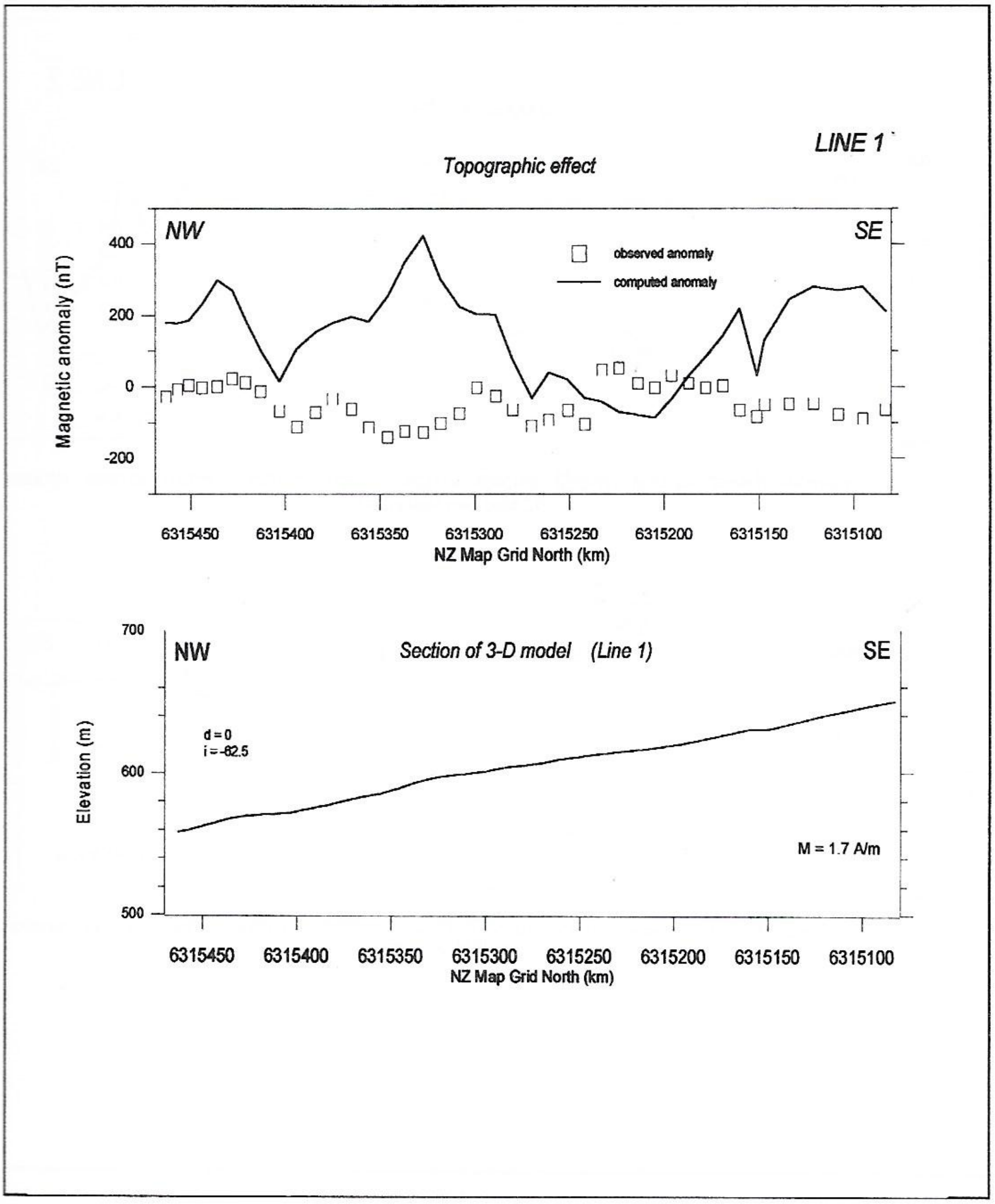

Figure 5: Comparison between observed anomalies and computed anomalies from the topographic modelling (Line 1)

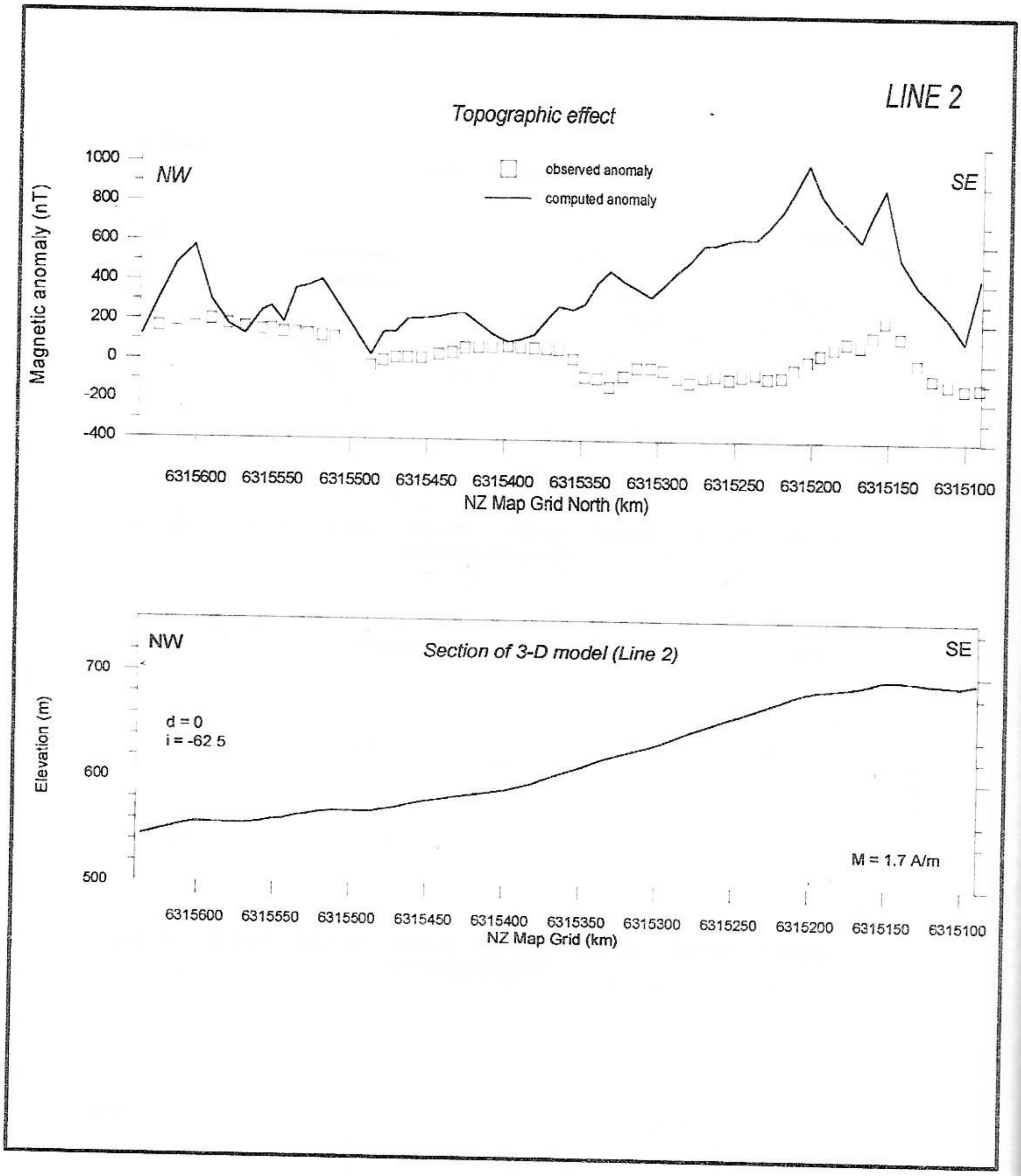

Figure 6: Comparison between observed anomalies and computed anomalies from the topographic modelling (Line 2)

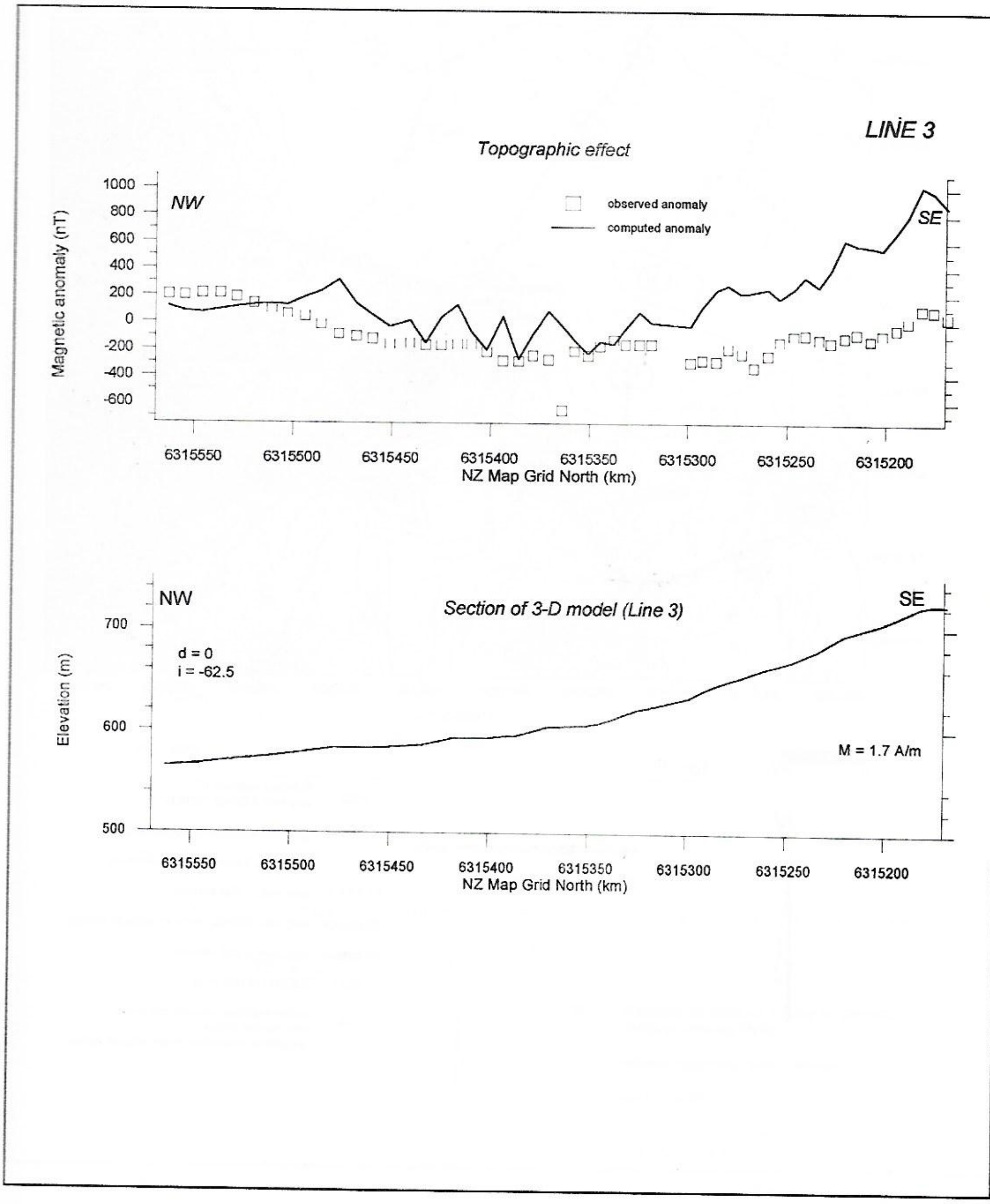

Figure 7: Comparison between observed anomalies and computed anomalies from the topographic modelling (Line 3)

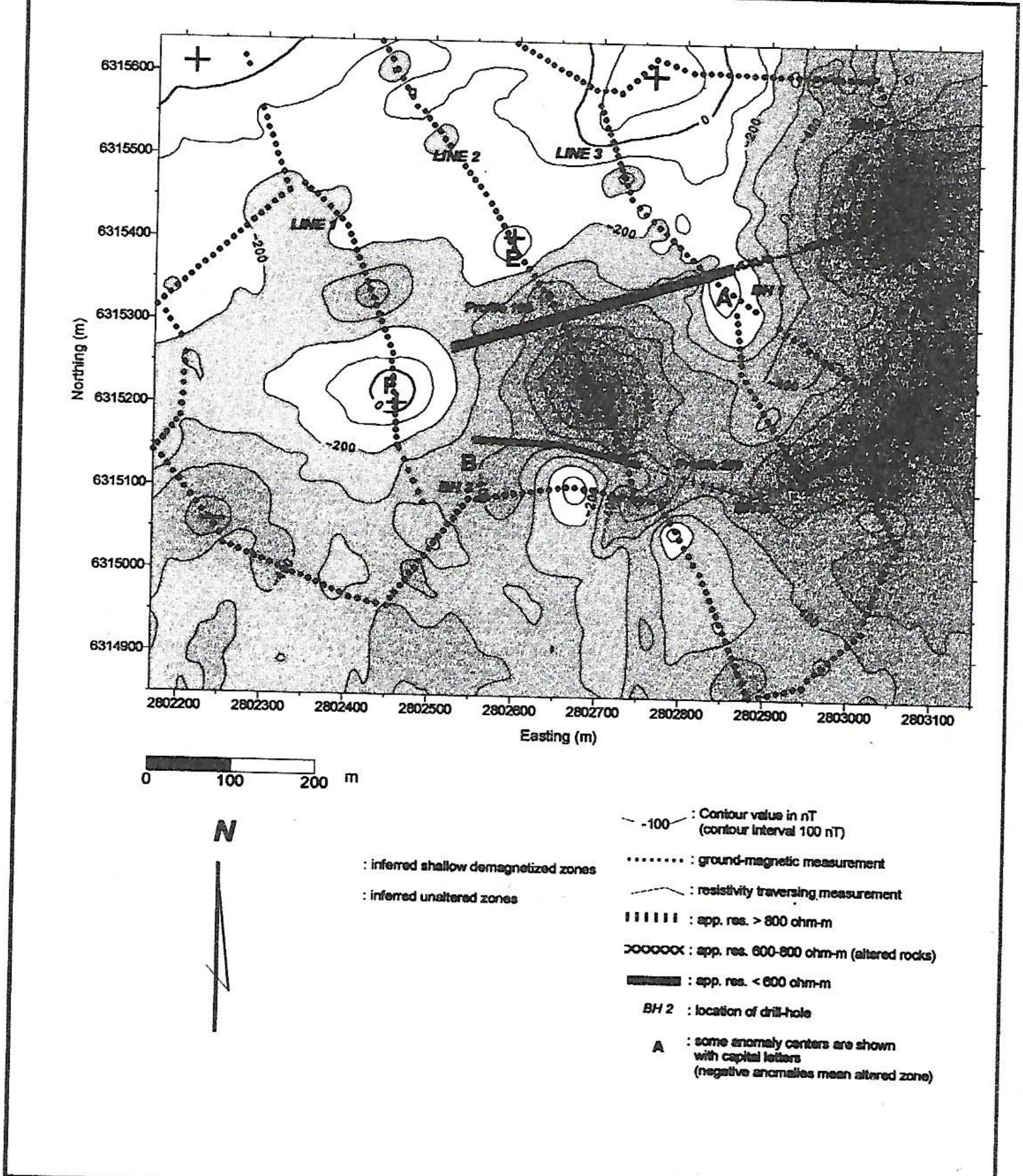

Figure 8: Residual anomalies reduced by topographic effect of the NW Maungaongaonga area

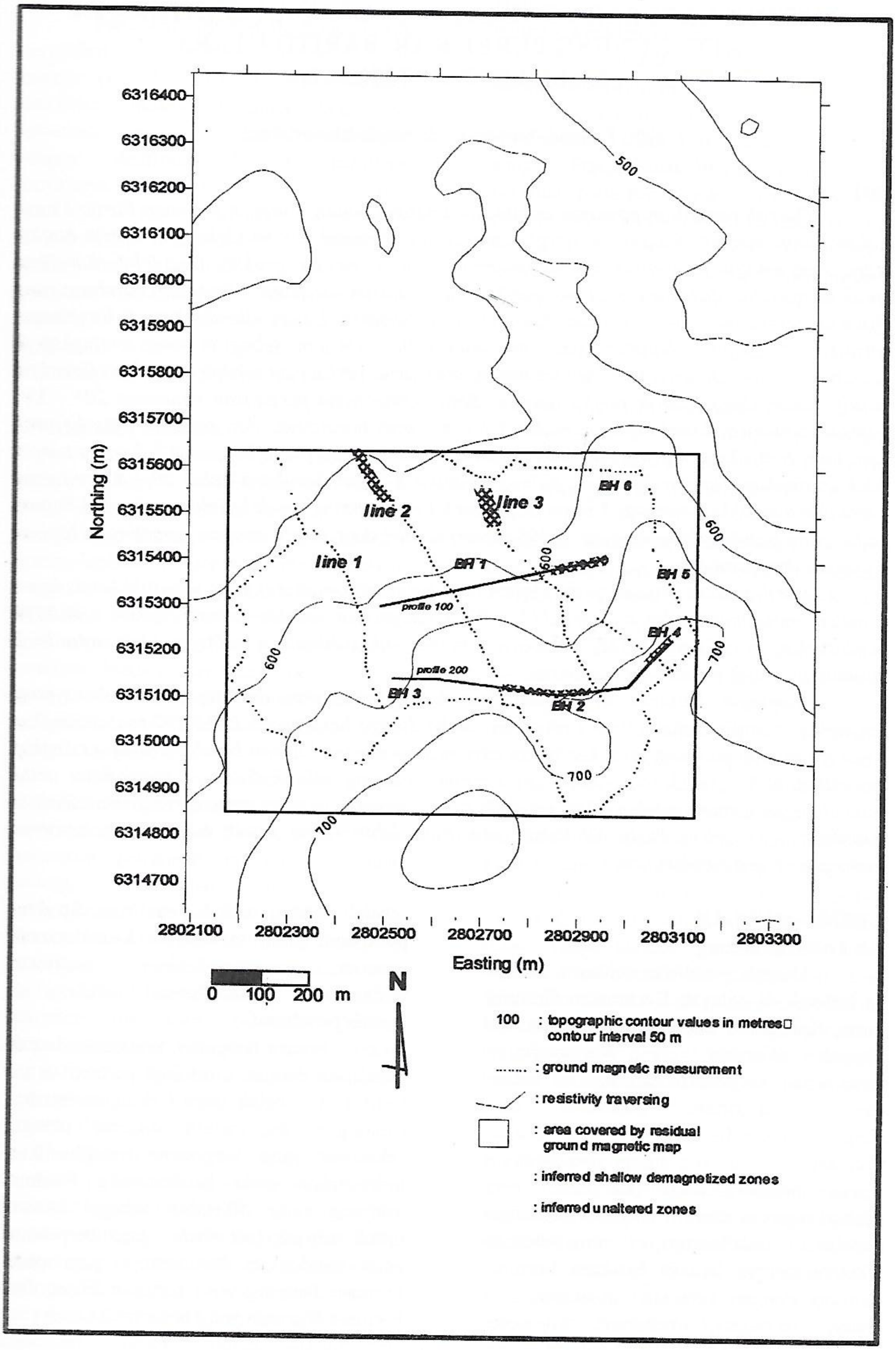

Figure 9: Map showing the interpretation of extent of shallow hydrothermal alteration (NW of the Maungaongaonga)