#43

Soil Science

Vol. 104, No. 3
Printed in U.S.A.

NOTE

Digital Computer Program for Particle-Size Distribution and Textural Classification of Soils[1]. Determination of sand, silt, and clay proportions is an integral part of soil analysis. The most common method for making such determinations employs a hydrometer. Although this method is not as accurate as the pipette-sampling method, it is theoretically sound, and it has the advantage of not requiring pretreatment of the sample. It does, however, require the plotting of concentrations against diameter and of interpolating concentrations at desired diameters, steps that are time-consuming and difficult to teach to laboratory assistants.

At least over short ranges, the diameter-concentration relationship is linear and lends itself to a short computer operation. With or without modifications, the program described in this paper should be of benefit to any laboratory that runs as few as a dozen samples a week. Since approximately 250 analyses can be calculated per minute, laboratories routinely determining hundreds of analyses for surveys could effect great savings through use of this program.

A program for computing results of hydrometer tests has been written by Knodel (4) and is a part of a gradation test handling material with diameter measurements of less than 5 μ to 5 inches. Knodel's program has the advantage of incorporating material larger than 2 mm., whereas the program described below is restricted to very coarse sand and smaller-sized particles. This latter program corrects for the "depth discrimination" cited by Day (2) and Casagrande (1); it also determines textural classification of the soils within classification boundaries set by the Soil Conservation Service (5).

METHOD

The Fortran II Source Program was written for an IBM 7072 computer. Essentially, it uses the two-point form of a straight line

$$\frac{y - y_1}{x - x_1} = \frac{y_1 - y_2}{x_1 - x_2}$$

which transforms into

$$CL = C(3) + \left[\frac{C(3) - C(4)}{\log DIA(3) - \log DIA(4)}\right] \cdot [\log (2.0\ \mu) - \log DIA(3)]$$

where CL is the percentage of particles 2 μ in diameter and smaller, and C (3) and C (4) are percentages of the total material that have particle diameters [DIA (3) and DIA (4)] larger and smaller, respectively, than 2 μ.

A similar equation is used, in which 50 μ or any diameter is substituted for 2 μ, to obtain suitable percentages and diameters above and below the selected diameter. The analytical procedure followed at our laboratory is to determine a percentage based on a 50 μ reading of silt plus clay and a 2 μ reading of clay. The latter is deducted from the former to fix silt, and the silt-plus-clay percentage is deducted from the total amount to determine the sand percentage. Since this injects errors occurring throughout the procedure into the sand figure, it may be undesirable. However, the program can be so modified that the sand percentage is determined directly by sieving and weighing the sand. Comparison of the sand percentage determined directly and by difference has shown a precision of ±1 per cent sand without the occurrence of any systematic errors.

Data collected are entered on data cards (table 1). Site and depth are entered in alphanumeric form. The observed stem readings at 30 seconds, 1 minute, and approximately 6 and 12 hours are entered. In military style, time at the end of stirring, and at the 6- and 12-hour readings is entered next. The initial amount of soil is the last entry per card.

It is necessary to precede data cards with a control card [FØRMAT (F5.0)] giving the stem reading value of the dispersant. This blank is maintained as a constant through as many analyses as desired. If a new solution of dispersant yields a different blank reading, a figure "1" is punched in K (column 36) on the last card of a data set, and followed with a control card having the new value of CLGON. All following calculations use this value in computing corrected stem readings until a figure "1" in column 36 is again read.

The program first calculates theta, the sedimentation parameter, as shown in table 43.7 of

[1] The author thanks D. L. Chery and B. K. Cross for their suggestions and criticisms.

TABLE 1

Data card

1–5	6–15	16–20	21–25	26–30	31–35	36	37–38
ID A5	IDPTH 2A5	RØB(1) F5.0	RØB(2) F5.0	RØB(3) F5.0	RØB(4) F5.0	K I1	IHR1 I2

39–40	42–43	44–45	47–48	49–50	51–60
MIN1 I2	IHR2 I2	MIN2 I2	IHR3 I2	MIN3 I2	CØ F10.0

Fortran Symbol	*Definition*
ID	Identification number of plot, site, etc.
IDPTH	Identification of depth of sample, or other alphanumeric identification.
RØB( )	Observed stem readings.
K	Indexing variable to reset CLGØN.
IHR1	Starting hour.
MIN1	Starting minute.
IHR2	Hour of third reading.
MIN2	Minute of third reading.
CØ	Weight of sample (grams).

Day (3), by comparison with observed reading in a data table. This table of 261 values is constructed on the premise that the hydrometer can be read only to ¼ of a division. Time is reduced to minutes, and diameters are obtained from the relation: $DIA = \Theta\ (t)^{1/2}$. The two-point equation is applied to find percentages at the two limiting diameters. Percentages of sand, silt, and clay are obtained by subtraction. These percentages are then used in a sorting process, comparing clay percentages, and silt or sand percentages to those of the textural classification triangle, to ascertain the texture.

As the program is written and compiled, failure to end any RØB in 0, 2, 5, or 8 will cause an apparent normal exit, with the information that a certain card was not read. Look for an erroneous RØB on the preceding card.

A listing of the program may be obtained by writing the author.

SUMMARY

A Fortran II source program was written to determine particle-size distributions and textural classifications of soil samples. The method of calculation is a derivation of the two-point method, and a correction is applied to adjust for depth discrimination.

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Received for publication April 27, 1967