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IDENTIFICATION OF MINERAL MATERIALS OTHER THAN SOIL BY THE DENSITY GRADIENT TUBE*

Wilkaan Fong and Paul L. Kirk

Paul L. Kirk, Professor of Criminalistics, School of Criminology, University of California, needs no introduction to our readers. He has contributed a number of articles to this Journal dealing with various phases of laboratory investigation of physical evidence in criminal cases. Two of these articles have dealt with the use of the density gradient tube in the identification of glass and of soils. His present article reports research on further applications of this tube.

Wilkaan Fong is a graduate of the school of Criminology of the University of California and was associated with Professor Kirk in research which forms the background of this article.—EDITOR.

Density gradient tubes have proven valuable in the identification of a number of different types of solid material, including particularly, glass (1) and soils (2). A number of other materials have been studied in a limited way, some of which have been reported elsewhere (3). The success of the gradient tube in the identification of soil might imply its utility with other constituents of a mineral nature. These include rocks, sand, cement, safe insulation, and ash. The first four items mentioned are the basis of the data reported in this paper, and further investigations are being carried out in the identification of ash by this method.

In a recent series of burglaries, pieces of soft sedimentary rock which showed a marked similarity of general appearance were found at two different crime scenes. The attempt to identify these rocks as being a portion of the same original rock led to the study of rock identification as reported here. Sand has been found in the shoes of burglars which have been left at the scene of a crime, also in other locations which made its identification desirable. In at least one burglary chips of concrete were found amongst the evidence. In safe burglaries insulation material from the safes is often found in the pants cuffs and in the automobiles used to transport the safes. As a result of these questions which were important because of actual case investigations, the study of these materials was made and is here reported.

EXPERIMENTAL

Density gradient tubes were established essentially as described by Goin and Kirk (2). The same liquids were used except that for rocks it was desirable to add a heavier layer of methylene iodide or methylene iodide mixed with bromoform. Also, safe insulation required a rather lighter gradient than is optimum for soils. The samples were prepared in various manners, depending on the circumstances.

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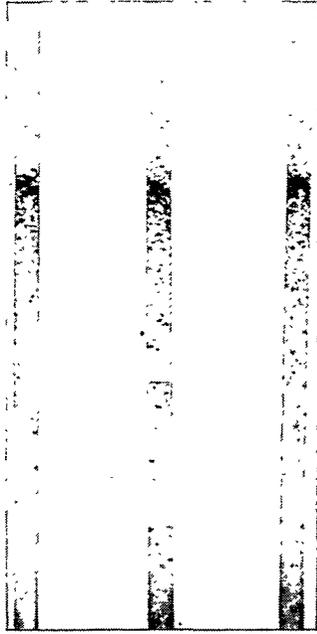


Figure 1

Center tube—Sedimentary rock from attempted burglary.
Outside tubes—Duplicate samples of sedimentary rock from successful burglary.

Rocks were ground as finely as possible with an agate mortar and pestle to obtain a fine powder similar to that of soil. Soft sedimentary rocks pulverize readily but igneous and other hard rocks are much more difficult to powder, and give increased difficulty from the standpoint of sampling because they contain often a number of discrete minerals. These may be separated from each other but be difficult to reduce to powder, and if inadequate samples are available, even the final powder may not be completely representative.

Sand was used as found without grinding, the only concern being that the sample should be representative of the original source of the sand.

Cement was sampled by chipping some of the material from the corner of a wall or other similar structure for comparison with other similar chips.

Safe Insulation was taken in a sufficiently large sample to be representative of the whole, or if there were large inclusions such as mica or other material occurring in chunks, these could be separated under the microscope and the gradient established without them, or a separate gradient established with those chunks alone. Alternatively, the insulation could be tested as found in the original source.

The powdered samples were weighed so that all samples used in a series would have exactly the same weight. It was convenient to introduce the dry powdered material into tubes containing gradients which had been established for about 24 hours so that the particles would equilibrate rapidly and without clumping together into aggregates which are very disturbing and require stirring of the gradient to break them up. This technique has allowed the establishment of a uniform gradient with a minimum of difficulty as compared with the original procedure in which the liquids were added after placing the sample in a dry tube. After the addition of sample, the gradient was allowed to equilibrate for a period of 24 hours longer to give final distribution. After this time, there is little if any change in the distribution of the particles up to several weeks or longer.

Results. In Figure 1 is shown the results obtained with the two rocks mentioned above which were recovered from two burglary scenes. It is clear that the center tube which represents a small fragment from one crime scene is actually identical with the outside tubes which are duplicates made from the larger rock found at the other scene. Figure 2 shows six additional sedimentary rocks from the same neighborhood which were very similar in character, appearance and color with the rocks which figured in the two burglaries mentioned. It was immediately apparent from examination of these tubes that the distributions were quite different from each other in every case and that none of them agreed in any particular with the distribution of the rocks which originally were believed to be identical and were so found.

A similar study was made of a number of hard rocks presumably igneous in character which were ground until fine and distributed in gradient tubes as described above. For reasons of economy of space the photographs showing the distributions are not included. The differences noted in these hard rocks were of approximately the same magnitude as in soft rocks and the identification is just about equally good.

Sand gradients were set up in identical manner using sand from various beach locations along the Pacific Coast and from sand mines in the interior of California. It was noted first that there was a marked difference in the color and general appearance of the different sand samples so that many of them could be distinguished from this appearance alone. On placing them in density gradient tubes, every sample behaved somewhat differently though the common high silica content led to similarity between all of them. Two samples taken from different regions around Lake Tahoe, California, were found to give a very sim-



Figure 2

Six sedimentary rocks of similar appearance collected from a single region.

ilar though not quite identical appearance. These were quite different from all the Coastal beach sands and from sand mines of the San Joaquin Valley. The appearance of these gradients is not reproduced here for reasons of space limitation but the technique is similar in its general application to that for soil and rock specimens.

Cement samples from five different buildings built at various times over a period of perhaps fifty years were tested in the gradient tube. The results are illustrated in Figure 3 which shows cement from 5 different buildings, tubes 3 and 4 being from the same building as a control on the identity of distribution when the concrete was from the same source. In addition, several cement samples were taken from the same cement structure in one instance and tested with respect to each other.

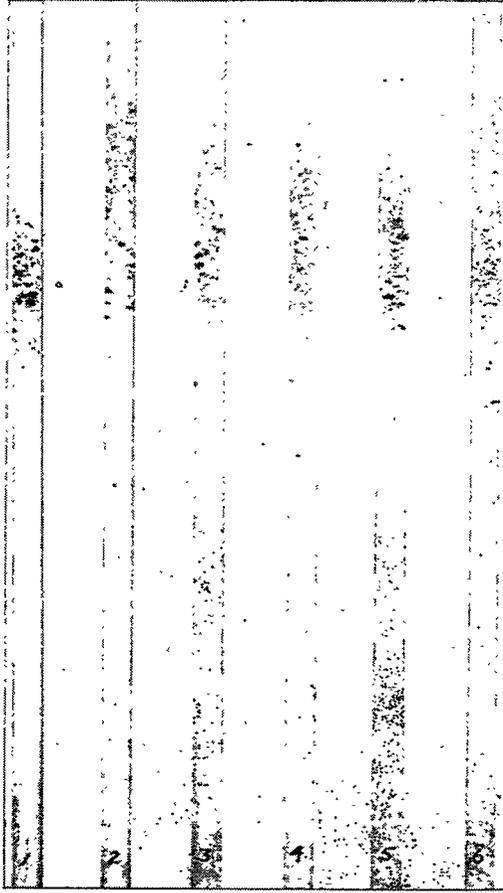


Figure 3

Powdered concrete from five similar buildings of different age. Tubes 3 and 4 are duplicate controls.

These distributions are not shown here but gave almost as striking differences as the differences shown in Fig. 3 with cement from different buildings. These samples were taken from several points of a concrete driveway and from a concrete wall of an adjoining garage which was built at the same time. The problem of sampling concrete is clearly not a simple one since two samples taken from the same structure may show relatively large differences. If, however, it can be shown that concrete damaged in, for example, one place is identical with concrete found on a person suspected of having damaged that place, there should be a virtual identity shown in such an instance. It may, therefore, be considered as having a marked value for criminal investigation when the sampling is properly performed.

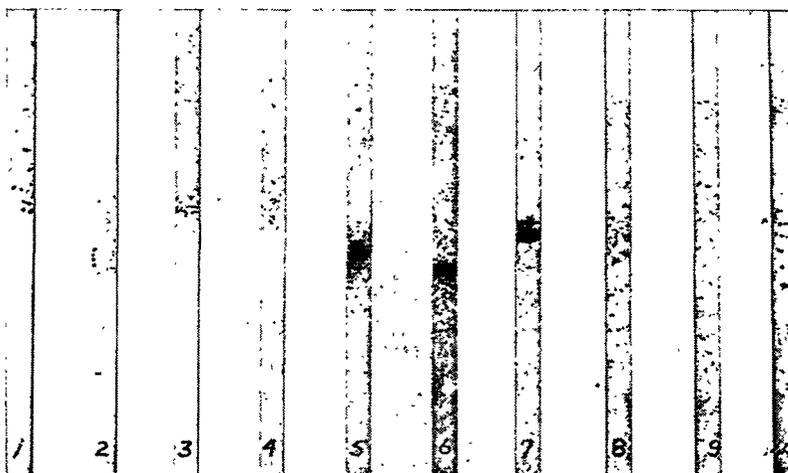


Figure 4

Identification of Safe Insulation.

Left to right—1. Material sorted from burglarized safe; 2. Material from sweepings of car used to remove safe; 3. Known material from burglarized safe; 4-7. Various safes; 8. Known sample from second burglarized safe; 9. Material from suspect's trouser cuff; 10. Same as 8.

The question of safe insulation is particularly important in criminal investigation because of the large number of safes which are damaged by violent methods in which the insulation is spilled, carried into automobiles, on clothing or shoes and is found on clothing of suspects and tools used by them. For the purpose of this study, insulation from four safes in a series of safe burglaries were collected along with twelve additional samples.¹ The appearance of the safe insulation when weighed and distributed in gradient tubes is shown in Figures 4 and 5. It should be noted that safe insulation is quite often easily distinguished on the basis of its inclusions. For example, mica was found in only four of the sixteen samples examined in this series. Of these, only in two cases was the mica at all similar and the amount of mica found in one of these was greatly less than in the other. Therefore, a single constituent can serve to distinguish between many samples of safe insulations. In other samples were found other distinguishable materials which could be readily separated. The problem of sampling here is also somewhat difficult since it is necessary that two samples to be compared should contain the same relative proportions of the ingredients found. Thus, if the insulation consists of a material which readily goes into a powder with a larger aggregate of a different material which separates readily,

1. Kindly furnished by David Q. Burd, Bureau of Criminal Identification and Investigation, Sacramento, California.

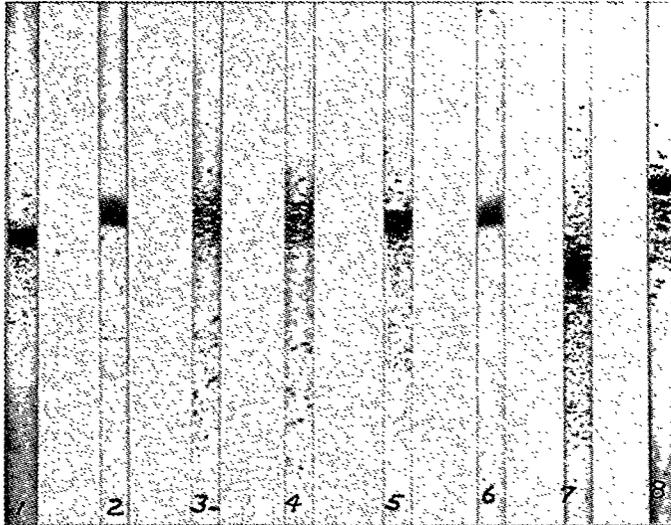


Figure 5

Other safe insulation from various known sources, except that 3 and 4 are controls from the same sample.

it is quite possible that a burglar's pants cuffs might contain both the powdered and the aggregate material. Since the ratio in which this is acquired may not be the same as that existing in the original safe insulation, it is desirable to segregate both the powdered inclusions and the powdered material and to treat them separately. This will require segregation under the microscope of the material from both sources. With this precaution, both types of constituent would be proven identical or non-identical, as the case may be. It was found possible to distinguish readily between all but two of the samples studied in this series. While it does not prove absolute identity of origin, the utilization of the technique should be extremely valuable in the investigation of safe burglaries. It should be pointed out that this is only one of the possible approaches to the study of safe insulation, but probably the best one so far suggested for determining identity of these materials since it does not destroy the material and shows all the differences which are likely to exist in the substances composing insulation.

REFERENCES

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2. Goin, L. J. and Kirk, P. L., *J. Crim. Law and Criminol.* 38, 267, (1947).
3. Kirk, P. L., "Density and Refractive Index, Their Application in Criminal Identification," Charles C. Thomas Co., Springfield, Ill., 1951.