4. MAGNETIC SURVEY

4.1 Introduction

Following completion of the gravity survey, a ground magnetic survey was carried out over the same area (i) to ascertain the exact position of the east-west striking dyke in the northern part of the area and (ii) to locate any other magnetic body that may have been present, e.g. kimberlite pipes or fissures.

4.2 Field work

Two Chemtron proton magnetometers (models G2) were used for the survey. Initially the sensor was mounted on a 3-metre staff but later it was decided to place the sensor in a backpack, because the wind caused slight swaying of the staff and because of dense bush in places. Readings and systematic checks were made every 10 m and a total of 14 650 readings were taken, including those necessary for the establishment of the 40 base stations.

The survey was carried out in north-south traverses but where anomalies were found, east-west traverses were added. Across the anomaly caused by the dyke, several traverses perpendicular to its strike were done (map 5).

A contour map (map 5) is used to present part of the data. Because the anomaly caused by the dyke is the only significant feature in the area, only the northern section of the area is shown.

The amplitude of the anomaly over the dyke varies between 100 and 500 nanoTesla (nT) against the background noise with a maximum range of 20 to 30 nT. The position of the dyke is therefore easily determined.

Like the majority of magnetic anomalies over thin dykes in South Africa, the anomaly has a positive component on the northern side of the dyke, which is larger than the negative component on its southern side (Richards , 1977; T. Hattingh, University of the Orange Free State, personal communication).

Using the available aeromagnetic data and aerial photographs the anomaly has been recognised as that being caused by a nearly vertical dyke and was called the Grasfontein dyke (Richards, 1973).

4.3 Calculations

Using the Koulomzine method (Koulomzine et al., 1970) the estimates of the centre of the dyke, the width and the depth to the top of the dyke were calculated. This method is based on the decomposition of the field curve $F_k = F(x)$ into its symmetrical and antisymmetrical components. The function $F_k = F(x)$ thus consists of the sum of two functions which can be expressed as follows ;

$$\Delta F_k = S(x) + A(x)$$

where $S(x) = \frac{1}{2}[\Delta F_k(x) + \Delta F_k(-x)]$

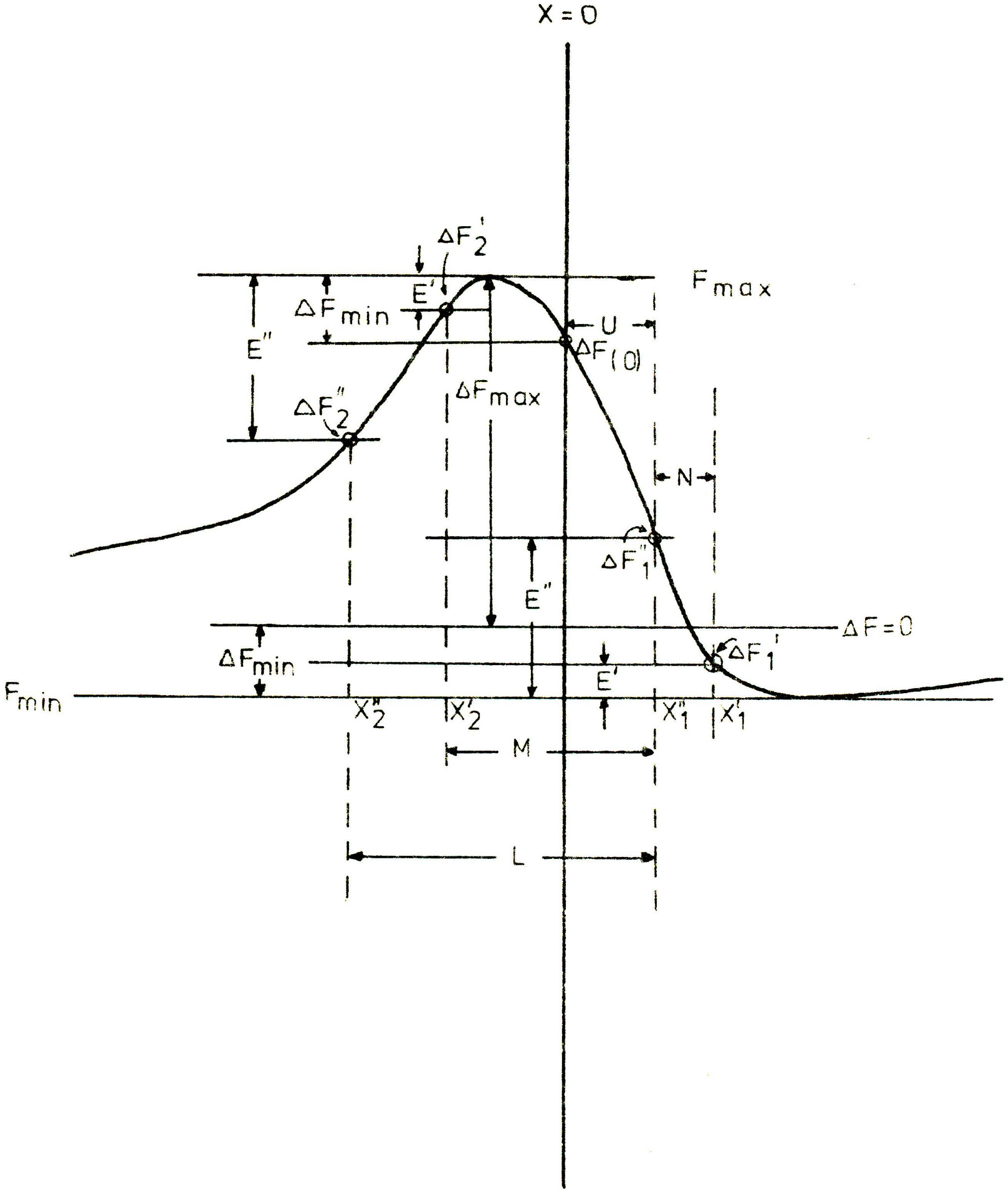
and $A(x) = \frac{1}{2}[\Delta F_k(x) - \Delta F_k(-x)]$

The x=0 position on the field curve, which corresponds to the centre of the dyke, is essential for separating the field curve into correct symmetrical and antisymmetrical components (Koulomzine et al., 1970). The point x=0 was graphically fixed using the Lamontagne method (Koulomzine et al., 1970) by calculating :

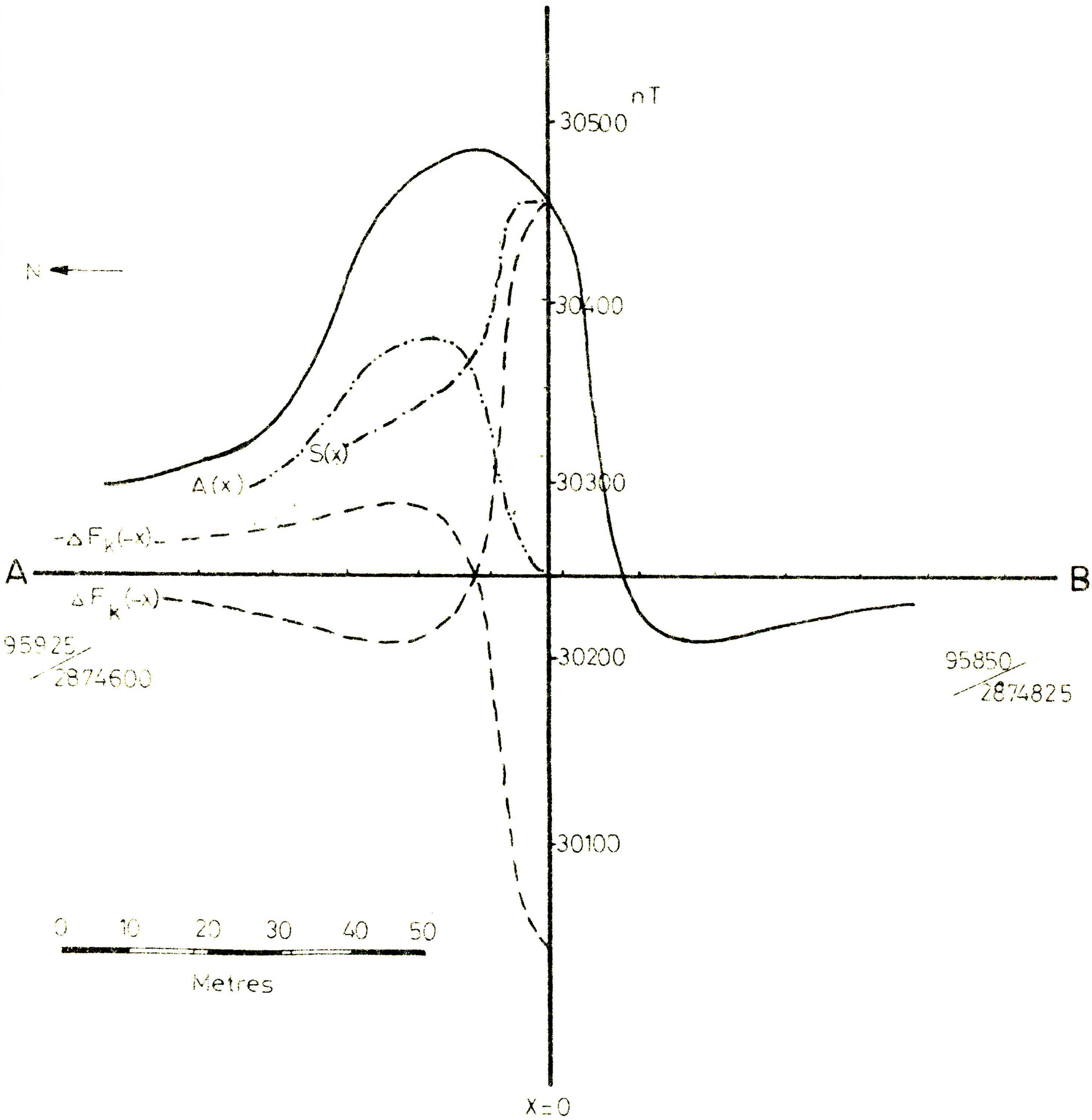
$$U = \frac{M \, . \, N}{L-M+N} \qquad \text{(Fig. 13)}$$

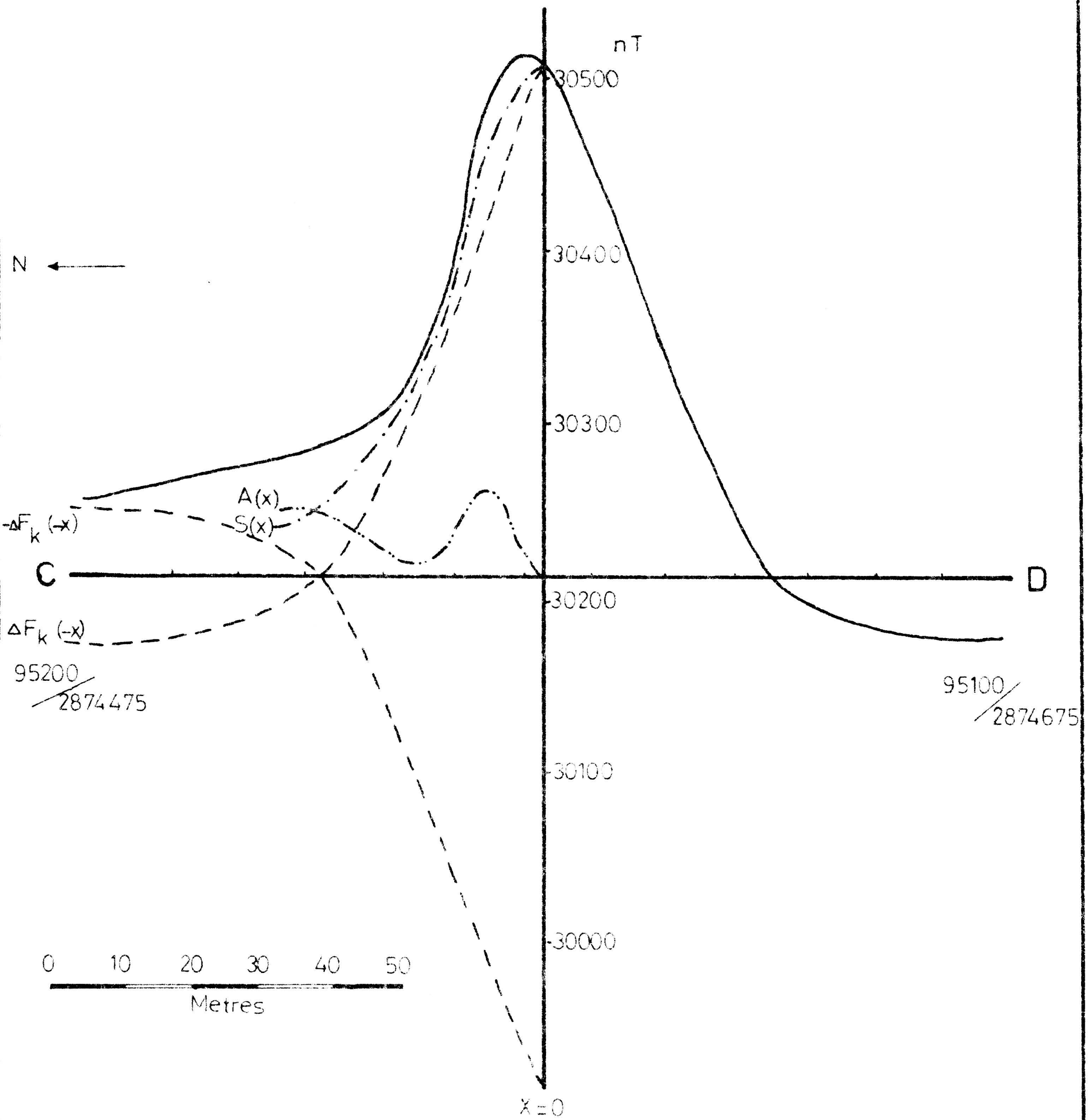
Two sets of conjugate points, $\Delta F_1'$ and $\Delta F_2'$ and $\Delta F_1''$ and $\Delta F_2''$ (fig. 13) were located on the field curve in such a way that the differences between their ordinates and the maximum and minimum are equal. This procedure was repeated four times on each of the three curves (figs. 14, 15 and 16) until the position where x=0 was satisfactorily determined on each of the curves.

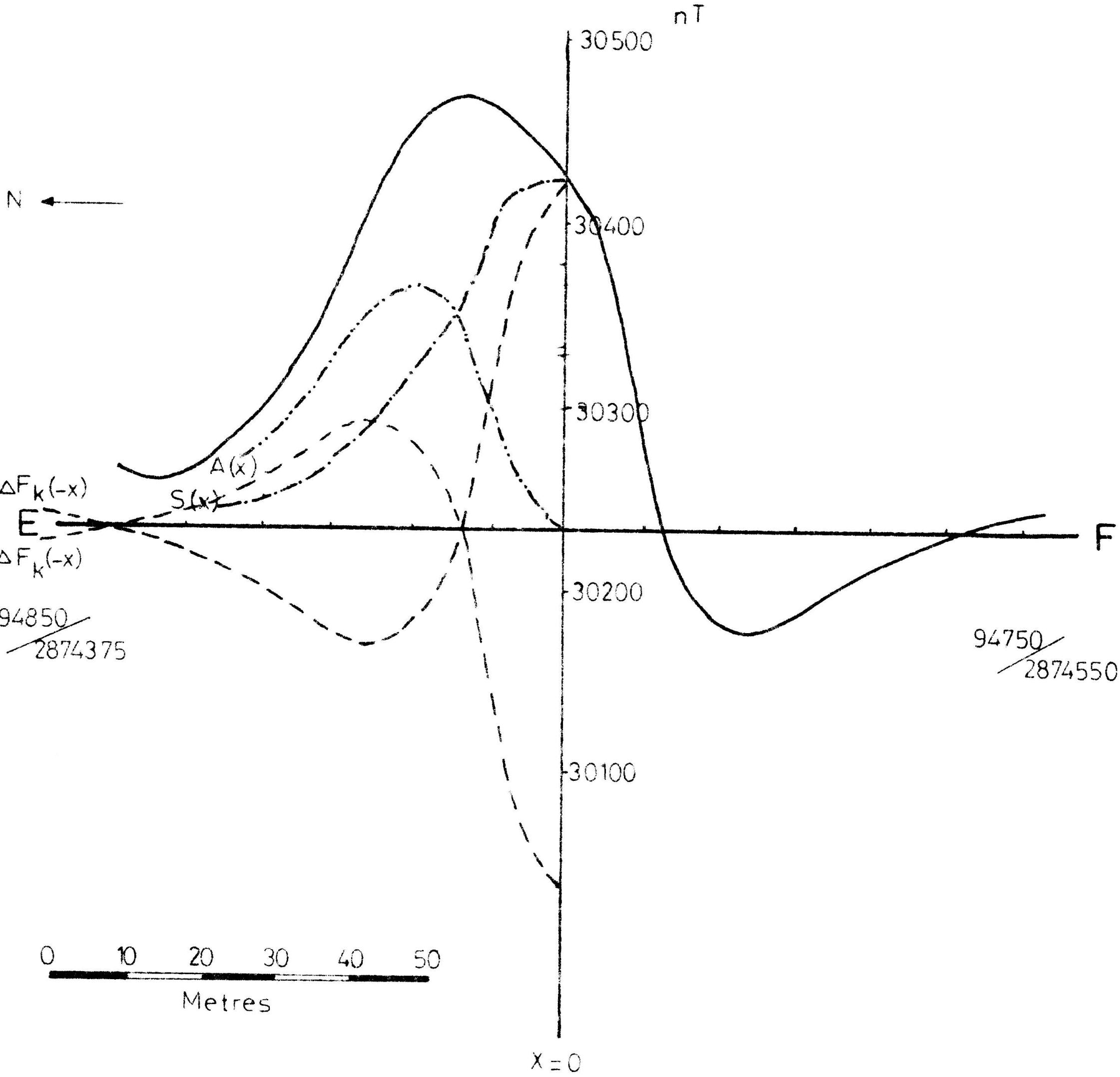
Due to the lack of information concerning the regional field the F=0 axis was simply determined perpendicular to the x=0 axis. The



Determination of the midpoint position of a dyke and the datum level from a total field magnetic profile by construction.


nT
30500
30400
30300
30200
30100
N
A(x)
S(x)
-ΔFk(-x)
ΔFk(-x)
A
B
95925
2874600
95850
2874825
0 10 20 30 40 50
Metres
X=0


nT
30500
30400
30300
30200
30100
30000
N
A(x)
S(x)
-ΔFk (-x)
ΔFk (-x)
C
D
95200/2874475
95100/2874675
0 10 20 30 40 50
Metres
X = 0



nT
30500
30400
30300
30200
30100
N
A(x)
S(x)
ΔFk(-x)
ΔFk(-x)
E
F
94850
2874375
94750
2874550
0 10 20 30 40 50
Metres
X = 0

symmetrical and antisymmetrical components were then constructed. The former is the locus of the midpoints between F_k (x) and F_k (-x) and the latter is the locus of the midpoints between F_k (x) and $-F_k$ (-x) (figs. 14, 15 and 16).

Four master curves (from Koulomzine and others, 1970) were used to calculate the width and depth of the top of the dyke. Table 3 gives the values obtained from these calculations;

TABLE 3 Calculated width and depth of Grasfontein dyke.

	S (x)		A (x)		AVERAGE	
	WIDTH	DEPTH	WIDTH	DEPTH	WIDTH	DEPTH
Profile 1	16,1	10,4	20,8	7,8	18,5	9,1
Profile 2	18,0	5,9	19,1	5,2	18,6	5,6
Profile 3	29,2	8,5	27,9	9,5	28,6	9,0

The average values for the width of the dyke range from approximately 18 to 28 m for the three profiles; while the depth varies from about 5,6 to 9,1 m. Depths obtained from models of the gravity survey over the dyke varied from 12 to 40 m. However that is down to unweathered dyke material. Drilling has shown that a clay consisting of decomposed basic material was present above un-weathered dyke material on Ruigtelaagte (Stettler, 1979) and that magnetic material in the clay could have been responsible for the difference (Stettler, 1979) Variations between the three profiles probably reflect the uneven geometry of the dyke such as different erosion levels to the top of the dyke and non-parallelism of its margins.

The above values for the width are slightly lower than those obtained in rough calculations using the maximum-minimum distance, the half-peak width and the half-slope distance methods used by Richards (1973). Values for the depth of the dyke for the profiles 1, 2 and 3 using the latter method are 16, 12 and 14 m respectively. These methods are however only applicable to very thin dykes (Richards, 1973).

Using available curves for estimating dip (Richards, 1977) the following results were obtained for the dip of the dyke along profiles 1, 2 and 3, viz., ∿ 100-105°, ∿ 90° and ∿ 90° from North respectively.

From the general trend of the contours of the total magnetic intensity map, it appears that the dyke has been displaced by dextral wrench faults (around peg 1300/400 and 750/550, Map 5) and has been interpreted as the Rooisloot fault (Day, 1980). Similar faults affecting the Grasfontein dyke have been described by Day (1976) just west of the study area.

In conclusion it appears that the position of the dyke had a considerable influence on the deposition of the gravels of the "Rooisloot". These gravels can be seen to be closely associated with the dyke over a considerable strike distance (figs. 1 and 2).

It seems likely that preferential weathering has occurred along the zones where dykes have intruded the country rock and these have been likely areas for river drainage. The area overlying the Grasfontein dyke, in the study area at least, is in fact a geographical valley (fig. 8).