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Liquid Lead Pencils Revisited

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In most cases, a Forensic Document Examiner has little trouble differentiating between the stroke made by a pencil and one made by a rollerball pen or a ballpoint pen. The liquid lead pencil, however, presents a more challenging stroke appearance which is a hybrid of the fluid ink of a rollerball pen and the striations of a ballpoint pen. This study will compare characteristics of the stroke lines of liquid lead pencils, graphite pencils, ballpoint pens, rollerball pens and gel pens, on original and photocopied documents. Forensic Document Examiners should be aware of the stroke characteristics of a liquid lead pencil when making a determination as to the writing instrument used on a document.

Introduction

The liquid lead pencil was first introduced in 1955 by the Parker Pen Company. It was touted as a pencil whose lead would not break, dull, or need to be sharpened and a line that does not smudge. (Conway, 1955) The liquid lead pencil's characteristics, applicability and drawbacks have previously been reported by Conway (1955), Hilton (1991), Alford (1961), and Souder (1955).

The liquid lead pencil is essentially a hybrid between a simple graphite pencil and a ballpoint pen. According to the manufacturer (in the case of this study: Pentech, a subsidiary of JAKKS Pacific, Inc., www.jakkspacific.com) the instrument contains "liquid graphite" which is referred to as Liquaphite. In comparison to a graphite pencil, the "ink" line produced can be erased, although the longer the mark is on the paper the more difficult erasure becomes. The liquid pencil can also be used when a #2 pencil is required, such as on a scantron test. Like a ballpoint pen, however, the liquid graphite solution is housed inside a pressurized chamber with a ball and socket at the tip. The liquid graphite is deposited on paper through friction between paper and pen.

Like the liquid pencil's physical characteristics, its line morphology is a hybrid between a ballpoint pen and a rollerball pen. At first glance, the stroke could easily be mistaken for that of a ballpoint pen because the "ink" line contains areas of striations, gooping and skipping which are visible to the naked eye. Because the "ink" is liquid, it absorbs into the paper and leaves visible bleed lines, similar to a rollerball pen, when viewed under magnification. The line is lighter in color than either a ballpoint pen or a rollerball pen; however, aside from having a grayish color, it does not at all resemble a line made with a graphite pencil.

Materials

1. Pentech Liquaphite 0.5mm Liquid Lead Pencil
2. Dixon Ticonderoga No. 2 HB Wood Pencil
3. Signo Uni-ball Gel Grip 0.7 Black Gel Pen
4. Sanford Uni-ball Black Fine Rollerball Pen
5. Paper Mate Comfortmate Black Fine Ballpoint Pen
6. Leica M205C Microscope
7. VSC-6000 (Foster & Freeman (USA) Ltd.)
8. Canon Image Runner 3570 Copier
9. Staples 30% Recycled Paper, 20 lb, 92 brightness

Method

Handwriting samples were prepared using each of the writing instruments named above, including the Pentech Liquaphite 0.5mm Liquid Lead Pencil, pictured in Fig. 1. Each sample consisted of a series of cursive lower case letters "l" and "e" (see Fig. 2) as well as a series of straight lines (see Fig. 3). Each sample was then examined under a microscope for line characteristics such as skipping, gooping, spectral reflectance, striation marks, quality and bleeding (See Figs. 4-13).

Each original sample and photocopied sample was examined microscopically with a Leica M205C microscope and imaged on a VSC-6000. The samples were photocopied in black-and-white on a Canon Image Runner 3570 copier.

Results

Note how similar the appearance of the liquid lead pencil is to that of a ballpoint pen.

Figure 1 Pentech Liquaphite 0.5mm Liquid Lead Pencil

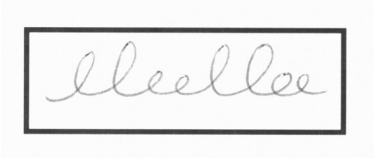

Figure 2 Cursive Lower Case Letters "l" and "e"

This combination was written with each writing instrument used in this examination.

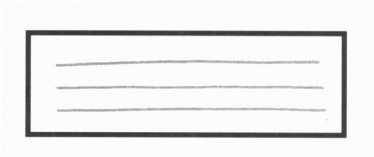

Figure 3 Straight Lines

Straight lines written with each instrument were examined.

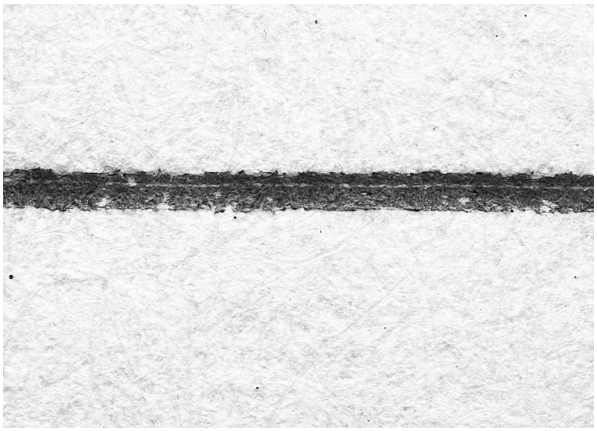

Figure 4 Liquid Lead Pencil Line Morphology

Note the striation mark running the length of the line.

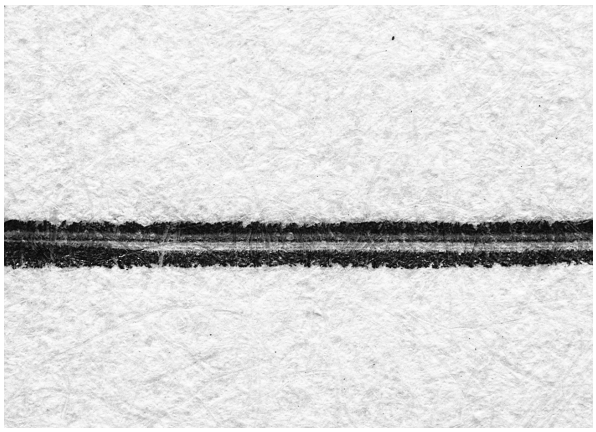

Figure 5 Ballpoint Pen Line Morphology

Note the striation mark running the length of the line.

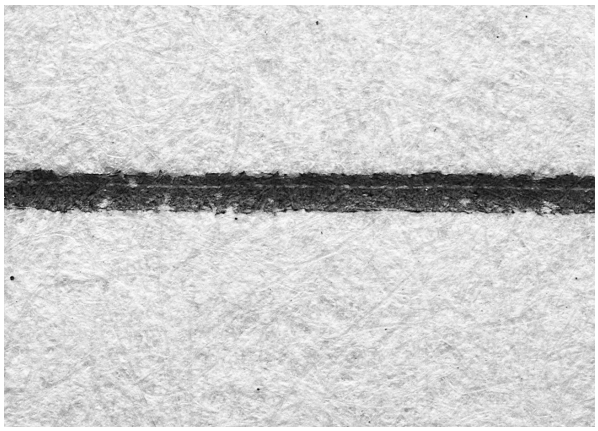

Figure 6 Liquid Lead Pencil Line Morphology

Note how the liquid lead soaks into the paper fibers and bleeds slightly.

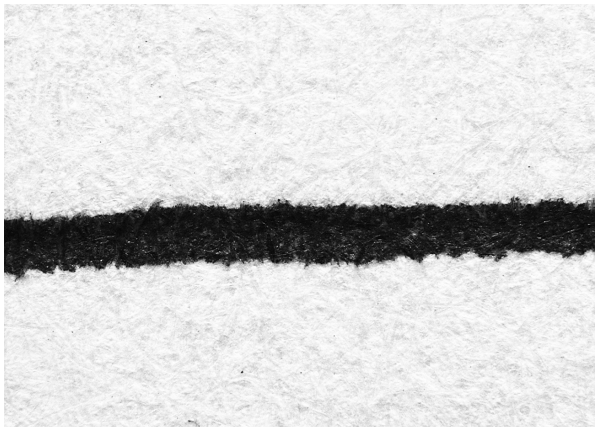

Figure 7 Rollerball Pen Line Morphology

Note how the ink soaks into the paper fibers and bleeds slightly.

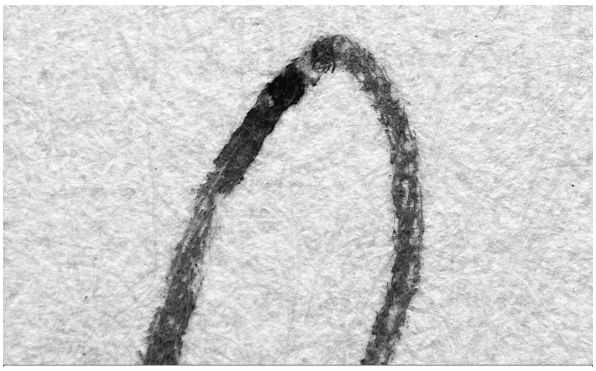

Figure 8 Liquid Lead Pencil Gooping & Skipping

Note the gooping near the top of the curve and the skipping on the left-hand side downward stroke.

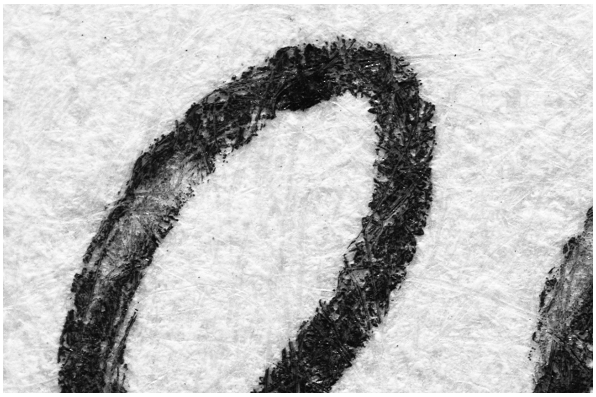

Figure 9 Ballpoint Pen Gooping & Skipping

Note the gooping near the top of the curve and the skipping on the left-hand side downward stroke.

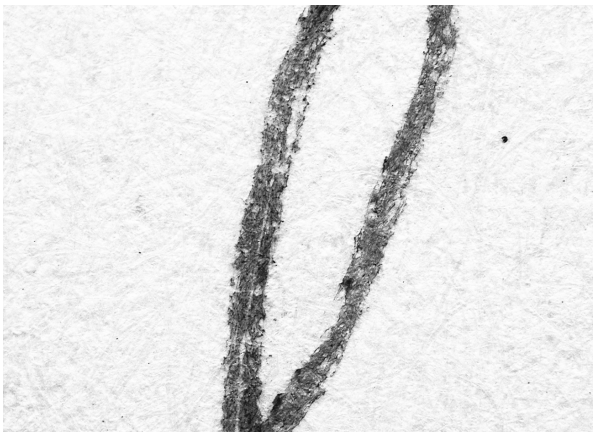

Figure 10 Liquid Lead Pencil Striations

Note the striation mark on the left-hand side downward stroke.

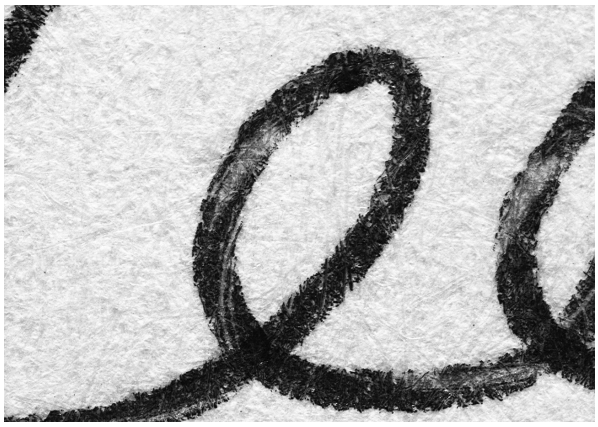

Figure 11 Ballpoint Pen Striations

Note the striation mark on the left-hand side downward stroke.

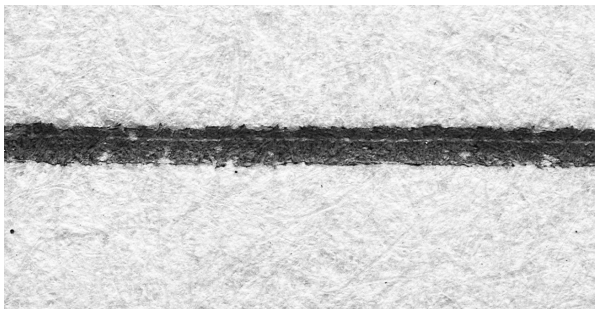

Figure 12 Liquid Lead Pencil Line Morphology

Liquid lead pencils do not exhibit spectral reflectance when viewed under a microscope. Also, piling of the graphite against the paper fibers, a characteristic of graphite pencils is not seen with liquid lead.

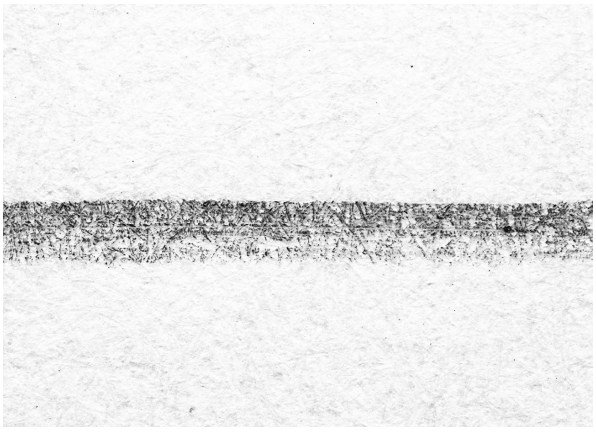

Figure 13 Graphite Pencil Line Morphology

Graphite pencils exhibit spectral reflectance and piling when viewed under a microscope.

Figure 14 Liquid Lead Pencil vs. Graphite Pencil

Note the deep groove line left by the Liquid Lead Pencil (top line). The Liquid Lead Pencil line and the graphite pencil line have similar erasability. Note the Liquid Lead Pencil (top line) lacks spectral reflectance found in the graphite pencil (bottom line).

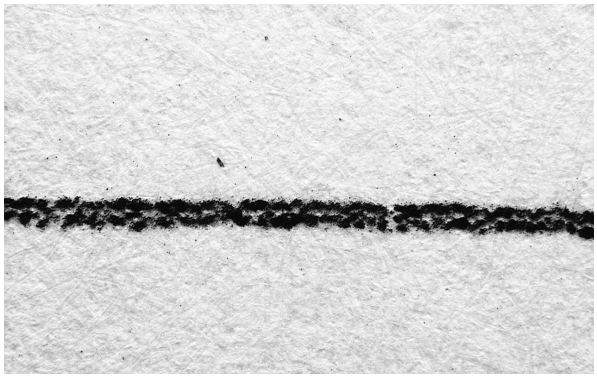

Figure 15.1 Photocopy of Liquid Lead Pencil

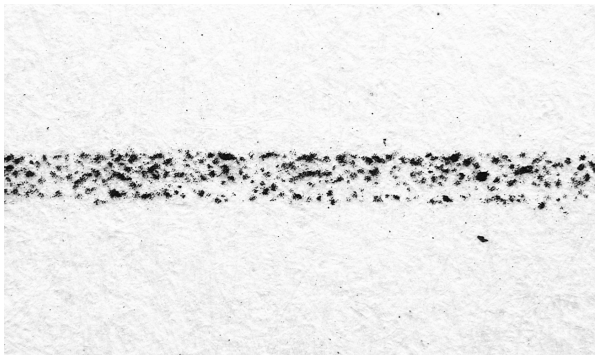

Figure 15.2 Photocopy of Graphite Pencil

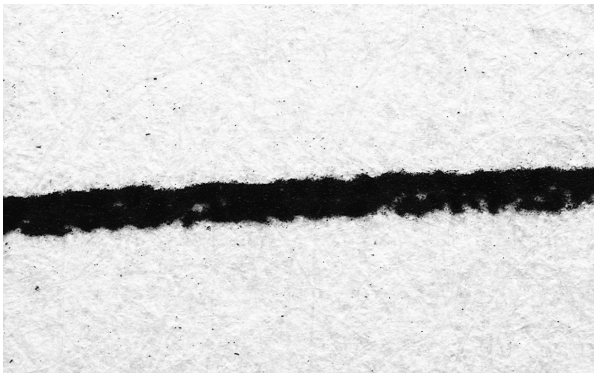

Figure 15.3 Photocopy of Gel Pen

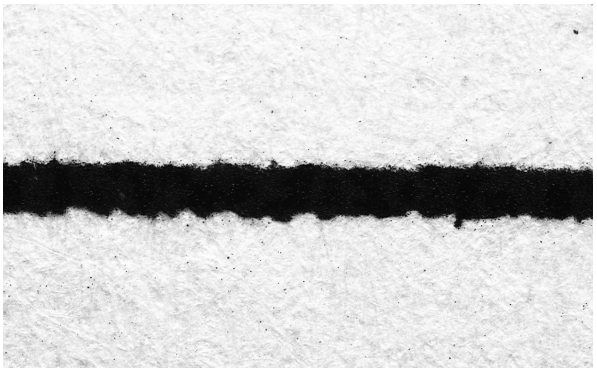

Figure 15.4 Photocopy of Rollerball Pen

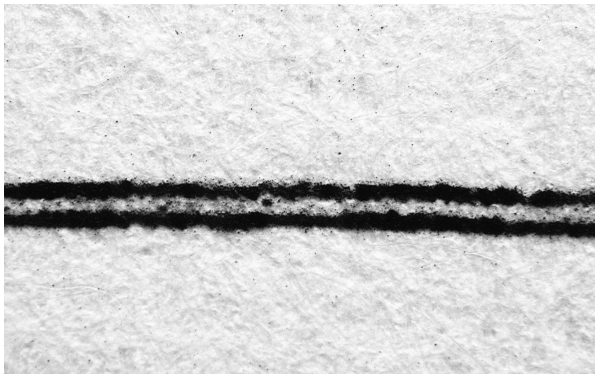

Figure 15.5 Photocopy of Ballpoint Pen

Figures 15.1-15.5
Straight line morphology shown on black-and-white photocopies made with a Canon Image Runner 3570.

Note that striations are still clearly visible in the lines of the liquid lead pencil, gel pen and ballpoint pen. Also note the sparseness of the graphite pencil line and the solidness of the rollerball pen line.

(All images magnified 32.40X)

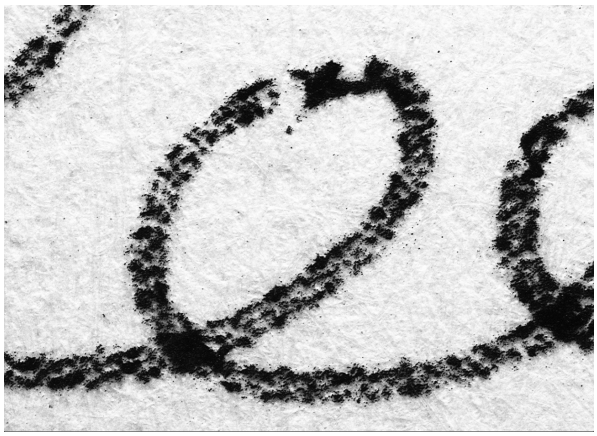

Figure 16.1 Photocopy of Liquid Lead Pencil

Figure 16.2 Photocopy of Graphite Pencil

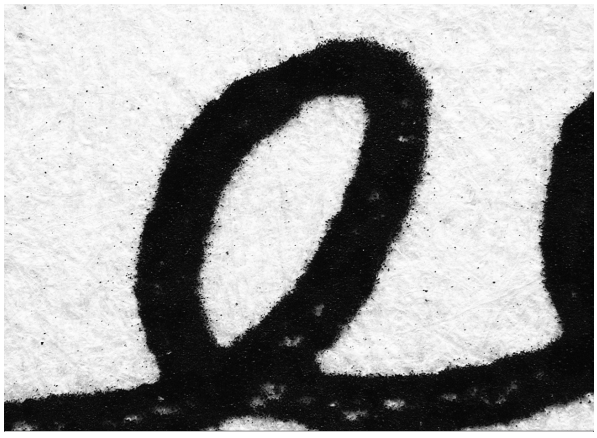

Figure 16.3 Photocopy of Gel Pen

Figures 16.1-16.5
Curved line morphology shown on black-and-white photocopies made with a Canon Image Runner 3570.

Note that striations are still clearly visible in the lines of the liquid lead pencil, gel pen and ballpoint pen. Also note the sparseness of the graphite pencil line and the solidness of the rollerball pen line.

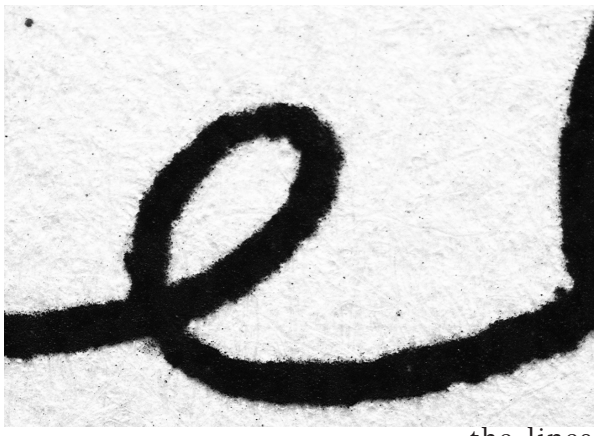

Figure 16.4 Photocopy of Rollerball Pen

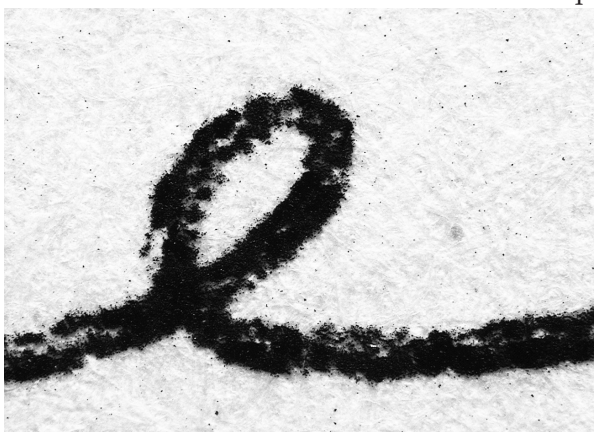

Figure 16.5 Photocopy of Ballpoint Pen

(All images magnified 32.40X)

Conclusion

The liquid lead pencil has a line morphology which shares many characteristics with that of a ballpoint pen. Striations, gooping and skipping are common. It also shares a feature of the rollerball pen, namely bleeding of the "ink" line into the surrounding paper. However, it can be noted that the rollerball pen's ink soaks into the paper more completely and has a more solid line quality due to its water-based ink.

Helping to differentiate the liquid lead pencil is its erasability and its washed-out gray color. Interestingly, the liquid lead pencil shares fewer line characteristics with a graphite pencil than it does with either the ballpoint pen or the rollerball pen. While the written line of a graphite

pencil exhibits spectral reflectance, the written line of the liquid lead pencil does not. Once on the paper, the liquid lead dries to a dull grayish substance. Because of its ball and socket construction, the liquid lead pencil leaves a much deeper groove in the paper than does a graphite pencil (see Fig. 14). Also, piling of the graphite against the paper fibers, a characteristic of graphite pencils is not seen with liquid lead.

Photocopies of each sample were made to determine which line characteristics would still be visible and those that would be lost. As seen in Fig. 15 and Fig. 16, striation marks are still clearly visible in both straight line and curved line patterns of the liquid lead pencil, the gel pen and the ballpoint pen. The rollerball pen line is much darker and more solid than any of the other lines, while the graphite pencil line is much less dense than the others. When one is presented with a photocopy, the liquid lead pencil can be differentiated from a gel pen, a rollerball pen and a ballpoint pen by the mottled pattern of the line, and can be differentiated from a graphite pencil by the presence of skipping, gooping and striations.

The liquid lead pencil stroke shares characteristics with, and could be mistaken for, both the ballpoint pen and the rollerball pen; therefore, Forensic Document Examiners should be aware of the unique line morphology of the liquid lead pencil. Original documents and good photocopies can adequately represent line morphology, enabling a diligent and competent Forensic Document Examiner to determine the type of writing instrument that produced the line in question.

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