STANDARD CHARTS FOR DIRECT DETERMINATION OF MAGNETIC SUSCEPTIBILITY USING THE PRINCIPAL EQUATION OF DOLGINOV ASTATIC MAGNETOMETER

By

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ABSTRACT

The arrangement of standard charts for measuring magnetic susceptibilities of rock specimens, has been greatly desired in many aspects since it will save for the calculator much labour and time spent during substitution and computation processes using the principal equation of Dolgniov astatic magnetometer. This paper consists of a complete study of how to calculate and design the standard charts, some of which are given for representation.

INTRODUCTION

It is well known that magnetic fields are mostly developed through electric circuits and magnetic materials and from the electromagnetic theory we have :

$\vec{B} = \vec{H} + 4\pi \vec{I}$, where $\vec{B}$ represents the flux density produced in the material, $\vec{H}$ is called the magnetic intensity which depends upon the shape of the material and $\vec{I}$ is the intensity of magnetisation or magnetic moment per unit volume which in general varies with $\vec{H}$ according to :

$$\vec{I} = \chi \vec{H}, \qquad (1)$$

where χ is the magnetic susceptibility per unit volume. The equa-

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tion used in Dolginov astatic magnetometer for measuring magnetic susceptibility (1), (2) (X) is as follows :

$$X = \frac{V}{P} \ominus . K , \qquad (2)$$

where : V = The volume of the two plastic tubes filled with the specimen or sample in a powder state ; i.e. the volume of the specimen.

P = The weight of the sample filling the two tubes.

$\ominus$ = The angle of the deflection due to the distance of the two tubes on the two arms of the magnetometer.

K = Constant for every special distance on the two arms of the magnetometer.

Since the magnetic interpretation (3) has taken its place beside the other important geophysical methods that are fundamental to petrolium and mining exploration, it is advantageous that we calculate accurately and in a short time the magnetic susceptibilities of rock samples. For this reason, standard charts are arranged to save both time and labour.

EXPERIMENTATION AND RESULTS

Using Dolginov astatic magnetometer, the magnetic susceptibilities (2) of various rock specimens were measured.

Rock specimen were brought from Eastern Desert — Wadi Safaga. The routine work of the magnetometer can be summarised as follows :

a) The two tubes of the magnetometer are filled with a certain weight (P) of the specimen in the powder state.

b) The two filled tubes are set on the two arms at a definite distance (a).

c) Knowing the instantaneous constant (K) for this distance on the arm and the volume (V) of the specimen (tube), we can determine the magnetic susceptibility by substitution in equation (2).

The determination of magnetic susceptibility for every specimen by substitution in quation (2), takes a lot of time and increases the experimental error during measurements. These considerations may be of great influence on the rsults, especially when these data are

treated as a reference in magntic interpretation of the field work in geophysical survey.

Consequently, the design of standard charts is necessary and greatly required in order to avoid disturbances and to save much time and effort for the calculator during the tedius substitution in equation (2) for every measurement.

DISCUSSIONS

It is easy and advisable for any research worker to design for his work, a plan (4), (5) by which he can obtain quick and exact results. This plan depends on the style and the system of treatment of any scientific problem. It is the purpose of this paper to facilitate the method of calculating magnetic susceptibilities so that we obtain more correct results in a very short time.

From the Dolginov equation, we can have much standard curves which would be very difficult to handle, if we do not tabulate them in such a way so as to use them in a good manner. So, we suggest the following systematic (6), (7) steps :

(a) It is better if we organise the work to groups. The group named after its weight for it, i.e., the group I for P = 1 gm, the group II for P = 1.1, the group III for P = 1.2 gm and so on.

(b) Every group must be divided into subgroups. These subdivided groups involve distances a_1, a_2, a_3 ... on the two arms of the magnetometer.

Multiplying the instantaneous constant (K) for every distance (a) with different deflections $\ominus$ (From 0 to 28°), we obtain for every distance numerous values for plotting charts. As a result, the group with eleven distances would give us a group of eleven curves as shown in Charts 1, 2 and 3 for Group I and in Charts 4, 5 and 6 for Group II.

(c) The range of our work in building the tables and in constructing the charts, includes weights for 1.0 gm to 1.5 gm. Every group is specialised for a value (from 1 gm to 1.5 gm) which increases regularly by 0.1 gm. Thus, we have six groups of tables and six groups of curves. Every set or group of curves consists of 11 curves.

The group of tables and curves are tabulated as follows :

No. Groups	Special	Serial weight P	Number of tables	Set of curves	Figures of Charts
1	G. I	P=1.0 gm	1,2,3	eleven curves	1 — 2 — 3
2	G. II	P=1.1 gm	4,5,6	eleven curves	4 — 5 — 6
3	G. III	P=1.2 gm	7,8,9	eleven curves	
4	G. IV	P=1.3 gm	10,11,12	eleven curves	
5	G. V	P=1.4 gm	13,14,15	eleven curves	
6	G. VI	P=1.5 gm	16,17,18	eleven curves	

N.B. (Because of time and space for publishment, we satisfy to to involve here six charts representing tables 1, 2, 3 ... 6 for the two groups I and II.

(d) For direct determination of magnetic susceptibility, it is necessary to know :

i — The kind of group as a function of the weight.

ii — From the distance of the two arms (a — K), we select the curve from the defined group.

iii — From the defection determined during measurement and from the selected cbart, we can determine directly and more reliable the magnetic suspectibility without tedius and prolonged calculation.

CONCLUSION

1) The tables calculated and the plotted charts make an essential distinction between the hard work, the procsss of substitution followed by prolonged calculations for every sample, and the direct determination of magnetic susceptibility of the same sample.

2) The design of the charts depends on a plan easily understood, not overbloaded with instructions for applying them.

3) In the near future, we would hope to accomplish much work by adding computed tables and plotting sets of charts including probable weights from 1.5 gm to 3.0 gm to cover a suitable higher range of mean density of rocks and minerals present in the crust of the earth..

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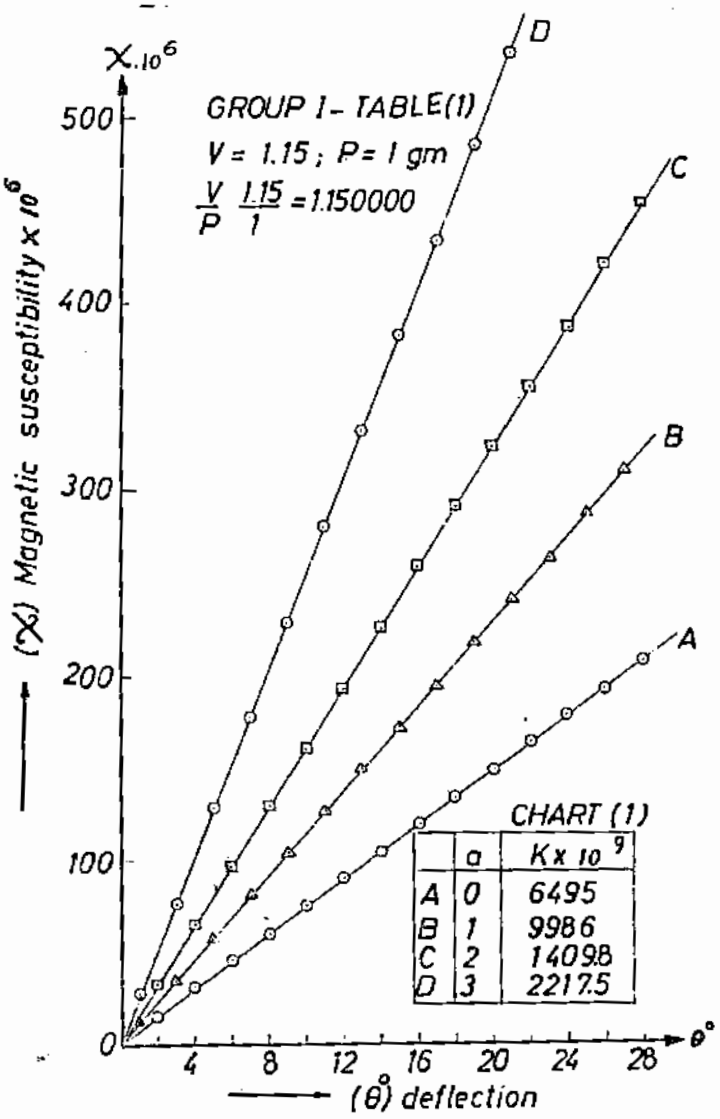

X.10^6
GROUP 1- TABLE(1)
V = 1.15 ; P = 1 gm
V/P 1.15/1 = 1.150000
(X) Magnetic susceptibility x 10^6
500
400
300
200
100
0
D
C
B
A
4
8
12
16
20
24
28
θ°
(θ°) deflection
CHART (1)
a
K x 10^9
A 0 6495
B 1 9986
C 2 14098
D 3 22175

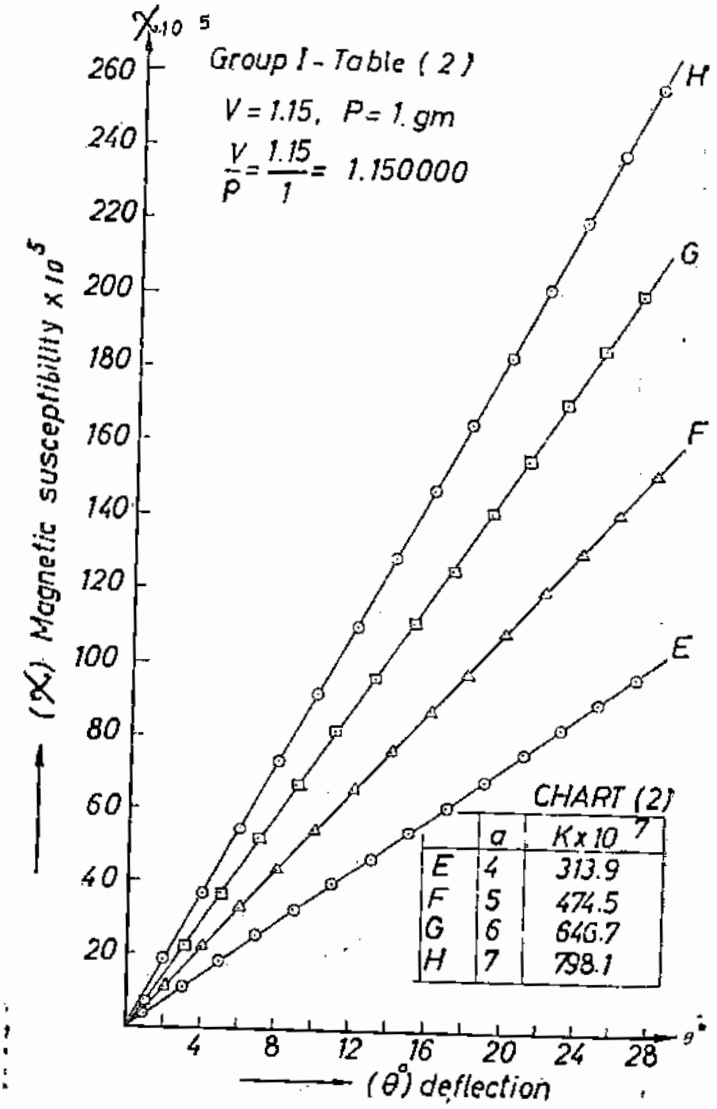
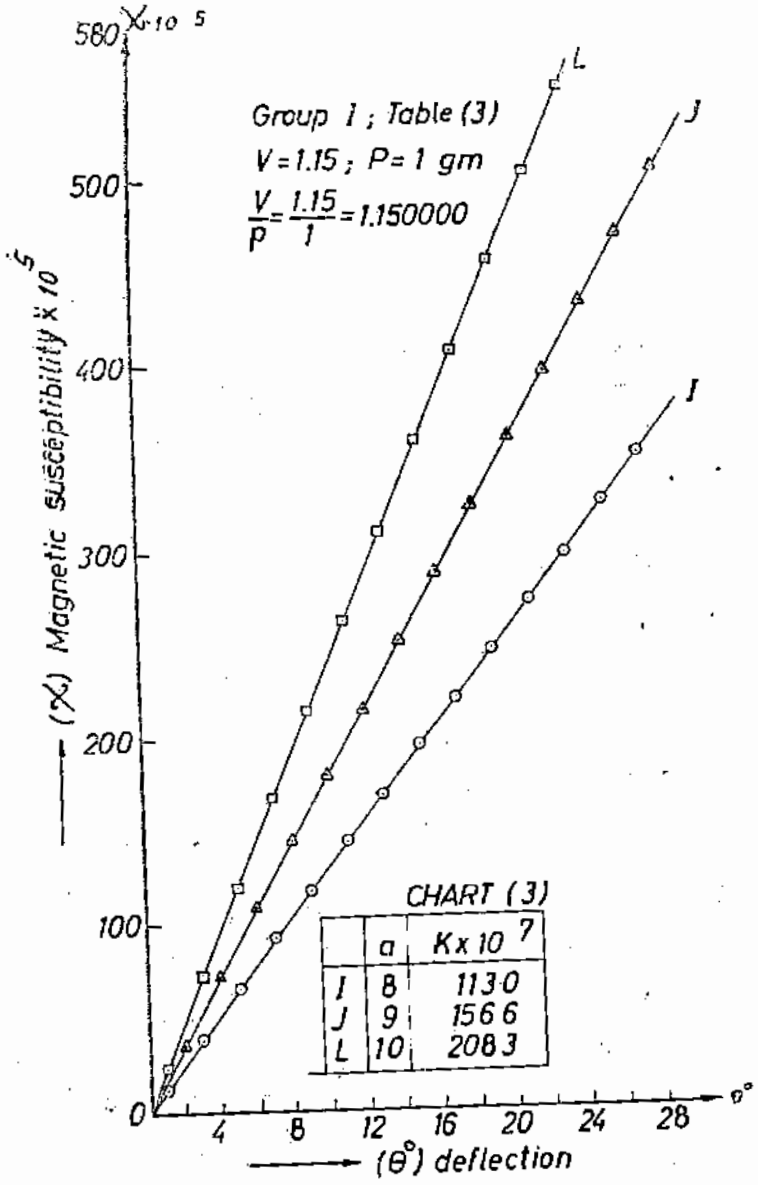
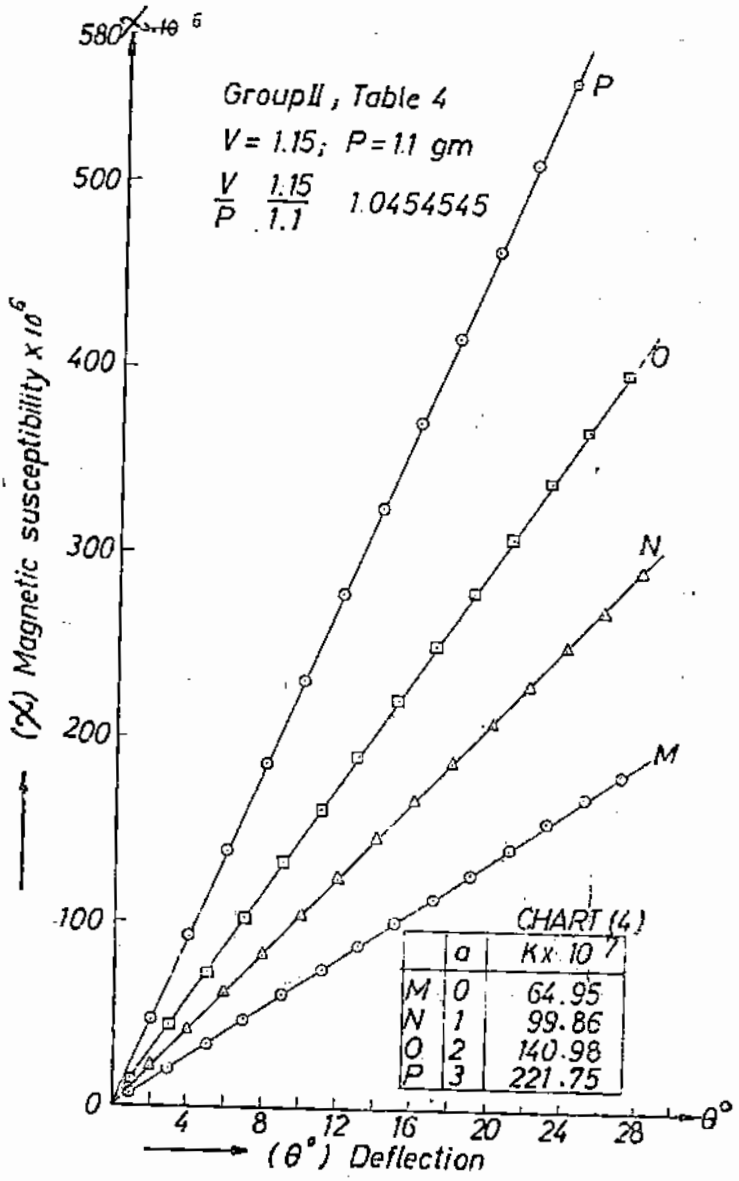
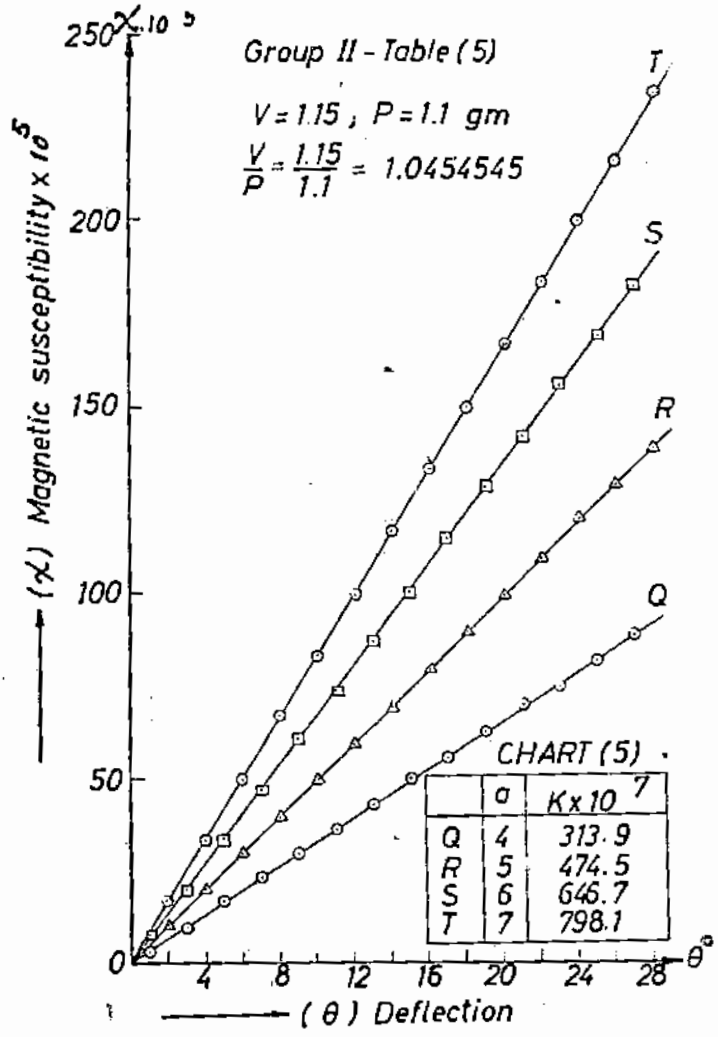


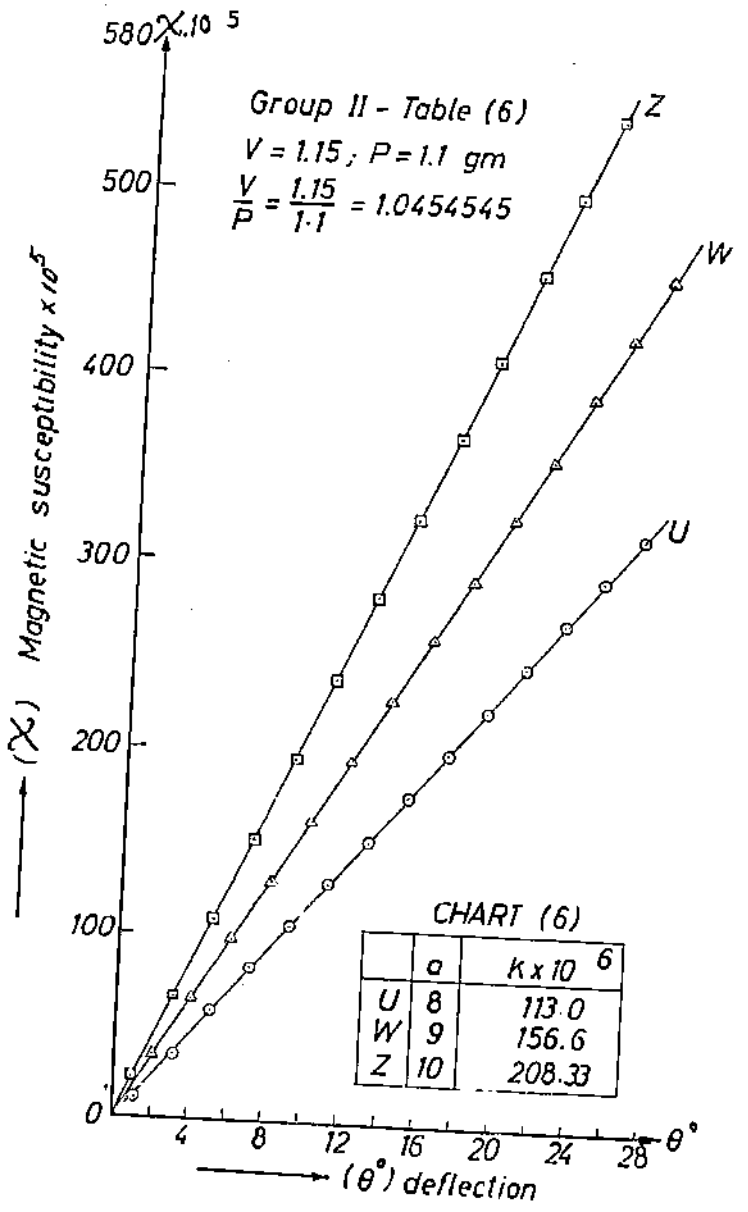
CHART (2)

	a	K x 10 7
E	4	313.9
F	5	474.5
G	6	640.7
H	7	798.1


χ·10 5
580
500
400
300
200
100
0
(χ) Magnetic susceptibility x 10 5
Group I ; Table (3)
V = 1.15 ; P = 1 gm
V/P = 1.15/1 = 1.150000
L
J
I
CHART (3)
a
K x 10 7
I 8 1130
J 9 1566
L 10 2083
4
8
12
16
20
24
28
θ°
(θ°) deflection


Group II , Table 4
V = 1.15; P = 1.1 gm
V/P 1.15/1.1 1.0454545
P
O
N
M
(χ) Magnetic susceptibility x 10⁶
(θ°) Deflection
θ°
0
100
200
300
400
500
580
4
8
12
16
20
24
28
CHART (4)
a
K x 10⁷
M 0 64.95
N 1 99.86
O 2 140.98
P 3 221.75


Group II - Table (5)
V = 1.15 , P = 1.1 gm
V/P = 1.15/1.1 = 1.0454545
T
S
R
Q
CHART (5)
Q 4 313.9
R 5 474.5
S 6 646.7
T 7 798.1
250
200
150
100
50
0
4
8
12
16
20
24
28
θ°
(χ) Magnetic susceptibility x 10^5
(θ) Deflection


580 χ.10 5
500
400
300
200
100
0
(χ) Magnetic susceptibility x 10^-5
Group II - Table (6)
V = 1.15 ; P = 1.1 gm
V/P = 1.15/1.1 = 1.0454545
Z
W
U
4
8
12
16
20
24
28
θ°
(θ°) deflection
CHART (6)
a
K x 10 6
U 8 113.0
W 9 156.6
Z 10 208.33