concurrent concentrate samples would have been almost impossible under mill operating conditions. In the case of the tests on the helicoid, the authors had ample concentrate available, taken under controlled laboratory conditions, and I cannot understand why they did not do a careful decantation–assay test on some of the concentrate to demonstrate whether or not there was no tin recovery in the range 8–13μ (cassiterite spheres). If they have any reliable sample of helicoid concentrate remaining from their test work, I invite them to carry out such a decantation–assay test to show the distribution of the tin values, with special reference to the size range 8–13μ (cassiterite spheres) and to report the result in their final reply to the discussion.

'Double recovery'.—Taking the whole of the discussion on the gravity concentration of fine material I get the impression that it is now the fashion to accept 'double recovery' as occurring, sometimes when the evidence is not absolutely conclusive.

Gravity Concentration of Fine Cassiterite

I. R. M. CHASTON, A.R.S.M., B.Sc., ASSOCIATE MEMBER

Further contributed remarks on paper published in January, 1962, pp. 215–25

Mr. F. A. Williams: When introducing his paper Mr. Chaston said[1] ~~that experiments were planned to explore the~~ possibility of screening at 200 to 300 mesh. Successful plant-scale screening at this very fine size, or even at 50 or 100 mesh, would offer attractive scope for tabling only the relatively small tonnage of screen undersize from jig tails, which undersize would contain most of the remaining free heavy mineral. The company with which I was formerly associated in Nigeria had tried using a Symons V-Screen for screening secondary jig tails. A 24-mesh screen lasted 200 hours which was considered satisfactory, but a 44-mesh screen wore out in a few hours. The sieve bend might have been a more promising approach to this problem. I would be very interested to know the type of screen with which Mr. Chaston proposed to make a split at 200 or 300 mesh.

Certainly the advent of the Wilfley shaking table just over 60 years ago had revolutionized gravity concentration, but before very long flotation, and to a lesser extent cyanidation, drove gravity concentration out of most of its strongholds, particularly in those mining industries which were concerned with the sulphide ores of lead, zinc, copper and gold. In the tin-mining industry, however, the shaking table flourished and the jig—the oldest mechanical ore dressing device—conquered new fields of application in the alluvial mining industries of the world, first on bucket

[1] etc. See references on page 688.

dredges and more recently in connection with gravel pumping. In those 60 years the designs of jigs and of shaking tables had been greatly improved. The old Harz-type jig with its space-wasting hydraulic compartment has been replaced by diaphragm jigs in which that space is utilized for concentration. To a large extent the Wilfley-type deck has been replaced by diagonally riffled decks. The big drawback of the usual single-deck table is its small capacity in relation to the floor space occupied, but the recent successful use of triple-deck tables has been reported.[2]

The advent of hydrocyclones ushered in another revolution in ore dressing and in this revolution Mr. Chaston has been prominent, making a notable contribution to the mathematics of the design and operation of hydrocyclones.[3] In Malaya the Mines Department Research Division, to which he was then attached, had demonstrated at plant scale that the use of hydrocyclones for desliming the feed to jigs in alluvial gravel-pump mining extended the recovery of cassiterite well into the size range for which shaking tables would formerly have been thought to be necessary. That development has already been described by Mr. Chaston.[4] Now in his latest paper, coupled with the additional information presented when he introduced it, the author has shown that the use of appropriately smaller hydrocyclones for desliming and sizing the feed to shaking tables extends

TABLE I.—*Mineral recovery in jigs in relation to concentration criteria*

Scale of concentration criteria*	Recoveries in jigs: Tin/columbite ores, Gangue Quartz	Comparable concentration criteria: Lead-zinc ores, Gangue Dolomite	Lead-zinc ores, Gangue Siderite	Copper ores, Gangue Schist
3·6	Cassiterite			
3·5		Galena		
3·4				
3·3				
3·2				
3·1		Pyromorphite		
3·0				Cuprite
2·9		Cerussite		
2·8				Chalcocite
2·7	Columbite	Anglesite		
2·6				
2·5				
2·4				Bornite
2·3			Galena	
2·2				
2·1	Zircon			Covellite
2·0			Pyromorphite	
1·9			Cerussite	Chalcopyrite
1·8			Anglesite	Malachite
1·7		Calamine		
1·6		Sphalerite		Azurite
1·5	Topaz	Willemite		
1·4				
1·3				
1·2				
1·1			Calamine	
1·0			Sphalerite	

*TAGGART, A. F. (See reference 6 on p. 688.)

the recovery of cassiterite from comminuted ores well into the still finer size range for which vanners, round frames and tilting frames would formerly have been thought to be necessary.

In Tables A, B and C (pp. 400, 401) Mr. Chaston has produced figures showing the recovery of wolfram on shaking tables fed with hydrocyclone underflows in the size ranges +60 to −30 mesh and +36 to −9μ. I have given[5] figures showing the recovery of several minerals in the specific gravity range 7·0 to 3·5 from hydrocyclone underflows fed to jigs and containing heavy and semi-heavy minerals in the size range 16 to 300 mesh. Composite particles of heavy minerals and gangue would, of course, behave similarly according to the overall specific gravity of each particle. For ores which have gangues heavier than quartz, recoveries in jigs can be deduced by means of concentration criteria[6] as is illustrated by my Table I for lead and zinc minerals in dolomite and in siderite gangues.

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Fineness of Gold in some Southern Rhodesian Mines

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Author's reply to discussion on paper published in November, 1961, pp. 49–73*

Dr. H. V. Eales: Dr. Cohen has asked whether a relationship between the grade of the ore and the purity of its gold could not be the result of secondary enrichment. It will be difficult to generalize until many more data become available, but it appears that near the surface gold is refined by removal of silver and that an enriched zone exists.[3] Further research is needed, however, to establish reliable criteria for distinguishing hypogene from supergene effects. Cases may arise where it is uncertain whether the variations are of primary or secondary origin, as at the Makanga mine in

*pp. 339–46.
[3] etc. See references on page 695.

the Bulawayo district, a small quartz reef which yielded richly in the early stages of development but failed as the 3rd level was approached. Near the surface coarse, nuggety gold occurred with galena and pyrite, but both the fineness and quantity of the gold dropped with increasing depth (see Fig. A) and with the appearance of sphalerite in the ore. In view of the fact that this relationship between gold purity and ore grade can also be proved to exist in some orebodies at appreciable depths (at and below the 20th level at the Turk mine, and at the 10th level of the Lone Hand mine in the Gwanda district, as shown in Fig. B) it seems inadequate to seek an explanation purely in terms of supergene processes.

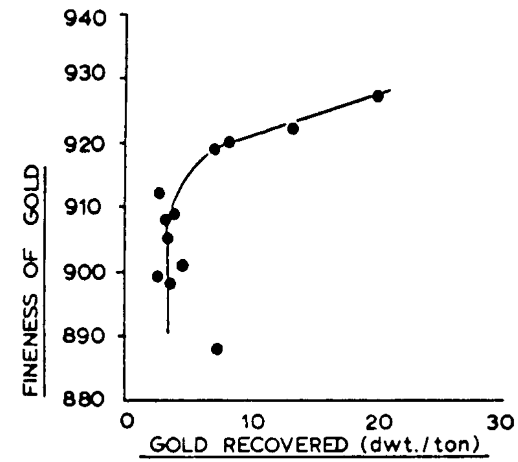

Fig. A.—Relationship between the fineness of gold recovered by amalgamation and the grade of the ore treated at the Makanga mine, Bulawayo district.

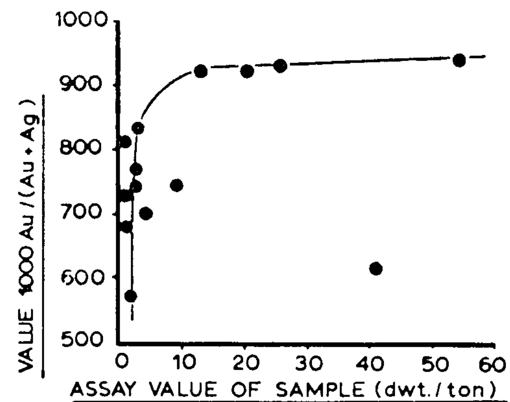

Fig. B.—Apparent fineness values of samples of Lone Hand mine gold ore, taken a 5-ft intervals on the 10th level, plotted against their gold content.