SCHTRAV - A FORTRAN program to calculate apparent resistivities for traverses using the generalised Schlumberger array

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Abstract

SCHTRAV is a FORTRAN program which interactively calculates and tabulates generalised Schlumberger array apparent resistivity values without approximating the geometrical factor. An automatic position facility is available during interactive data reduction.

INTRODUCTION

SCHTRAV is written in FORTRAN 77 and runs interactively through a .CSS on the Tasmania Department of Mines Perkin-Elmer 8/32 mini-computer. Field data from a generalised Schlumberger array are input and the program calculates the apparent resistivities. The resultant file of tabulated apparent resistivities may be edited later through the Perkin-Elmer edit facilities.

THE APPARENT RESISTIVITY FORMULA

Parasnis (1973) gives the apparent resistivity of the generalised Schlumberger resistivity array as

$$\rho a = \frac{\pi}{2l} \cdot \frac{(L^2 - x^2)^2}{L^2 + x^2} \cdot \frac{\Delta V}{I}$$

provided that the potential probes are sufficiently far from either current electrode, say at least 10 times the distance $2l$. ΔV is the voltage between the potential electrodes, I is the current in the ground, L, l and x are as shown in Figure 1.

As programmable pocket calculators and computing facilities are now ubiquitous it seems unnecessary to use the above approximate formula. The apparent resistivity of any four electrode resistivity array is as follows

$$\rho a = \frac{\Delta V}{I} \cdot 2\pi \frac{1}{\left(\frac{1}{C_1P_1} - \frac{1}{C_2P_1} - \frac{1}{C_1P_2} + \frac{1}{C_2P_2}\right)}$$

where P_1, P_2 are the potential electrodes; C_1, C_2 are the current electrodes; C_1P_1 is the distance between C_1 and P_1, *etc*. The expression in this form is used by SCHTRAV to calculate the apparent resistivity. As a matter of interest, we shall now transform the expression, without approximation, so that it resembles the approximate formula.

$$\Delta V = \frac{I\rho}{2\pi} \left\{ \left(\frac{1}{C_1P_1} - \frac{1}{C_2P_1}\right) - \left(\frac{1}{C_1P_2} - \frac{1}{C_2P_2}\right) \right\}$$

$$= \frac{I\rho}{2\pi} \left(\frac{1}{L-l-x} - \frac{1}{L+l+x} - \frac{1}{L+l-x} + \frac{1}{L-l+x}\right) \qquad \text{for } L>x$$

$$\therefore \rho = 2\pi\frac{\Delta V}{I} \frac{1}{\left(\frac{1}{L-(l+x)} - \frac{1}{L+(l+x)} - \frac{1}{L-(x-l)} + \frac{1}{L+(x-l)}\right)}$$

$$= 2\pi\frac{\Delta V}{I} \frac{1}{\left(\frac{2(l+x)(L^2-(x-l)^2) + 2(l-x)(L^2-(l+x)^2)}{(L^2-(l+x)^2)(L^2-(x-l)^2)}\right)}$$

$$\therefore \rho = 2\pi\frac{\Delta V}{I}\,\frac{L^4-L^2[(l+x)^2+(l-x)^2]+(l+x)^2(l-x)^2}{2l(L^2-(l-x)^2+L^2-(l+x)^2)+2x((l+x)^2-(l-x)^2)}$$

$$\therefore \rho = 2\pi\frac{\Delta V}{I}\,\frac{L^4-2(l^2+x^2)L^2+l^4-2x^2l^2+x^4}{4l(L^2-l^2-x^2+2x^2)}$$

$$\therefore \rho \quad \frac{\pi}{2l}\,\frac{\Delta V}{I}\,\frac{(L^2-x^2)^2}{L^2+x^2}\,\Big|\,\frac{-2l^2L^2+l^4-2x^2l^2}{-l^2}$$

which reduces to the approximate formula when (L-x)>>2*l*.

INTERACTIVE RUNNING

To start the program type 'SCHTRAV X.Y', where X.Y is the name you give to the file which will contain the reduced data. The screen will respond with

"THIS IS AN ASYMMETRICAL SCHLUMBERGER ARRAY PROGRAM.
IF YOUR ARRAY IS NOT SCHLUMBERGER THEN YOU HAVE THE
WRONG PROGRAM.
ENTER NAME AND NUMBER OF TRAVERSE (80 CHARACTERS MAXIMUM)".

Enter name and number of traverse (80 characters maximum), then enter title/number *etc.* of traverse and this will be written as the first line of your file, followed by the line:

"ASYMMETRICAL SCHLUMBERGER ARRAY"

and the screen will then respond with:

"DO YOU WISH TO ENTER FURTHER INFORMATION?
(E.G. DATE, LOCATION, COMMENT)"

If your reply is "Y" for yes the response is:

"ENTER A LINE OF INFO., 80 CHARS.MAX."

and you should then enter up to 80 characters of information. The screen will continue to request a line (80 characters) of header information while you continue to respond with "Y" to "DO YOU WISH TO ENTER FURTHER INFORMATION?" In response to "N", the screen will ask for field data, beginning with:

"ENTER HALF CURRENT ELECTRODE SPACING"

followed by:

"ENTER HALF POTENTIAL ELECTRODE SPACING"

The required values should be in metres.

The next screen response is:

"DO YOU WISH TO ENTER DATA IN AUTOMATIC OR MANUAL MODE?" (A/M)

If you answer A (for AUTOMATIC) the computer will display successive potential electrode positions and you will only have to enter ΔV/I. If you answer M (for MANUAL) the computer will require you to enter both the mean position of the potential electrodes and ΔV/I.

The screen response to A is:

"ENTER FIRST (CENTRE) POSITION OF POTENTIAL ELECTRODES
AND POSITION INCREMENT, IN METRES
POSITIVE FOR N OR E, NEGATIVE FOR S OR W
INCREMENT MUST HAVE APPROPRIATE SIGN
..... POSITIVE IF MOVING TO MORE POSITIVE POSITION
AND NEGATIVE IF MOVING TO MORE NEGATIVE POSITION"

After entering these values the screen response is:

"ENTER RESISTANCE VALUE FOR ELECTRODE POSITIONS
x1 AND x2 TYPE 0.0 to QUIT",

where x1 and x2 appear as the appropriate numbers.

Entering the resistance value will cause the screen to display the calculated apparent resistivity, the potential probes centre position, the positions of the potential probes, and the resistance value ($\Delta V/I$).

The program will continue to type the next potential probe positions and prompt for the resistance value unless the user terminates the program by typing "0.0".

If you answer M (for MANUAL) then the screen response will be:

"ENTER POTENTIAL PROBE POSITION FROM CENTRE, RESISTANCE
TYPE 0.0, 0.0 to QUIT."

"Centre" is the midpoint of the current electrodes.

In response to these values the request will be repeated until "0.0,0.0" is entered, upon which the program will terminate.

The user is protected throughout the program against failure to supply an answer known to the computer. For example, failure to respond with A or M to the query about automatic or manual mode will invoke the response:

"ANSWER A or M"

REFERENCE

PARASNIS, D.S. 1983. *Mining geophysics. Methods in geochemistry and geophysics 3.* Elsevier : Amsterdam.

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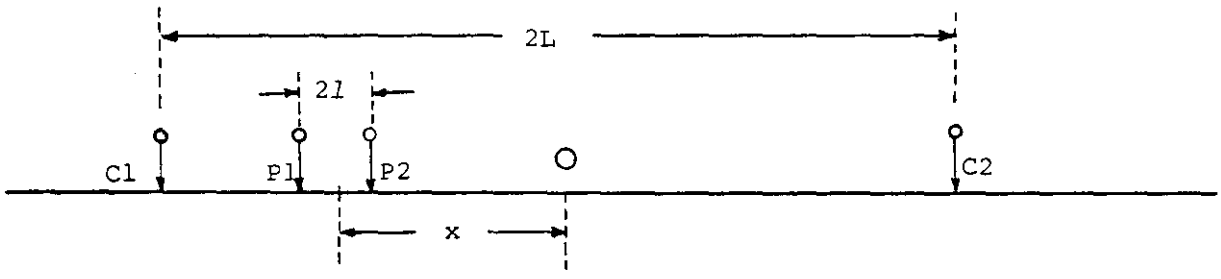

Figure 1.