CHAPTER THREE

GEOPHYSICAL DATA AQUISITION

3.1 INTRODUCTION

The gravity and magnetic geophysical techniques exploit the fact that variations in the physical properties of in-situ rocks give rise to variations in some physical quantity which may be measured remotely- at the surface of the ground or above it- without the need to touch, see or disturb the rock itself (Peterson and Reeves, 1985). These observed variations, when corrected appropriately and presented as two-dimensional (2-D) maps of "anomalies" over the earth's surface, may be interpreted in terms of three-dimensional (3-D) subsurface variations of rock properties. These variations in physical properties must relate, to a greater or lesser extent, to the geology of the subsurface.

Both gravity and magnetic methods consist of three stages:

(i) measurement of the specific field values at or above the ground surface **(data acquisition)**;
(ii) processing of the measured data **(data processing)**
(iii) interpretation of the processed data in terms of rock property variations within the subsurface in accordance with known geology **(data interpretation)**.

Gravity and magnetic techniques are often grouped together as the *potential field methods*. There are however some basic differences between them. Gravity is an inherent property of mass and the measured gravity field is only dependant on the subsurface density distribution. The magnetic field is not only dependant on the type of minerals contained in a rock, but also on the inducing fields, both past and present. Density variations are relatively small, and the gravity effects of local masses are very small compared with the regional field of the earth as a whole, often in the order of 1 part in 10^6 to 10^7. Magnetic variations on the other hand, are relatively large, in the order of 1 part in 10^3.

The aeromagnetic method of geophysical surveying has been established in less than five decades as a powerful method in mining and petroleum exploration (Reford and Sumner, 1964). Many important discoveries can either directly or indirectly be credited to an aeromagnetic survey. The most distinguishing features of the aeromagnetic method, in comparison with other geophysical prospecting schemes, is the rapid rate of coverage and low cost per unit area explored (Peterson and Reeves, 1985).

The gravity method can be used to map and model any geological feature that will lead to a lateral variation in the density distribution of the subsurface material. These features can be relatively shallow, such as sinkholes in dolomitic terrain, giving rise to high frequency variations in the observed gravity field, or it can be relatively deep, such as subsurface salt domes, giving rise to low frequency variations in the observed gravity field.

Airborne magnetic surveys can be used to:

(a) Delineate volcano-sedimentary belts under sand or other recent cover, or in strongly metamorphosed terrains where ancestral lithologies are otherwise unrecognisable. The combined use of gravity and magnetics is very helpful in this role. Important gold and base metal deposits have been found as a result of such programs (e.g. Reeves, 1985).

(b) Identification and delineation of post-tectonic intrusives. Typical of such targets are zoned syenitic or carbonatite complexes, kimberlites, tin bearing-granites and mafic-ultramafic intrusives (e.g. Kimbell et al., 1984)

(c) Recognition and interpretation of faulting, shearing, and fracturing not only as potential hosts for a variety of minerals, but also as an indirect guide to epigenetic, stress-related mineralisation in the surrounding rocks.

(d) Interpretation of configuration and structure of magnetic basement underlying sedimentary basins applied to hydrocarbons and / or uranium exploration.

(e) Direct detection of deposits of magnetic iron.

(f) Identification of environments favorable for groundwater exploitation including fracture systems in crystalline rocks and bedrock aquifers under alluvial covers.

3.2. DATA ACQUISITION, GRAVITY:

3.2.1 FIELD PROCEDURE

3.2.1.1. Previous work:

During December of 1975, the Geological Survey of South Africa, in collaboration with the Institute for Geological Research on the Bushveld Complex, initiated a regional gravity survey in the Globersdal-Lydenburg–Belfast area of the eastern Transvaal to gain more information on the structural relationships of the Bushveld Complex and to produce a gravity map on a scale of 1 : 250000. For that survey, fourth order gravity base stations were established in the survey area at Globlersdal, Dullstroom, Machadodorp and Lydenburg. Gravimeter readings were taken at each base station and at the pendulum station at the Transvaal Museum in Pretoria, throughout a 24 hour period at each station. This resulted in a set of readings for each base station, from which absolute gravity values for the first-order gravity base stations were then calculated (Hattingh, 1980).

3.2.1.2. Conduct of present survey and data acquisitioning

The present survey constituted about 731 gravity observations, covering an area of approximately 25km by 30km. The gravity stations were distributed as evenly as possible on 1km grid spacing. The elevation of the gravity stations were determined mostly simultaneously with the gravity readings and when not done simultaneously, remote and fairly indelible spots marked with painted stones were selected to repeat either or both the gravity and elevation measurements should the need arise. In most cases, however, the elevation determination preceded the gravity measurement by some days and when these markers' positions were not found later for gravity measurements, new elevation measurements were taken and the last gravity reading re-observed to reduce error that could emanate due to long time drift effect.

All data were tied in to one of two base stations of which the absolute values were known. The one base station is at Marble Hall, Figure 3.1, the other at Groblersdal, Figure 3.3. A photograph showing the base station at Marble Hall is shown in Figure 3.2.

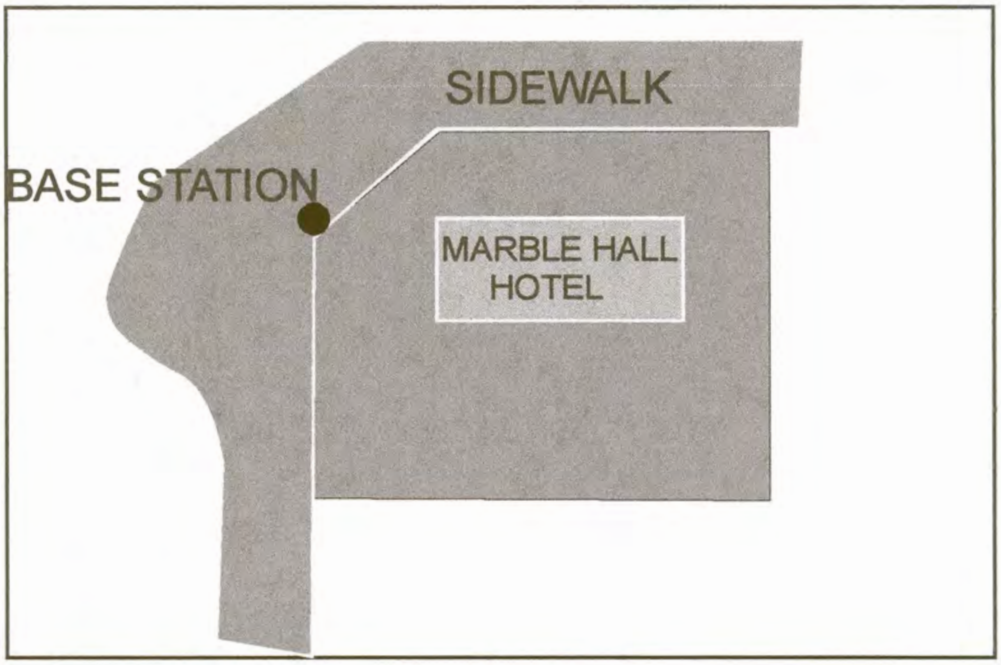

Figure 3.1: Locality map of the base station at Marble Hall

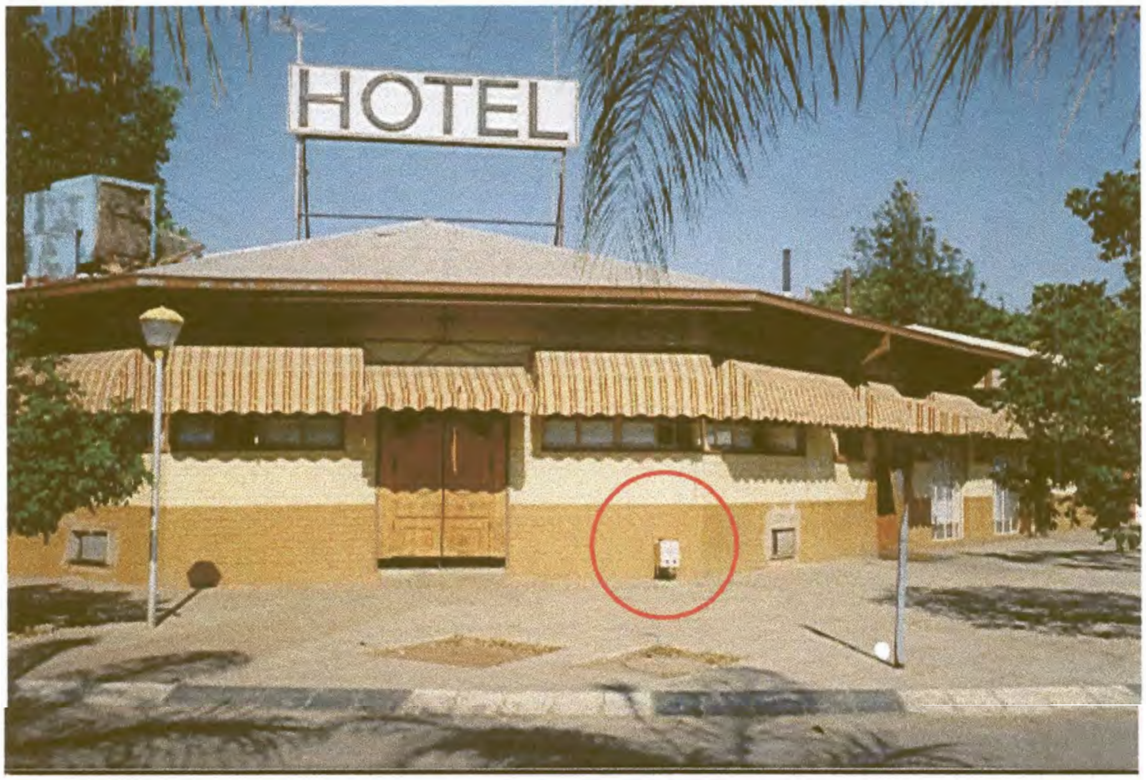

Figure 3.2: Photograph of base station at Marble Hall

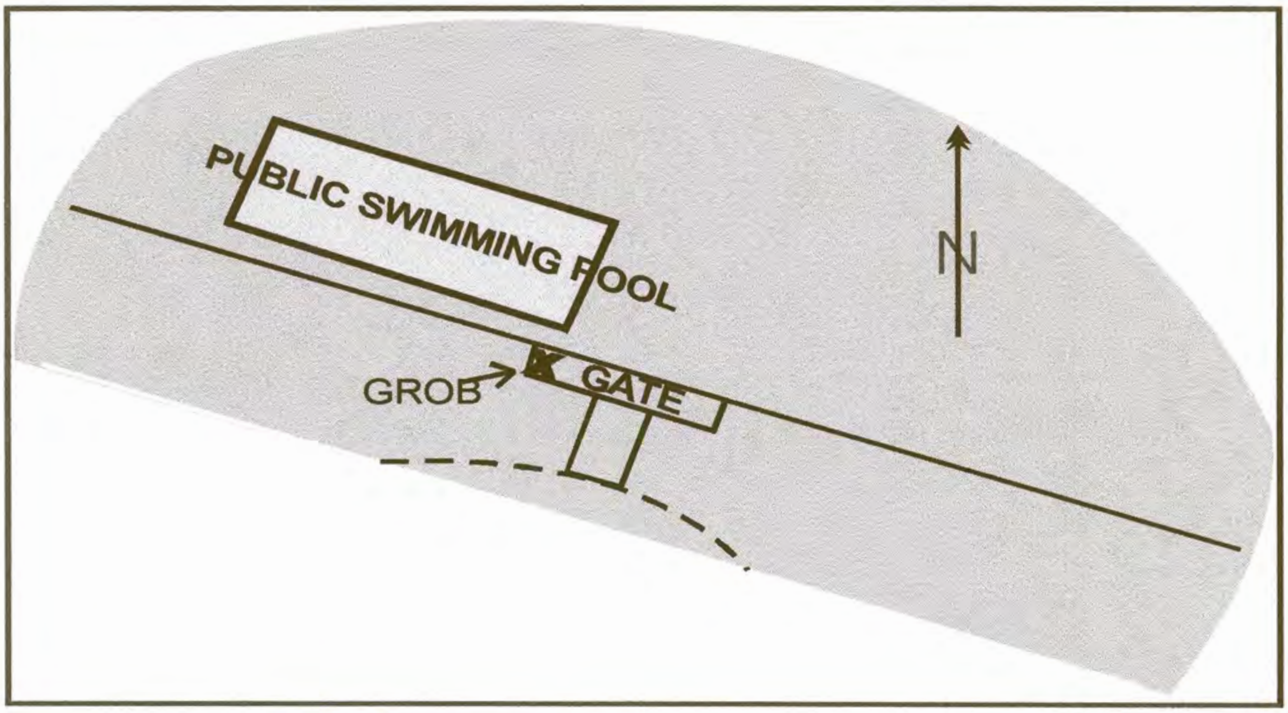

Figure 3.3: Locality map of gravity base station at Groblersdal

Data acquisition covered several areas with different settings with low and fairly high reliefs, nature reserves, dried river beds, farmlands, settlements and previously mined areas. The actual distribution of the gravity stations is shown in Figure 3.4a.

Each gravity position was identified by using a combination of numbers from 1 – 30 vertically and 01 – 25 horizontally reflecting the area coverage for the survey (approximately 25km by 30km) such that the stations are numbered 101,102,...125;1201, 1202...1225; 3001, 3002,...3025. Figure 3.4b shows the sequential numbering of the gravity stations.

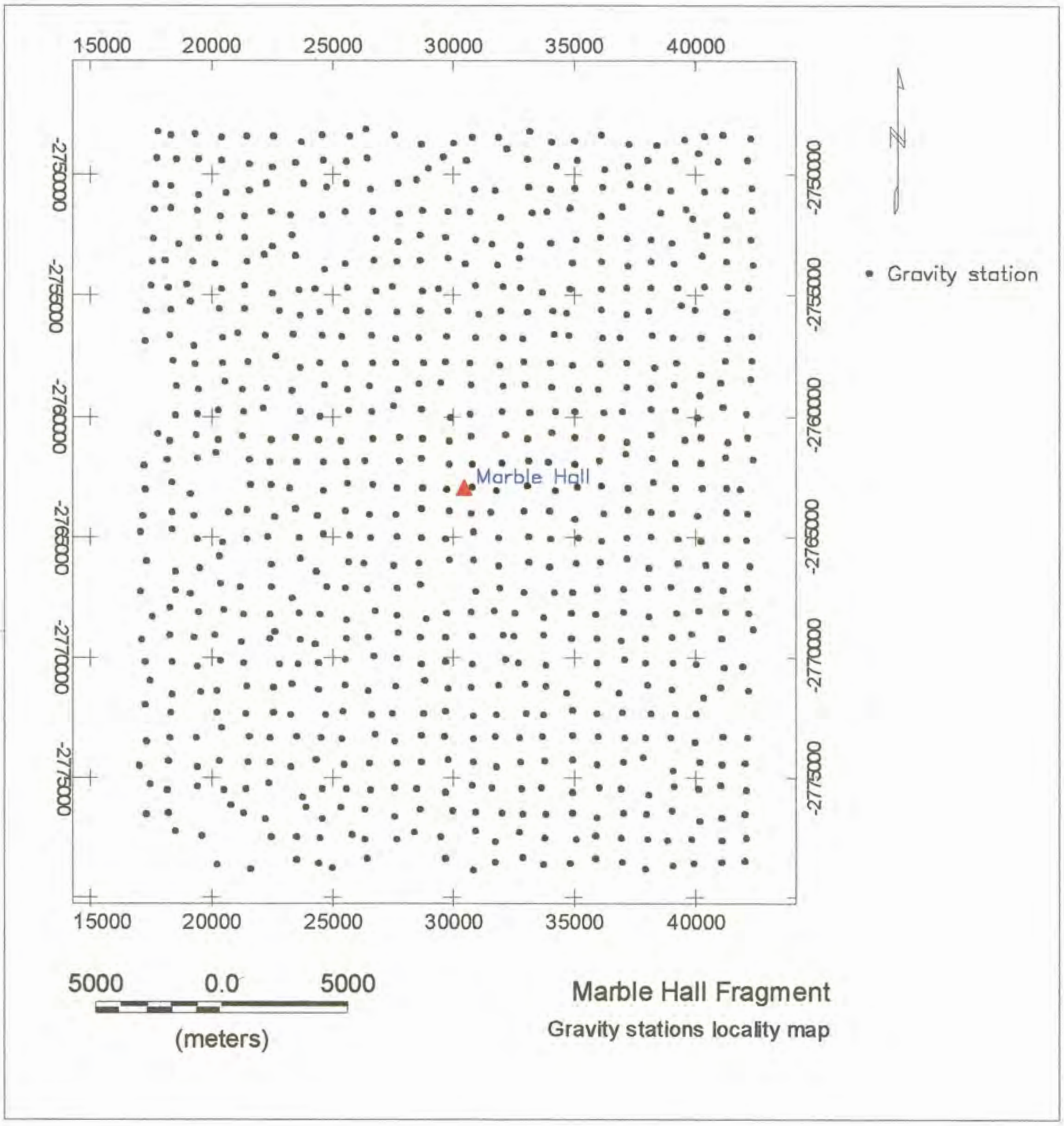

Figure 3.4a : Gravity station locality map

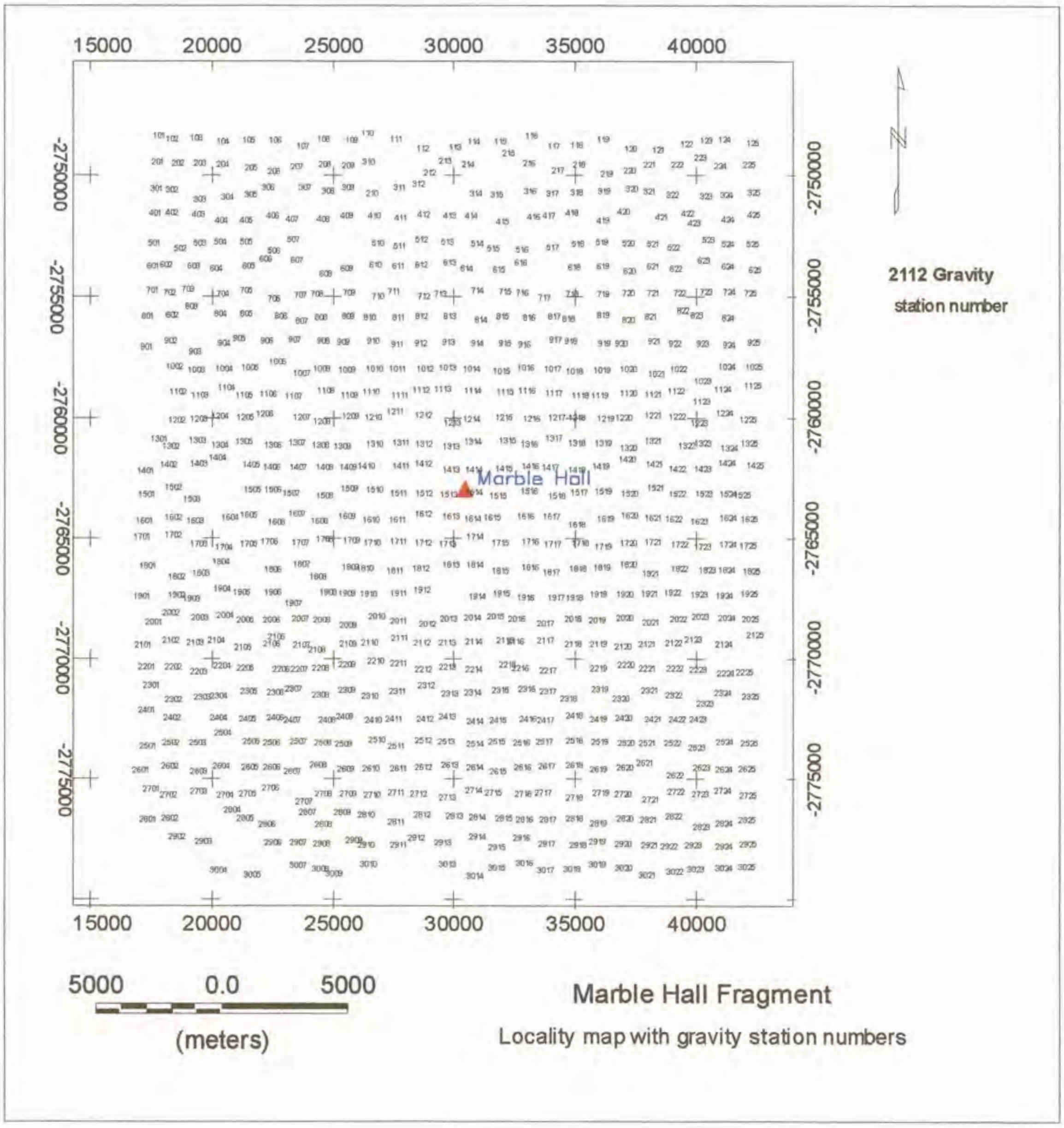

Figure 3.4b. Locality map identifying each gravity position by number

The survey commenced with the identification and location of two trigonometrical beacons within the research area. One was located in the northern part and the other in the southern part of the research area. These were to be used as control or reference points for the determination of the latitude, longitude and elevation position of each gravity station. The coordinates of these beacons are:

For the trigonometrical beacon used in the north, labeled Rooibok 51

X= +2746031.40m, Y= -33290.53m, Z= 1117.7m

For the trigonometrical beacon to the south of Marble Hall, named Mosesrivier Mond 58

X= +2765779.90m, Y= -32414.33m, Z= 967.6m

The coordinates and elevations used for these trigonometrical stations were for System Lo 29^0 and were obtained from the list containing the coordinates of the South African Survey Grid and heights of beacons above mean sea level published by the Department of Public Works and Land Affairs, Directorate of Surveys and Mapping, issued on April 7, 1989.

Two other elevation control points named during the survey as Dam (located on Roets game farm) to the north and Bas1 (located close to a farmland) in the south of Marble Hall respectively were surveyed to and from Trig 58. The spatial coordinates and elevations calculated for these control points were used as references in calculating the elevations of several gravity stations in the survey area. The need to have four reference elevation positions arose because, for the fast static mode under which the differential GPS measurements were taken, the accuracy in measurement decreases beyond 12-15 km range. The additional stations were also used to reduce cumulative error that might result from little differences in determined elevation values.

Four gravity base stations numbered, –10, -1, -2, -3 corresponding to positions at Groblersdal, Dam, Lebowa and Marble Hall respectively were used for this gravity survey. The base stations and corresponding absolute gravity values are listed in Table 3. The absolute gravimeter station at Groblersdal determined by Hattingh (1977) was re-calibrated during the current survey and this constituted a first order base station to which the other three gravity base stations were tied. This was done in order to be able reduce the gravity values to the same datum as the countrywide survey and to tie this present survey to the previous surveys. Several readings were taken at each of these base stations at the commencement, during and at the end of each daily survey, in order to correct for long term drift effects. By using the scintrex autograv gravimeter, the absolute gravity value of the field stations were determined to an average accuracy greater than 0.03 mgal relative to the absolute gravity value of the first order base station at Groblersdal.

A software controlled Scintrex autograv (CG3) gravimeter supplied by the the Iron and Steel Corporation of South Africa (ISCOR) and 4000 SSE Trimble Geodetic Surveyor supplied by the Department of Land Survey, University of Pretoria, were used for the gravity and elevation determination respectively. An accuracy of 0.03 mgal or better was achieved for the gravity measurements while better than 7cm accuracy was achieved for the elevation determinations.

Table 3: Base station values

Station ID	Name	Absolute gravity (mgal)
-10	Groblersdal	978670.24
-3	Marble Hall	978677.74
-2	Lebowa	978656.48
-1	Dam	978653.77

3.2.1.3. Laboratory determination of densities of rock samples

In the gravity method, the physical rock property is density, and density variations at all depths within the earth contribute to the broad spectrum of gravity anomalies (Paterson and Reeves, 1985). This density in turn depends on the porosity and gross mineralogy of rocks in bulk.

For the current research, several fresh rock samples from outcrops were taken at different locations and in some cases, four to five samples of the same lithological unit were taken at each location for density determination in the laboratory. The fresh samples were cut into two different geometric shapes viz cubic and cylindrical. At least 3 smaller samples of nearly uniform geometric shapes were obtained from each rock sample. Densities were determined at the South African Council for Geoscience. The densities are given in Table 4.

Table 4: Densities obtained for rocks in the research area.

Rock Formation		**Density (g/cm^3)**
Makeckaan Formation		2,75
Nebo Granite		2,67
Pretoria Group		2,75
Dolomite		2,85
Bushveld basic rocks	Upper zone	3,08
	Main Zone	2,95
Bloempoort Formation		2,69
Archaean Granite		2,67

3.2.2. DESCRIPTION OF EQUIPMENT

3.2.2.1. GRAVITY EQUIPMENT (SCINTREX AUTOGRAV GRAVIMETER- CG3)

The precision of data from a gravity survey depends upon the gravimeter and the accuracy of the spatial coordinates of the observation station. The following factors affect the ultimate precision of gravity data generated by a gravity survey (Seigel, 1993):

Instrumental factors

- Shocks and vibrations :
- Power-Down
- Extreme Temperature Shocks
- Elastic relaxation
- Levelling
- Calibration
- Long and Short Term drifts

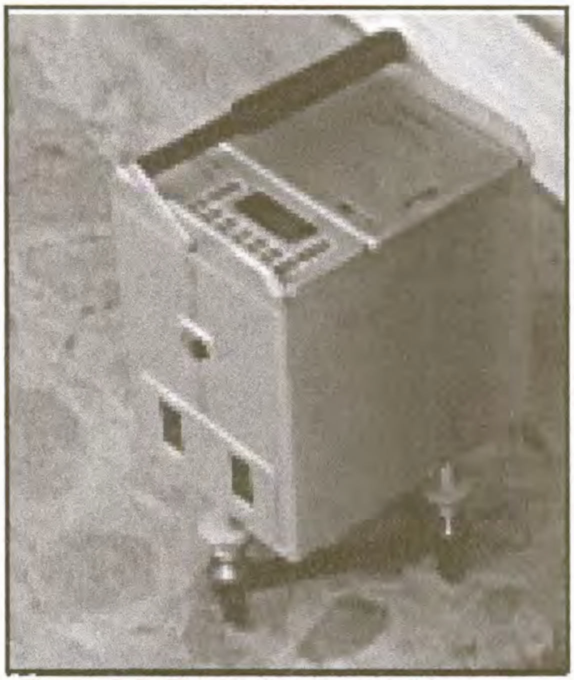

Figure 3.5: The Autograv gravity meter

External Factors:

- Seismic Noise
- Selection of Station Location
- Wind-Induced Vibration
- Atmospheric Pressure.

Based on all the above factors that can directly or indirectly militate against the quality of the data gathered in the field, the Scintrex autograv (CG3) supplied by the Iron and Steel corporation of South Africa (ISCOR) proved to be most robust. The choice of this equipment was not only based on its robustness and accuracy but also its operating speed. This was a major factor in lieu of the size and ruggedness of the survey area.

The Scintrex Autograv belongs to a new generation of land gravimeters matching or exceeding the precision of the previously top of the line LaCoste meters with the following more desirable characteristics (Seigel, 1993) :

- Straight forward to manufacture : The Autograv does not apply the astatic principle, with its critical dependence on dimensional precision.
- Mechanical Simplification : In the Autograv some of the mechanical complexity of the astatic meters are replaced with electronic circuitry to achieve the same high sensitivity, with the ease of replication and suitability for routine production inherent in the use of electronics. It also meant eliminating the use of micrometer screws and gears, with their mechanical imperfections.
- Tolerance of Rough Field Use : A fused quartz element, with its inherent super-elasticity, is utilized.
- Freedom from Ambient Temperature Variations.
- World wide Range : The Autograv has a resolution of 1 microgal, without the need for any mechanical reset mechanisms.
- High Precision Measurements : With a standard deviation of the order of 5 microgal or better.
- Electronic and Software Control of the Measurement: This carries with it freedom from the subjective judgement of the operator in making the measurement. It allows for many novel and useful features such as intelligent signal processing, correction for tilt errors

and tidal effects, etc. This implies the elimination of micrometer screws and gearboxes, with their mechanical imperfections and limitations of linearity, etc.

The gravitational force on the proof mass is balanced by a zero-length spring and a relatively small electrostatic restoring force. The position of the mass is sensed by a capacitative displacement transducer. An automatic feedback circuit applies a DC voltage to the capacitor plates, producing an electrostatic force on the mass, which brings it back to a null position. The feed-back voltage, which is a measure of the relative value of gravity at the reading system, is converted to a digital signal and then transmitted to the instrument's data acquisition system for processing, display and storage in solid state memory.

The inherent strength and excellent elastic properties of fused quartz, combined with limit-stops around the proof mass, permit the instrument to be operated without clamping. Further protection is provided by a durable shock mount system which supports the sensor within the housing.

The parameters of the gravity sensor and its electronic circuits are chosen so that the feedback voltage covers a range of over 7000 milligals without resetting. Low noise electronic design, including an auto-calibrating 23 bit analogue to digital converter, results in a resolution as high as 1 microgal, thus equipping the gravimeter for both detailed field investigations and large scale regional surveys (Seigel, 1993).

The sensor is enclosed in a sealed aluminium chamber to essentially eliminate the effect of external pressure changes. The most critical components, including the gravity and tilt sensors, are in a double oven, which reduces long-term external pressure changes by a factor of 100,000. A temperature sensor is in close proximity to the spring to provide a compensation signal for residual temperature changes. Such residual changes are usually less than 1m°K. Some of the other, less critical electronic components are in an outer oven, thermostatically controlled to a fraction of a °K.

The signal from the gravity sensor is sampled once a second and the samples are averaged for sufficient time (depending on the ambient noise conditions) to reduce the random error to the desired level. Noise rejection is assisted by an algorithm which statistically rejects individual high noise readings (Seigel, 1993).

Software controlled corrections are made, in real time, for

- long term drift of the sensor,
- residual sensor temperature variations,
- sun and moon tides,
- tilt of the sensor out of the vertical.

The CG-3 communicates with the outside world through an RS-232 port.

Table 5 shows a typical data printout, including

- station number,
- corrected gravity values,
- calculated standard deviation of one second samples,
- tilts out of the vertical (in arc seconds),
- internal residual sensor temperature variations in m°K
- residual tidal correction
- the number of one second gravity measurements which has been averaged
- the number of noisy readings rejected
- the time of the measurements.

Table 5. Typical gravity data as recorded by the Scintrex Autograv gravimeter in the investigation of the Marble Hall Fragment.

```
---------------------------------------------------------------------------------
SCINTREX V4.1        AUTOGRAV / Field Mode            R4.4
                                                              Ser No:    507282.
Line:       0.  Grid:       1.    Job:       0.  Date: 98/04/24  Operator:       1.

GREF.:                         0. mGals         Tilt x sensit.:             211.5
GCAL.1:                   5781.241              Tilt y sensit.:             329.7
GCAL.2:                        0.               Deg.Latitude:              -25.12
TEMPCO.:                   -0.1276 mGal/mK      Deg.Longitude:             -29.10
Drift const.:                0.787              GMT Difference:             -2.hr
Drift Correction Start    Time: 12:18:20        Cal.after x samples:           12
                          Date: 98/04/20        On-Line Tilt Corrected = "*"
---------------------------------------------------------------------------------
Station  Grav.      SD.    Tilt x  Tilt y    Temp.    E.T.C.   Dur  # Rej     Time
   -10. 2945.765* 0.035    -3.     -1.     0.11   -0.096    50      0  16:05:56
   -10. 2945.770* 0.036    -3.     -1.     0.12   -0.096    54      0  16:07:02
   -10. 2945.780* 0.042    -3.     -2.     0.14   -0.097    72      0  16:08:14
   -10. 2945.830* 0.032     0.     -3.     0.09   -0.097    42      0  17:13:58
   -10. 2945.830* 0.034    -1.     -1.     0.10   -0.097    46      0  17:15:10
   -10. 2945.835* 0.024    -1.     -1.     0.11   -0.097    24      0  17:16:12
   -10. 2945.845* 0.031    -2.     -1.     0.12   -0.096    40      0  17:16:49
    -3. 2953.305* 0.039    -3.     -0.     0.10   -0.102    61      1  16:34:48
    -3. 2953.300* 0.037    -2.     -0.     0.11   -0.102    57      0  16:36:09
    -3. 2953.295* 0.048    -0.     -2.     0.11   -0.102    94      1  16:41:10
    -1. 2929.355* 0.030    -5.     -1.    -0.22    0.018    37      0  07:36:19
    -1. 2929.375* 0.049     0.     -1.    -0.20    0.020    97      0  07:37:20
    -1. 2929.385* 0.052    -0.     -1.    -0.19    0.022   108      0  07:39:22
    -1. 2929.250* 0.036     0.      8.     0.08   -0.061    51      0  15:02:15
    -1. 2929.265* 0.045    -5.      5.     0.11   -0.062    83      0  15:04:02
    -1. 2929.280* 0.034     1.      1.     0.12   -0.064    48      0  15:06:30
  1004. 2918.705* 0.034    -1.     -8.    -0.15    0.116    48      0  09:36:49
  1103. 2919.455* 0.038    -3.     11.    -0.14    0.122    60      0  09:50:12
  1104. 2922.255* 0.044     2.     -4.    -0.16    0.108    77      0  09:21:34
  1105. 2927.120* 0.041    -3.      9.    -0.19    0.098    69      0  09:06:58
  1202. 2919.110* 0.033    -1.      2.    -0.11    0.128    44      0  10:10:06
  1203. 2923.445* 0.044    -0.      4.    -0.10    0.130    81      0  10:21:23
  1204. 2926.885* 0.044   -13.    -11.    -0.09    0.131    77      1  10:31:10
  1205. 2933.000* 0.035    -8.     -2.    -0.21    0.086    50      0  08:50:57
  1206. 2936.300* 0.006     0.     -3.    -0.28    0.061     5      0  08:21:29
  1206. 2936.325* 0.048    -4.     -6.    -0.23    0.062    93      0  08:21:47
  1301. 2918.695* 0.042     2.     -5.    -0.01    0.123    71      0  11:21:26
  1302. 2922.310* 0.044     5.      4.    -0.01    0.104    78      0  11:59:45
  1303. 2927.210* 0.046   -10.     -5.    -0.07    0.131    86      0  10:52:02
  1304. 2933.980* 0.040     1.      8.    -0.08    0.131    64      0  10:44:13
  1305. 2937.320* 0.040    -2.      9.    -0.24    0.071    64      0  08:32:57
  1403. 2932.740* 0.048    -8.    -12.     0.02    0.088    92      0  12:21:41
  1404. 2939.375* 0.046    -6.      0.     0.05    0.063    86      0  12:50:44
```

The spatial coordinates of each station were obtained using a Trimble 4000 SSE geodetic surveyor. The system utilises the signal from Navstar satellites to compute the locations and the height at anytime of the day to great accuracy (at least 1cm accuracy).

3.2.2.2. DATA ACQUISITION, POSITIONING (TRIMBLE 4000 SSE GEODETIC SYSTEM SURVEYOR)

The Trimble 4000SSE Geodetic Surveyor Series is designed for high precision survey, positioning and navigational applications. This receiver continuously tracks L1 (Link 1) and L2 (Link 2) position code, when available, and utilizes cross-correlation measurements during periods of Anti-Spoof (AS) encryption. This enables dual-frequency code tracking, and thus, high precision measurements at all times. When used with another GPS Geodetic Surveyor and the GPSurvey™ Software Suite, three-dimensional coordinate differences between stations can be determined. Other outputs include : station position, normal section azimuth, slope distance, and vertical angle between the two survey points (Trimble Navigation Limited, 1992).

The 4000SSE offers surveys in Static, FastStatic™, Kinematic, and Pseudostatic modes. It also determines time, latitude, longitude, height and velocity. A navigation capability with over 99 way points is also available.

When used in differential GPS (DGPS) mode, RTCM (Radio Technical Commission for Maritime Survaces) corrections can be generated at one unit and used by another to provide corrected positions at a one-fix-per-second rate. The 4000SSE receives L1 and L2 signals sent from the Global Positioning System (GPS) NAVSTAR satellites. The receiver automatically acquires and simultaneously tracks up to 9 GPS satellites. It precisely measures carrier and code phases (C/A and P, when available) and stores them in an internal, battery backed-up memory. The 4000SSE receiver continuously tracks P-code with 9 parallel channels when AS is off and utilizes Trimble's unique cross-correlation measurements during times of AS encryption. This enables the recovery of full-cycle L1 and

L2 phase signals and dual-frequency code tracking at all times (Trimble Navigation Limited, 1992).

GPS survey baselines are measured by recording GPS satellite data simultaneously with receivers positioned at each end of the baseline. Latitude, longitude, ellipsoidal height values, and the GPS satellite ephemeris data are referenced to the World Geodetic System (WGS-84).

The TRIMVEC Plus software computes

- slope distance accurate to :

Length :	5mm + 1 ppm x baseline length
Azimuth :	1.0 sec + 5/ baseline in km

- vertical distance accurate to :

1 cm + 1 ppm x baseline length.

For example, on a 10-kilometer line, a slope distance accurate to 1.5 cm may be expected.

The GPSurvey and TRIMVEC Plus software performs the data downloading and the processing and quality checking of the results. Interactive menus simplify the planning and scheduling of surveys. Loop-closure tests and transformations to state plane systems increase production quality and quantity.

Survey project can be scheduled and entered into the receiver prior to arriving at the job site to reduce field operations. On the other hand, last minute changes can be easily accommodated and surveys can be started with a single keystroke.

Position fix, time, satellite tracking data, and other quantities are displayed on the front-panel liquid crystal display. It must be noted that the real time position fixes displayed here have moderate accuracy and are not survey measurements. When the receiver is tracking a sufficient number of satellites, but not placed in a "survey mode", the receiver automatically determines time and position and some other quantities without user action. This is its **"positioning mode"** (Trimble Navigation Limited, 1992).

The 4000SSE Geodetic System Surveyor also provides many advanced features such as Event Marker input, 1 PPS output, NMEA outputs, RTCM inputs and optional RTCM outputs, and an extended (99 waypoints) navigation feature. The receiver has dual I/O ports, three power ports, an event marker and 1 PPS port, and an optional external frequency input. While one I/O port is being used for sending or receiving the differential GPS corrections, the second can be used to store measurements for later post-mission analysis and archiving.

OPERATING ENVIRONMENT :

The Trimble 4000SSE Geodetic Surveyor can be used in all normal survey applications. However, the following can have an adverse influence on the results.

- High-Power UHF / TV Radio Signals:

High-power signals from a nearby radio or radar transmitter may overwhelm the sensitive receiver circuits. It is safer to try not to survey within a quarter mile of powerful radar, TV, or other transmitters. However, low-power two-way radio's don't interfere with 4000SSE operations.

- Temperature :

The receiver operates in air temperatures from -20° to +55°C.

- Humidity:

The Surveyor is sealed and buoyant. A waterproof vent allows internal air pressure to adjust to altitude changes.

Figure 3.6: The GPS system in the survey area

The optional geodetic and kinematic antennas contain dessicant used to absorb moisture within the unit. The dessicant is contained in a plug that screws into the antenna base.

Figure 3.6 shows the equipment being adjusted at one of the trigonometric beacons in the survey area and Table 6 shows a typical processed data from the 4000SSE geodetic surveyor.

Table 6. A typical processed elevation data obtained from the software controlled 4000SSE Geodetic Surveyor used in the investigation of Marble Hall Fragment

```
**** Adjusted Coordinates ****

Projection Group: User-defined TM
Zone Name:       LO 29
Linear Units:    meter
Angular Units:   degrees
Datum Name:      Kaap

Station        Station         North             East            Ortho.     Ellip.
Short Name       ID                                              Height     Height
13060002       13060002    -2760355.65843    22218.39329      0.00000    853.34238

13070001       13070001    -2760247.41925    23171.72938      0.00000    865.72182

14060003       14060003    -2761221.54190    22145.38343      0.00000    861.25141

14070018       14070018    -2761222.45645    23194.96351      0.00000    871.04878

15060016       15060016    -2762128.40748    22206.34655      0.00000    872.11923

15070017       15070017    -2762283.65564    22926.09133      0.00000    878.45024

16040005       16040005    -2763268.28467    20487.61432      0.00000    857.42884

16050004       16050004    -2763167.22269    21234.56598      0.00000    869.63132

16060011       16060011    -2763442.51089    22314.87709      0.00000    880.90067

17030015       17030015    -2764342.29981    19216.37142      0.00000    869.26554

17040012       17040012    -2764469.66483    20252.17219      0.00000    859.60835

17050006       17050006    -2764341.07201    21207.59588      0.00000    868.83457

17060007       17060007    -2764219.69336    22076.89075      0.00000    880.92143

17070010       17070010    -2764271.77968    23311.46372      0.00000    894.31145

18020014       18020014    -2765643.36704    18345.23561      0.00000    863.67391

18030013       18030013    -2765486.44015    19320.97340      0.00000    876.15365

18070008       18070008    -2765103.42954    23346.20727      0.00000    897.46639

18080009       18080009    -2765605.70423    23986.27979      0.00000    904.06935

DAM 0001        DAM 0001   -2755136.46000    27594.46000      0.00000    882.64000


***** End of Report *****
```

3.2.2.3. DATA ACQUISITION: MAGNETIC SUSCEPTIBILITY (KT-9 Kappameter)

The KT-9 kappameter is a state-of-the-art, hand-held field magnetic susceptibility meter for obtaining accurate and precise measurements from outcropping rocks, drill cores and rock samples. Special design features make the KT-9 superior in measuring uneven rock surfaces and well suited to automated drill-core logging with digital recording, Figure 3.7.

The KT-9 kappameter has many unique features which include :-

(i) Easy to use : With a special measuring pin protruding from the centre of the measuring head. In order to take a reading, the pin is simply pressed against the sample to be measured. When the KT-9 is removed, it automatically displays the true measured susceptibility of the sample in SI units.

(ii) Hi-sensitivity – The maximum sensitivity of the KT-9 is 1 x 10^{-5} SI units. The largest value that can be read is 999 x 10^{-3} SI units. The auto-ranging capability of the unit gives it the best sensitivity range available.

(iii) True susceptibility – Unlike all other current commercial instrument which measure the apparent susceptibility, the KT-9's automated correcting routine displays the true susceptibility.

(iv) Uneven samples – The measurement of magnetic susceptibility is dependent upon the volume of material being sampled. The presence of an uneven surface creates air space gaps due to the sensor sitting up on bumps. This causes serious errors in the measured susceptibility of all other currently available commercial units. The KT-9 overcomes this problem by spacing the sensor a fixed distance away from the sample by means of a pin. The average of repeated measurements (placing the pin in different locations) averages the errors due to bumps to provide the true reading of the magnetic susceptibility. There is no reduction in the effective sensitivity of the KT-9 kappameter, because of the automatic compensation built into the unit.

(v) Variable audio – In the scan mode, the KT-9 has a variable audio tone that is directly proportional to the measured susceptibility. This allows for quick scanning of a rock surface and visually correlate areas of varying susceptibility.

(vi) Data averaging – The average of up to the 10 stored readings can also be displayed. This allows for very accurate measurement of uneven surfaces while in the pin mode, as well as improved data quality for smoother surfaces in the no-pin mode.

(vii) Digital output to a computer – The KT-9 can be connected to a computer via the serial port and a special cable. The KT-9 can then be controlled completely from the computer in a special remote mode.

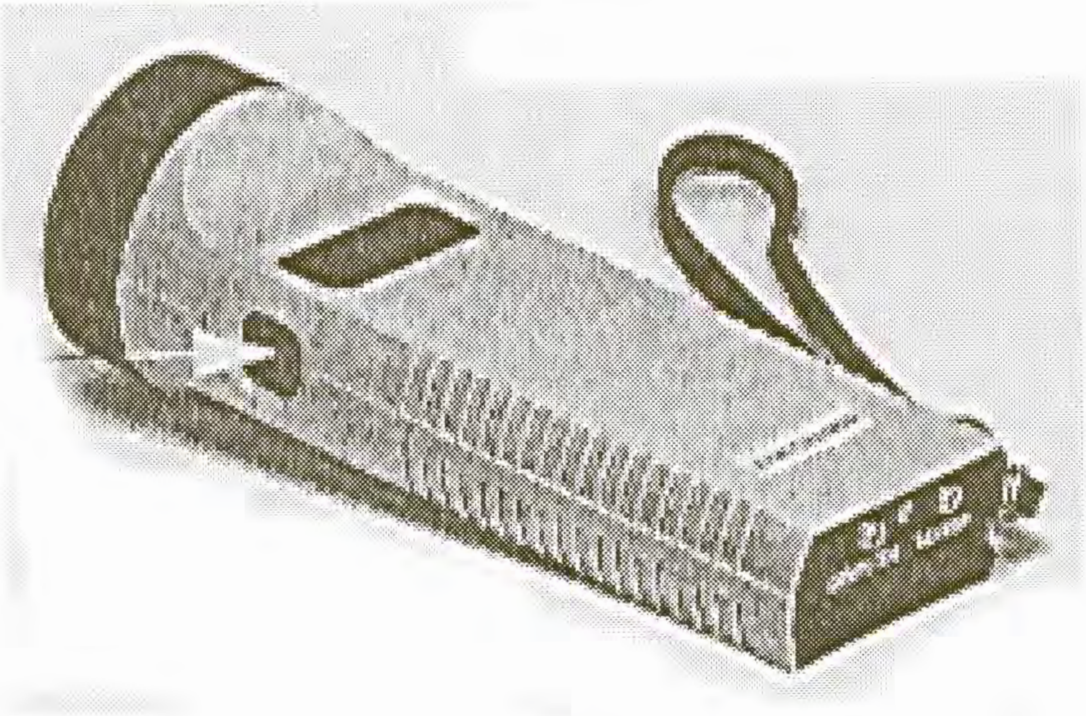

Figure 3.8. The KT- 9 Kappameter (Susceptibility meter)

3.3 DATA ACQUISITION, AIRBORNE MAGNETIC DATA

High density airborne magnetic data were purchased from the Council for Geoscience. The data were flown with a ground clearance of 60m and a line spacing of 87m.