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Julio H. Bradley

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SEQUENCE OF PENCIL STROKES

JULIO H. BRADLEY

The author has been an Examiner of Questioned Documents in Argentina since 1953 when he graduated from the University of Buenos Aires as a Calígrafo Público Nacional. Mr. Bradley maintained a private practice in Buenos Aires and La Plata until 1962 when he was appointed an official document examiner for the Courts of Buenos Aires as a result of competitive examinations. Mr. Bradley also serves as a professor for examining students for the career of document examiner in the Faculty of Economic Sciences of Buenos Aires. He is a Corresponding Member of the American Society of Questioned Document Examiners, and his present paper was prepared for and submitted to the 1962 annual meeting.—EDITOR.

Pencils most frequently used in handwriting are those made of graphite, copying pencils, and colored pencils. It will be convenient to recall how they are made.

The first are made with a blend of powdered graphite and clay forming a paste which, after passing by pressure through holes in a metallic plate, form the leads which are baked in a furnace with a temperature of 1200 degrees centigrade and are later enclosed in the cylinders of wood or used in mechanical pencils. A greater proportion of clay used in the blend leads to a higher degree of hardness of the lead. Very soft pencils are composed by 75% of graphite and 25% of clay; the soft ones are made with 65% of graphite and 35% of clay; the hard ones are made of 45.5% of graphite and 54.5% of clay, and finally the very hard ones are composed by 40% of graphite and 60% of clay. Of course, these quantities are susceptible of a little variation according to the degree of hardness that is wished to attain.

Copying pencils are made of clay, little quantities of graphite, and a coloring substance forming a paste that is pressed through a sieve in a similar way pointed out for the manufacture of graphite pencils from where the leads emerge and then are dried without heating so as not to destroy the coloring substance. The coloring generally is methyl violet or methylene blue. The components are finely pulverized and pasted with water or with the addition of an agglutinant substance such as saponaceous solutions of gum lac or gum tragacanth and sometimes albumin or oleic salts, etc.

Colored pencils are also made with a paste composed by the blend of graphite chemically prepared, purified kaolin, and aniline. The greater proportion of kaolin used in the blend will determine a greater hardness of the lead.

As noted, pencils are composed by a conglomerate of different elements forming a substance that constitute the writing material called lead.

CHARACTERISTICS OF PENCIL STROKES

Graphite pencil strokes are formed by deposit of little particles of graphite at the same time as the lead wears away by the erosion caused by the paper whose surface is sufficiently rugged to bring about this erosion. Microscopic examination with illumination from one side reveals small dots or lines of silvered metallic brightness.

As copying pencils have almost no graphite, they do not show the lines of metallic brightness observed in graphite pencil strokes, and in some kind of pencils the brightness that appears is due to small additions of graphite or to the cementing material. In this latter case the brightness is very different showing a slightly yellowish tonality.

In colored pencil strokes, deposits caused by friction with the fibers of the paper and longitudinal lines of brightness are also observed when illuminated by a stream of light perpendicular to the stroke.

DETERMINATION OF THE DIRECTION OF PENCIL STROKES

The determination of the direction of pencil strokes, whether they be of graphite lead, copying, or colored pencil, is practiced with the aid of a stereoscopic microscope preferably under magnification about 30 diameters and with illumination from one side at an angle ranging from 30 to 40 degrees approximately related to the paper plane. In thin papers the examination sometimes may be done with transmitted light and with the same magnification. The determination is made by observation of the side of the fiber transversal

to the stroke containing a greater deposit of graphite. This deposit reveals the direction of the movement of the pencil; the deposit is made on the side of the fiber from where the stroke begins. If it takes place on the right side of the fiber, the stroke has a direction from right to left; and so if it comes from the left, from above or from below, the deposit will take place on the left side, above or below the fiber.

It is also advisable for a better determination to observe a considerable number of fibers partially out of the stroke intersecting the stroke.

When the pencil has a hard lead and the stroke is done with considerable pressure, it shows continuous parallel striae, indentations, or scratches.

DETERMINATION OF SEQUENCE OF GRAPHITE PENCIL STROKES

As in the many other problems in the investigation on questioned documents, the determination of the sequence of pencil strokes has its limitations and is conditioned by the circumstances. That is why the observation must be made with an essentially critical spirit.

The methods for establishing the sequence of strokes at a crossing are three, but for each of them the same recommendations about illumination and magnification are given. The magnification must be from 30 to 40 diameters, and the use of a stereoscopic microscope is advisable. It is sometimes convenient to adopt the oblique viewpoint, using, for that purpose, a microscope with an inclination joint or the construction of a special slanting stage. The illumination must be preferably incident and from a concentrated source an angle of 45 to 50 degrees according to the surface of the paper and normal to the stroke. However, the observation must be done by rotating the paper 360 degrees around its center looking for the most convenient viewpoint.

When enough pressure has been exerted on the paper a furrow remains that is clearly noticeable with a stereoscopic microscope. The crossing of two strokes is something similar to two strokes on a piece of wax. The upper or last one will show a continuous furrow or indentation across the lower one.

As it has already been said, pencils of hard lead are composed of a greater proportion of clay. When one of these pencils is used with considerable pressure the resulting stroke shows continuous parallel scratches or striae in its length. When a crossing takes place these scratches are interrupted in the

lower stroke by the upper one which shows these striae in a continuous way. We can compare these circumstances to those caused by a steel whisk passed on the surface of a piece of wax. Each one of the wires of the whisk will cause a furrow in the surface all the length of the stroke. If the whisk is then passed perpendicularly to the first stroke the latter will erase the former in the place of the crossing while the furrows executed last are continuous. The wax would play the part of the graphite and the wires of the brush would be represented by the particles of baked clay.

The third method recommended for the determination of sequence of pencil strokes is to observe the continuity of lines of brightness taking place in the intersection. The stroke executed in the second place will show these lines of brightness in continuity of disposition in relation to the rest of the stroke. The microscopic observation must be very carefully and thoroughly done because the bright lines vary in disposition and size according to the angle of illumination in relation to the direction of the stroke and to the deposit of graphite on the fibers of the paper.

DETERMINATION OF SEQUENCE OF COPYING PENCIL STROKES

The determination is very difficult in some cases so it is necessary to get the same results of observation by means of different methods. The examination must be practiced with the aid of transmitted, incident, and widespread tenuous light and in all cases with a magnification of approximately 35 diameters.

With transmitted light: The direction of the stroke must be determined first by observation of the deposits of the particles left against the fibers of the paper. Once this determination is made the deposits at the point of intersection of the two strokes are observed. The upper stroke will show at the intersection deposits which remain constant and almost "clean" on only one side of the fibers, without interruptions or being diffused by the intersecting stroke.

With incident light: Fixing the illumination at an angle of 45 to 50 degrees in relation to the surface of the paper and rotating the paper 360 degrees around the center or the intersection of the strokes and choosing the most convenient point of observation, it will be determined whether certain bright lines or striae caused by the tip of the pencil are or are not interrupted, clear or diffused by

those corresponding to the intersecting stroke. The continuity of the above mentioned characteristics of the stroke at the intersection shows that it has been executed subsequently.

With widespread tenuous light: This examination must be done as a complementary test in order to corroborate the previous two and besides because it has the advantage over the other two that it allows one to appreciate better the difference of the tonality or color intensity of both strokes, allowing one to state that the upper stroke is the one that shows the continuity of the color intensity especially at the edges of the line that continues on both sides of the crossing.

It is very important that the results of the three methods be in agreement. In case identical results are not obtained a definite conclusion must not be stated, as the different quality of the lead, the different pressures exerted, the different points sharpnesses of the lead provide the strokes with variable features that do not permit an easy conclusion. It is advisable then to perform a series of tests with a similar paper and if possible with a similar pencil. When the strokes were made on a paper placed on a soft support the observation of the furrows at the crossing may be highly useful. If the strokes were done with equal pressure the

upper one will show the furrow to be continuous at the point of intersection.

SEQUENCE OF GRAPHITE PENCIL AND COPYING PENCIL STROKES

The determination of the sequence is practiced in a way identical to that which is done in the case of pencil strokes, that is to say by observing the continuity of the lines of brightness at the intersection.

SEQUENCE OF COLOR PENCIL STROKES

The determination is accomplished in this case by observing the longitudinal bright lines caused by the illumination perpendicular to the stroke. These bright lines of the first stroke are interrupted at the intersection by the second one which shows them without solution of continuity.

The same indications are applied to the cases of crossing of strokes of pencils of different color or of color pencil and graphite pencil or copying pencil. The color pencil stroke will show the bright lines to be continuous if it has been done in the second place and interrupted at the point of intersection when executed previously to the stroke producing the interruption.