

of native copper. However, it was believed that if twelve samples were selected from nine separate streams that cut across the strike of the flows, and five samples from the Kettle River, most of the sample points would not overlie or be very close to a copper zone. One sample (No. 7) was collected 200 ft downstream from an exposure of native copper in the Kettle River.

The results of chromograph tests of size fractions are given in Table III.

**Table III. Copper Content, Ppm, in Size Fractions of Active Stream Sediments, St. Croix Park Area, Minnesota**

Mesh	Average of 12 Stream Samples	Average of 4 River Samples	Sample No. 7 River Sample
-9	8	5	300
-9+32	3	0	50
-32+80	3.5	0	0
-80+150	14	6	10
-150+200	109	56	20
-200	370	240	150

Sample No. 7 and the samples from Fillson Creek (Fig. 5) are similar both in copper distribution and nearness to a mineralized source. The other St. Croix Park samples display a different distribution in that the coarser fractions are very low in copper. This is interpreted as an expression of an additional factor in the geologic history of the material, the effect of transport to a greater distance from the metal source.

### Conclusion

Heavy metal distribution data for soil fractions of till and for active stream sediments show that the soil size fraction containing the highest proportion of heavy metals may differ in materials of different geologic history. A channel-flow hypothesis can explain the distribution curve of heavy metals in till. It is suggested that the distribution curve of heavy metals is a result of the geologic history of the sampled material, and it follows that a distribution curve indicates something of the geologic history of the soil.

Understanding of the heavy metal distribution trends is a useful guide in selection of sample material in geochemical reconnaissance work. A great

deal more data will be needed before it is possible to make reliable predictions of the type of distribution a certain soil sample might have. It is hoped that this article will stimulate further investigation in materials of various origins.

### Acknowledgment

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## Graphical Representation of Theoretical Soluble Losses by CCD

by R. J. Woody

**D**ESIGN of the most economic continuous counter-current decantation (CCD) circuit is based on selection of the number of stages and the wash

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volume that will give the minimum summation of the following items:

- 1) Capital and operating costs of the CCD circuit.
- 2) Capital and operating costs of the precipitation circuit.
- 3) Value of the dissolved product lost.



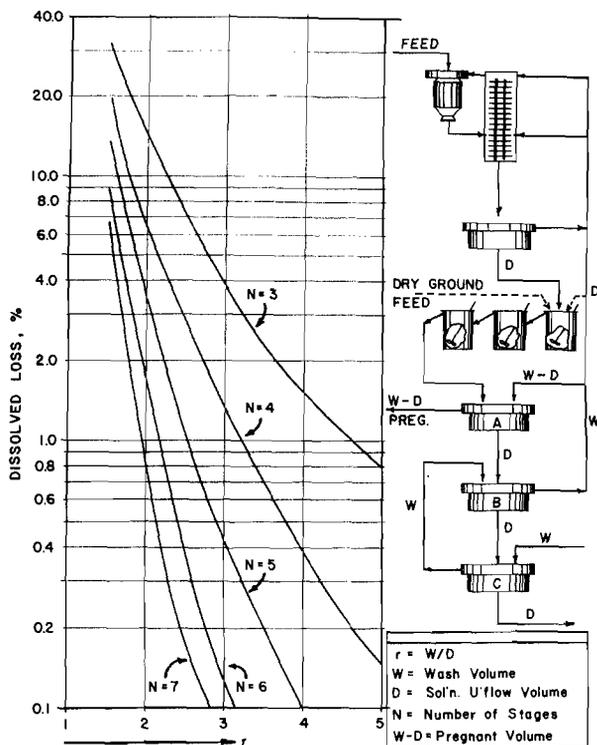


Fig. 2—Straight CCD after grinding dry or in solution.

The curves in each of these charts are the result of substitution in formulas developed for the particular flowsheets. The derivation of these formulas is presented here.

Figs. 1 and 2, and perhaps other charts like them, could be extremely useful to the design engineer for determining the most efficient system to recover products dissolved from ores and similar raw materials. Such charts are also useful for com-

## Derivation of Soluble Loss Formulas

### Solution on Dry Grind Flowsheet (Fig. 2)

According to the same nomenclature used in the derivation for Fig. 1:

$$C_u = x, \text{ and} \\ C_o = r x.$$

From product balance at thickener C:

$$B_u = C_u + C_o - \text{zero} = x(r + 1), \text{ and} \\ B_o = r B_u = x(r^2 + r).$$

From product balance at thickener B:

$$A_u = B_u + B_o - C_o = x(r^2 + r + 1), \text{ and} \\ A_o = \frac{D}{W - D} A_u = (r - 1) A_u$$

$$= x(r^3 - 1).$$

From the overall balance:

$$\text{Total dissolved} = C_u + A_o \\ = x + x(r^3 - 1) \\ = x r^3$$

Percentage loss for three stages:

$$\text{Soluble loss, pct.} = \frac{100x}{x r^3}$$

For  $N$  stages:

$$\text{Soluble loss, pct} = \frac{100}{r^N} = 100 \left( \frac{D}{W} \right)^N$$

parison of actual and theoretical washing efficiency of existing plants.

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# Distribution Curves for Sink-and-Float Separation of Iron Ores

by Rudolph G. Wuerker

WITH the growing complexity of ore dressing processes and the diversity of equipment, efficiency control has become increasingly important in beneficiation. In the case of iron ore dressing, there have been sporadic attempts<sup>1-3</sup> to establish the optimum separation for various ores so that grade and recovery would be readily predictable. But no rigorous statistical analysis and graphical presenta-

tion of such tests could be found in the literature of this country.

### Tests Made with Iron Ores

Expanding upon existing methods of plant supervision and efficiency control, an investigation was started in the ore dressing laboratory at the University of Illinois on the applicability of distribution analysis to iron ores. A sample of crude ore was obtained from the Ohio mine of Cleveland-Cliffs Iron Co. at Ishpeming, Mich., consisting mostly of alternating bands of hematite and siliceous gangue, both about 1/4 in. wide. The ore was heavily coated with limonite, which often filled the cracks.

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