UR1976-66

1976/66. Resistivity interpretation using the filter transform method programmed for the Wang 700 B.

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A programme (2B1) which allows very rapid calculation of resistivity models for indirect interpretations of field soundings has been prepared for the Wang 700/702. The method of calculation uses the filter transformation method first described by Ghosh (1971). The filter used is based on the sinc (x) function with coefficients selected such that the process is most efficient when dealing with Schlumberger configuration. The filter outlined by Ghosh (1971) did possess deficiencies but these have been overcome as suggested by O'Neill (1975).

The programme uses a long set of selected, accurately calculated coefficients similar to those of O'Neill (1975).

The method involves calculation of resistivity ratios and exponential depth functions in the non-integral form listed below which avoids the difficulties of the combined solution of Bessel and Stefanesco integrals. The calculation iterates from the bottom of the section and the present programme is operable for four layers. It is possible that the capacity of the Wang 700 B might allow calculation for a fifth layer but this development may be unnecessary. Having produced a resistivity transformation by iteration the transform function is filtered and weighted. The result is the resistivity curve for the input data. Since no series or integral evaluations are necessary the process is simply arithmetical and very rapid.

$$T_{34} = \rho_3 \frac{(1 + k_{34}e^{-2d_3/u})}{1 - k_{34}e^{-2d_3/u}}$$

where T_{34} is the transform for the third interface
ρ_3 is the resistivity of the third layer
k_{34} is the reflection coefficient of the third and fourth layers ($= \rho_4 - \rho_3/\rho_4 + \rho_3$)
u is the depth function, $y = e^u$
d_3 is the depth to the third layer.

$$T'_{23} = \rho_2 \frac{(1 - e^{-2d_2/u})}{1 + e^{-2d_2/u}}$$

$$T_{234} = \frac{T'_{23} + T_{34}}{1 + T'_{23}T_{34}/\rho_2{}^2}$$

$$T'_{12} = \rho_1 \frac{(1 - e^{-2d_1/u})}{1 + e^{-\ d_1/u}}$$

$$T_{1234} = \frac{T'_{12} + T_{234}}{1 + T'_{12}T_{234}/\rho_1{}^2}$$

The programme

Register occupancy	-	0 to 54, 11 free
Verify	-	5441
Last step	-	500
Basic mark	-	0
Process time (incl.input)	∿	1 minute

Operation

Wind on the paper as the curve is plotted *above* the data print.

1. Prime, verify (5441), *SEARCH O*. (note: there are no titles).
2. Key ρ_1, GO; ρ_2, GO; ρ_3, GO; ρ_4, GO.
3. Key d_1, GO; d_2, GO; d_3, GO. Data is printed. (Note: Seven values must be keyed. (see below))
4. Calculation commences and lasts 10-15 seconds.
5. Wind on paper. Search O for next curve.

Curve reference

Since no axes are plotted the curve must be compared with the field plot (or master graph paper) by using asymptotic values (usually for ρ_1) and the module of calculation. The resistivity scale is established using an asymptote but the depth scale must be fixed by measuring 47 mm right from the first plotted point. This provides the value $d = 1$. Since the module size is standard at 62.5 mm the plot may be correlated. Thus a false origin of $1,\rho_1$ is usually easily found. In some cases $1,\rho_4$ may be more easily established. The plot is log-log to the base 10.

NOTES

The programme is accurate to better than 0.5-1% for k values - $0.98>k>1.00$ and better than 1.5% for $- 1.00>k>-0.98$.

The programme may be unstable in certain cases where $d_1 <1.6$ and this will show in the plotting of a single near origin point obviously off the curve. (Solution of this problem is to greatly extend the filter). This occasional and, in view of the condition, rare problem in no way detracts from the interpreted curve as a whole.

The programme is for Schlumberger curves only. Wenner calculations will require replacement of the filter sub routine.

2 or 3-layer curves

To this point it has been assumed that the user will calculate four layers - the limit of the present programme. However, since the method is iterative the information necessary to calculate two or three layer curves is present and may be easily extracted. To do this one must key resistivity values such that basal k values = o.

i.e. for two layer curves, input $\rho_4 = \rho_3 = \rho_2$
and for three layer curves, input $\rho_4 = \rho_3$.

It is not necessary to equate d values (*i.e.* $d_3 = d_2 = d_1$ or $d_3 = d_2$) respectively but it is suggested in order to minimise possible confusion.

Whatever type of curve is being calculated *seven* pieces of data must be input.

REFERENCES

GHOSH, D.P. 1971. Inverse filter coefficients for the computation of apparent resistivity standard curves for a horizontally stratified earth. *Geophys.Prosp.* 19:769-775.

O'NEILL, D.J. 1975. Improved linear filter coefficients for application in apparent resistivity computations. *Bull.Aust.Soc.explor.Geophy.* 6(4):104-109.

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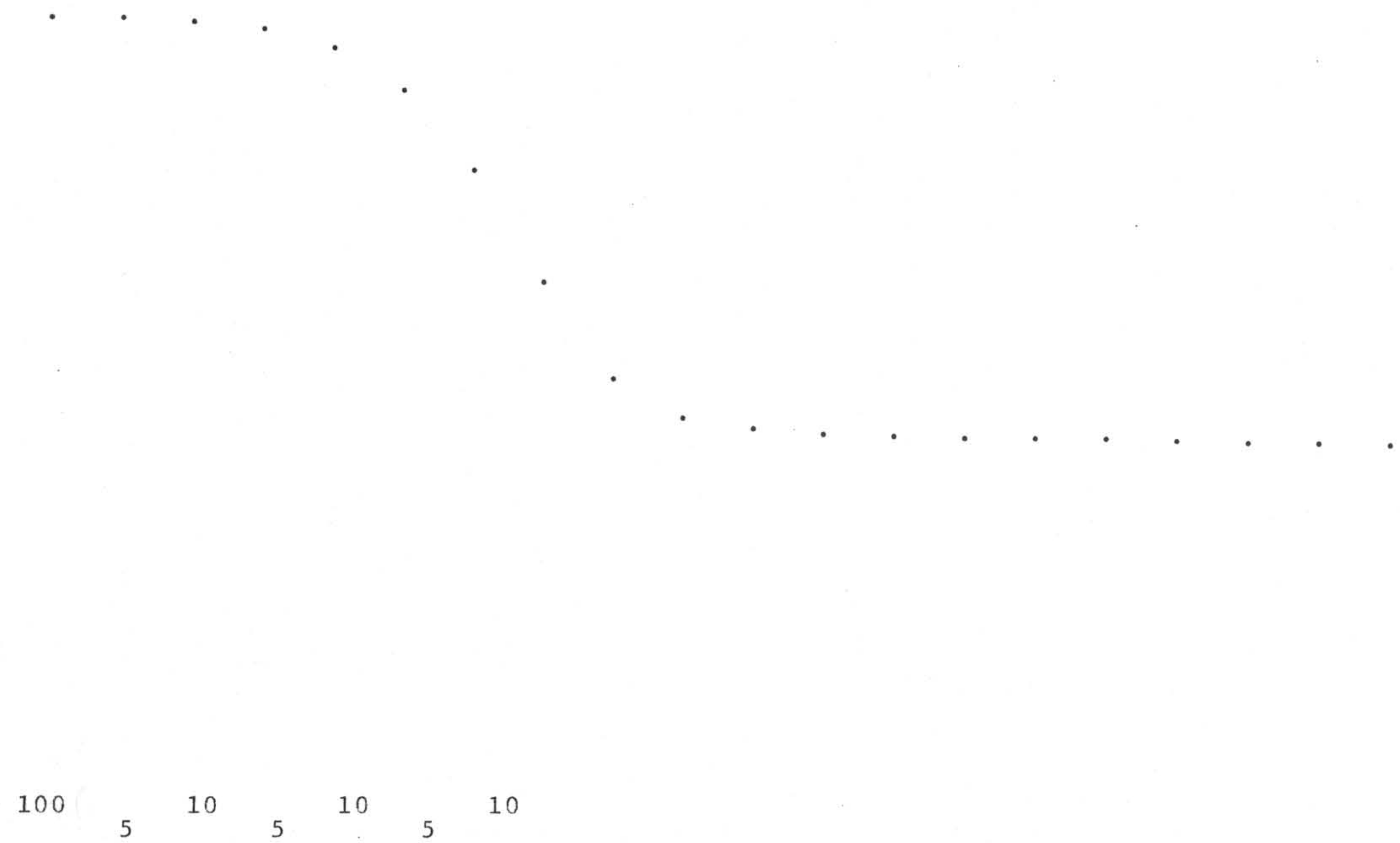
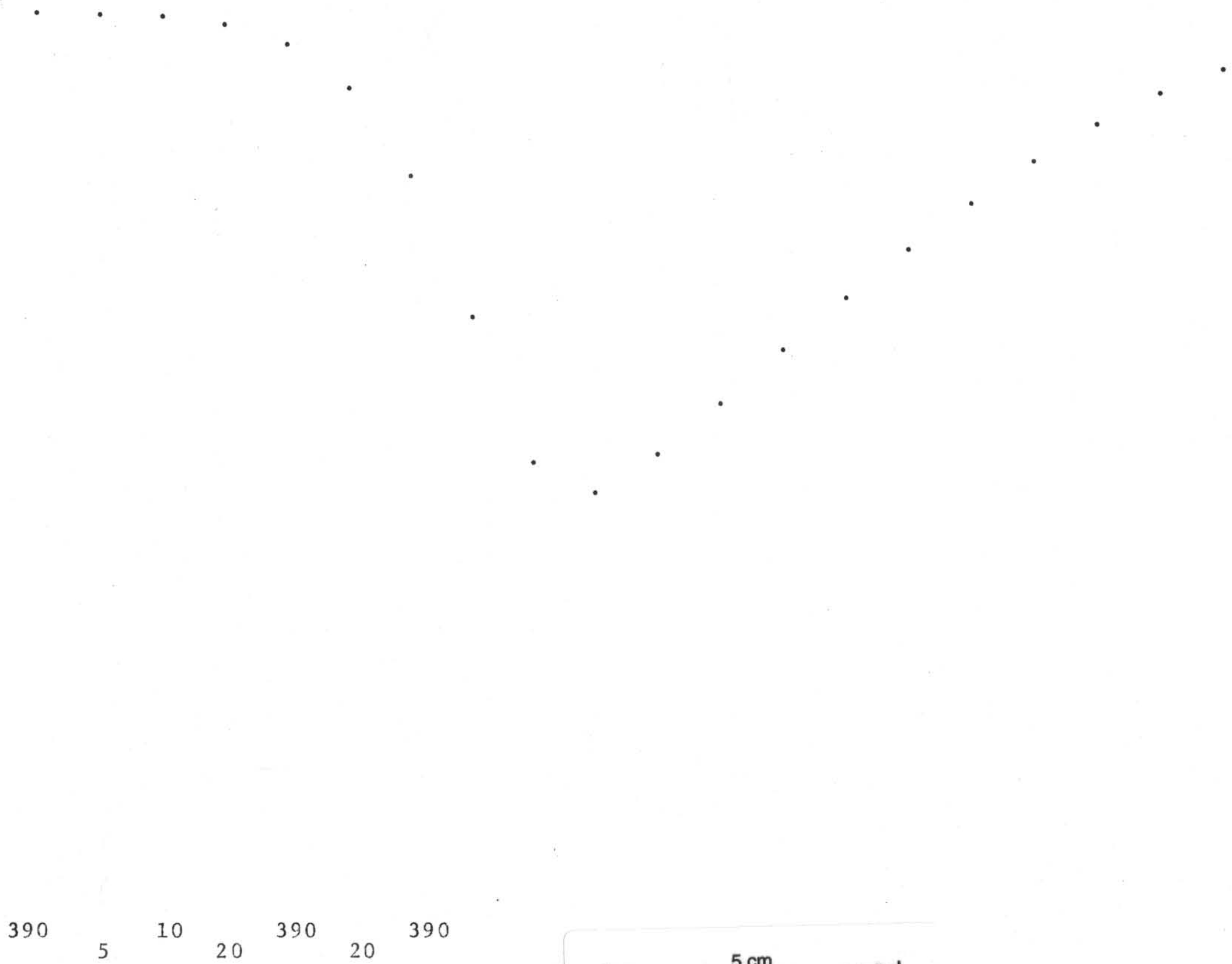


EXAMPLE OF PRINT-OUT: 2-layer curve.



EXAMPLE OF PRINT-OUT: 3-layer curve.

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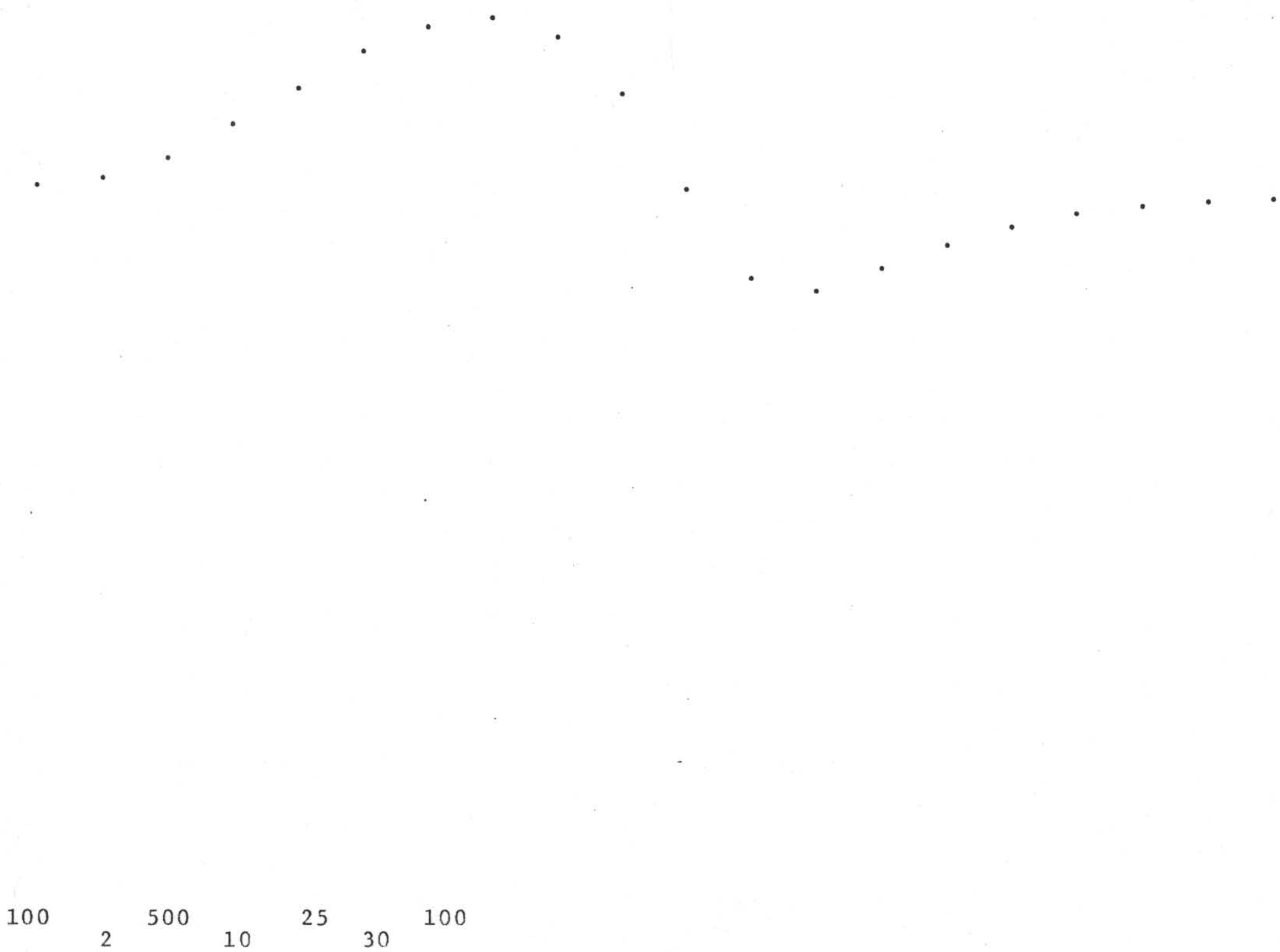

EXAMPLE OF PRINT-OUT: 4-layer curve.