Isotope Separation by Thermal Diffusion in Liquid Metal

Abstract. *Isotopic enrichment of several percent has been obtained in liquid lithium metal by applying a temperature gradient over a single-stage separation column. For other metals the method should have the highest efficiency, if these have low melting points and are liquids over a wide temperature range.*

As a result of our studies of atomic mobilities in liquid metals (*1*), we have developed a single-stage column for the separation of isotopes by thermal diffusion (thermotransport, thermomigration). A steel tube, 10 mm in inner diameter, was held in a vertical position. A bundle of stainless steel capillaries (50 mm long and 0.5 mm in inner diameter) was placed in the bottom portion of the tube (separation portion) in order to decrease convectional stirring. A lump of lithium metal was placed above the capillary bundle and the whole apparatus was evacuated. While still under vacuum, the metal was melted and poured into the separation portion of the tube, covering the orifices of the capillaries. A switch of a valve then caused the vacuum to be replaced by a slight surplus pressure of argon, ensuring break-free filling of the capillaries. The volume of Li metal was so chosen that the surface of the liquid was about 5 mm above the capillary bundle. The metal was kept under a temperature gradient (530°C at the surface, 250°C at the bottom end of the column) for 4 days to ensure the establishment of a steady state. Subsequent analysis showed an isotope separation of about 4 percent between the top and the bottom of the tube with the light isotope enriched at the high temperature.

Since the quantities which may be separated by this process approach 1 cm^3, this appears to be a relatively easy and inexpensive way to obtain isotopic enrichments of a few percent, even in a considerable bulk of material. According to the theory (*2*), the obtainable separation is proportional to the relative mass difference of the isotopes and to the factor $(T_c^{-1} - T_h^{-1})$, where T_c and T_h are, respectively, the temperatures at the coldest and hottest parts of the column. The process is thus especially applicable to metals with low melting points and those which are liquids over a wide temperature range.

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References and Notes

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Martian Craters: Comparison of Statistical Counts

Abstract. *Comparisons of the various crater counts obtained from the Mariner IV photographs indicate that, out of 300 to 600 possible craters mapped by different investigators, only about 120 craters can be reliably identified. Thus, only a lower limit for the Martian crater density can be established from the Mariner IV data.*

In an initial report on the Mariner IV results, Leighton *et al.* (*1*) indicated that over 70 craters were readily distinguishable on the unrefined photographs. In a subsequent analysis of the best of the preliminary photographs (frames 7 through 14) I counted 89 reasonably well-defined craters (*2*). This count was considered to be a lower limit for the number of craters and it was estimated that the loss of craters larger than 20 km in diameter, due to poor definition, amounted to less than 30 percent. Thus, the estimated upper limit for the number of craters visible on these frames was about 120. A similar result was obtained by Hartmann (*3*) who found 85 craters on the best photographs.

In apparently exhaustive studies of the crater density Chapman *et al.* (*4*), using frames 2 through 15 of the preliminary photographs, cataloged 288 craters; Marcus (*5*) counted 645 craters on frames 3 through 14. Similar results were obtained by Leighton *et al.* (*6*) who found at least 300 and possibly 600 craters on ACIC (Aeronautical Chart and Information Center) renditions of the final, calibrated, and contrast-enhanced pictures. Since the counts by Leighton *et al.* were not made directly from the photographic records, their results are open to question. Chapman *et al.*, Leighton *et al.*, and Marcus have assumed that the apparent consistency of their crater counts confirms their conclusions.

In view of the low contrast and generally poor definition of the pictures, the identification of 300 or more craters seems questionable. Since no direct comparison of the individual craters was made, the apparent confirmation of the results could be fortuitous. Fortunately, a limited comparison can be made, since line drawings of the craters counted in frames 4, 7, and 11 are given by Chapman *et al.* and the ACIC renditions for all frames are given by Leighton *et al.* (*6*).

For purposes of this study, each line drawing was rectified photographically by projecting a negative image of the drawing onto a plane which was inclined so that the borders of the drawing exactly matched the borders of the corresponding ACIC map (the borders of each version correspond to the edges of the original frames). Sheet film was then placed on the plane so that the resulting film positive could be used as an overlay.

The comparisons of the two interpretations of frames 4, 7, and 11 were made by superimposing each transparency on the corresponding ACIC map and determining which craters were common to both. In order to allow for minor cartographic errors, several different fits of the pairs of transparency maps were tried. The numerical results (Table 1) represent an average of several different attempts to correlate the craters of each frame. Figures 1 through 3 show the ACIC maps of frames 4, 7, and 11 with the transparencies superimposed in positions representing the best fits between the two renditions.

A crater was considered to be com-

Table 1. Commonality of crater counts on frames 4, 7, and 11.

Crater class	Craters listed (*4*) (No.)	Common craters (av. %)
	Frame 4	
A	2	75
B	8	25
C	9	0
	Frame 7	
A	19	68
B	20	18
C	6	0
	Frame 11	
A	14	100
B	9	33
C	9	45