Kun C. Cheng,[1] *M.S.; Nellie Cheng,*[2] *B.S.; and Yuh C. Wei,*[3] *Ph.D.*

A Study on the Use of Photopolymer Reflex Plate in the Forgery of Chinese Seals*

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ABSTRACT: This study compares the identifying characteristics between the impressions made with original Chinese seals and photopolymer replicate seals, and between the impressions made with two photopolymer replicate seals that originate from one single negative. Various seal materials common to the Chinese community such as cow's horns and ivory are employed. Other than the common factors such as different incident angle upon imprinting or different degree of inking that constitute the natural variation in impressions, the physical changes of the seal materials with temperature will be considered. This study concludes that photopolymer replicate seal impressions can be differentiated from the originals in respect to print density and stroke morphology, but it is very difficult to differentiate between two photopolymer replicate seal impressions with the same origin. This study also proposes a simple method for the examination of forged Chinese seal impressions.

KEYWORDS: forensic science, questioned documents, Chinese seal, stamps, forgery, photopolymer reflex plate

The Chinese seal is an art interwoven with cultural heritage. Its use dates back to 1000 years before the Qin Dynasty, when printing was invented. The seal can be made of cow's horns, wood, stone, ivory, bone, crystal, bamboo, plastic, ceramic, bronze, etc. The characters on the seal are usually carved in Chinese calligraphy—*zhuan* script, *lishu, kaishu, xingshu,* and *caoshu*—in relief (white carve), in intaglio (red carve), or in both. Oriental Chinese and Japanese like to use personal seals for the purposes of authentication or as tokens of social status.

In the past, forged Chinese seals were mostly produced with photoprinted zinc plate, which is etched chemically to form the surface plate pattern (Fig. 1). An impression of this type lacks the three-dimensional attributes of that made with a knife-carved seal; differentiating it from the genuine seal impression shall not be difficult (1). Nowadays, there are easier and better ways of forging Chinese seals such as the use of photopolymer plate, polymer injection molding machines (Fig. 2), and carving machines (Fig. 3). Forged seals made with carving machines are discernible from others by their carving needle exertion position and framing lines and angles (Fig. 4), while those made with photopolymer plate and polymer injection molding machines employ the genuine impression, as the template for platemaking renders them hardly distinguishable.

Any Chinese seal impressions, colored or black-and-white, can be scanned into the platemaking equipment, and the negative used for forgery will be created within a very short time. The possibility of replicating two identical Chinese seals with photopolymer relief plate has been confirmed. The ease of fabricating forged seals poses a security problem in Chinese society since personal seals are commonly used for authenticating important documents such as bank checks in lieu of signatures.

Experimental

Apparatus

- Twelve Chinese seals of which three are made of cow's horns, five of wood, one of ivory, one of crystal and the remaining two of plastic. All seals are cut in relief but one is in intaglio. (The materials and their respective numbers used are chosen according to their usage ratio in Taiwan.)
- Fuji SCANART 230 scanner with a resolution of 1000 dpi.
- Japan TOKYO OHKA Co.-MF94H photopolymer plate, 0.94 mm in thickness, 65 deg A(Shore) in hardness.
- Fuji SDF100 negative.
- Philips fluorescent lamp (350 nm UV).
- Taiwan Goaan Tain Co.-GT-FA4 developing machine.
- 80 g/m^2 Canon A4 size photocopier paper.
- Japan KAGAKU SOBILTD stamp pad ink. (It is used mainly to obtain fingerprints due to the minute particle size of the pigment.)

Methods

Freely and naturally imprint the 12 Chinese seals onto a sheet of A4 paper. Their impressions, which are in black-and-white, are used as the original impressions (Fig. 5*a*). Place the sheet of paper onto the scanner to produce a negative for replication (Fig. 5*b*). Expose the photopolymer plate under the masking of the negative to the named light source for 50 s. Develop the photopolymer plate in water for 3 min in the developing machine; the nonexposed part will be washed away while the exposed part remains intact. A photopolymer reflex plate containing 12 replicate seals is then formed (Fig. 5*c*). Replicate another set of seals by repeating the above procedures with the same negative. This is done to study the possibility of differentiating between photopolymer replicate seals that

[1] Questioned document examiner, Forensic Science Laboratory, Ministry of Justice Investigation Bureau, Taipei, Taiwan, Republic of China.

[2] Scientific officer, Document Examination Laboratory, Department of Scientific Services, Institute of Science and Forensic Medicine, Singapore 169078.

[3] Associate professor and chairman of the Department of Graphic Communication, Institute of Graphic Arts, Chinese Culture University, Yang-ming-shan, Taipei, Taiwan, Republic of China.

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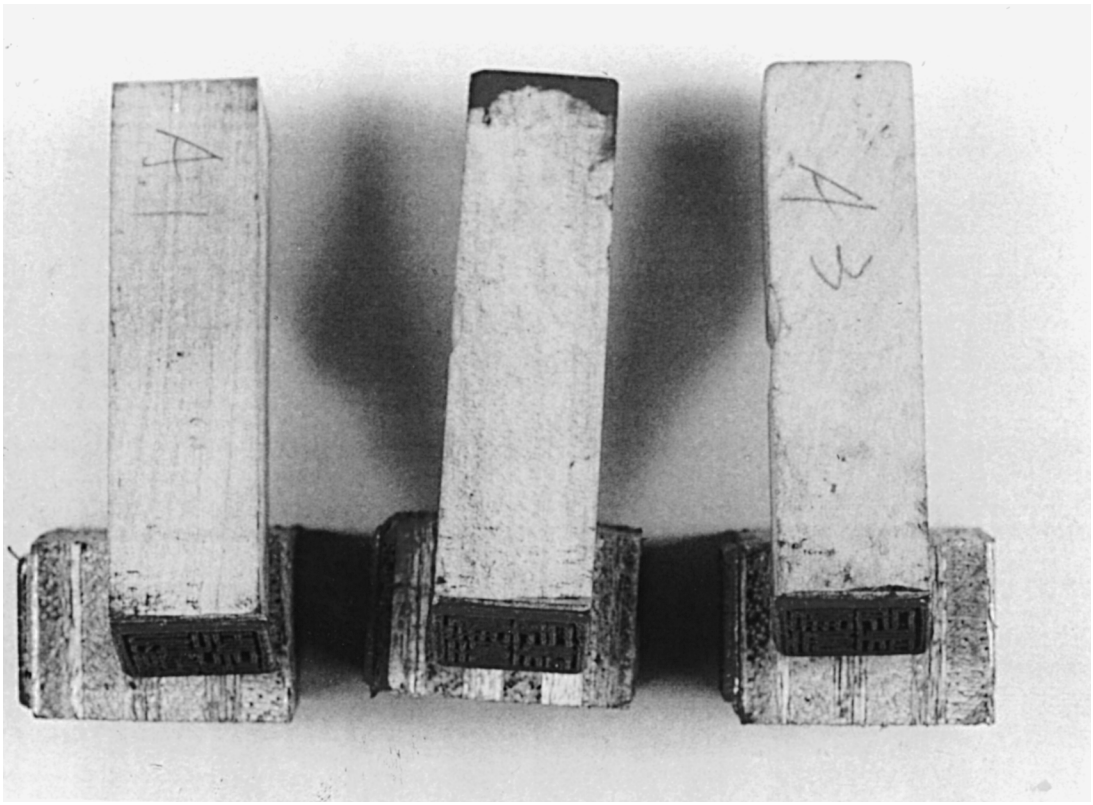


FIG. 1—*Forged Chinese seals produced with photoprinted zinc plate.*

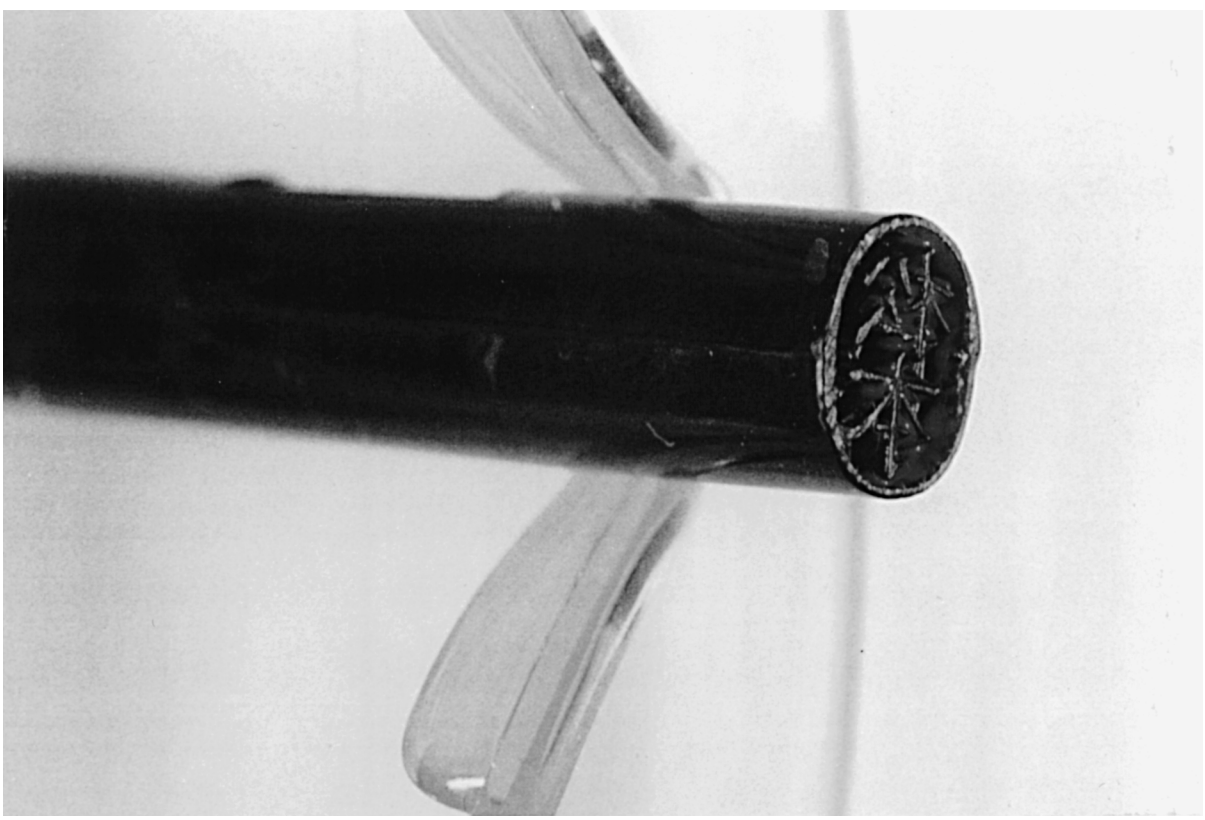


FIG. 2—*A forged Japanese seal produced with polymer injection molding machine.*

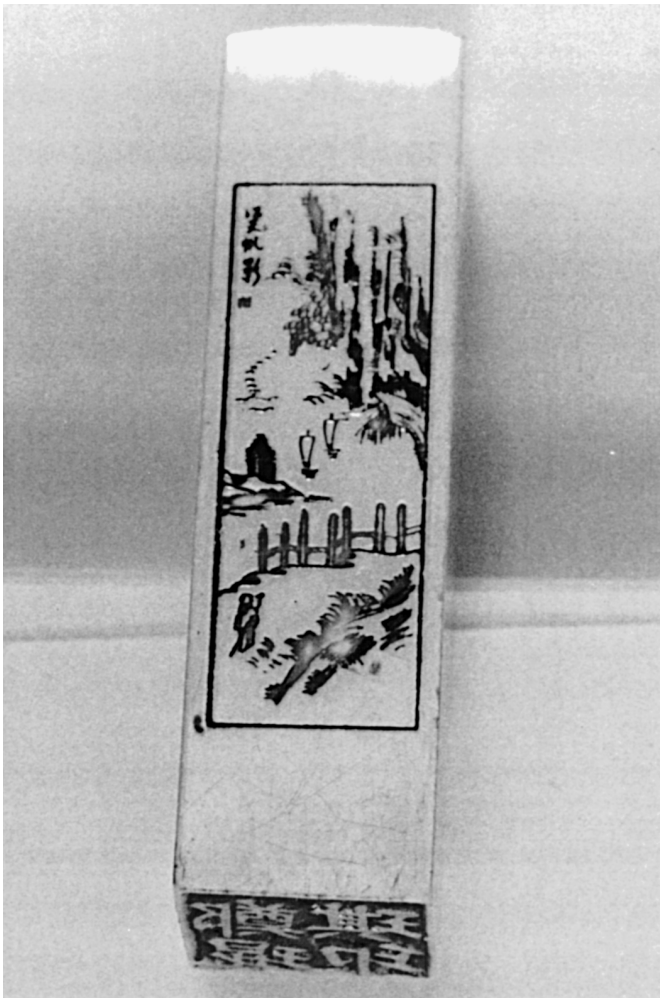
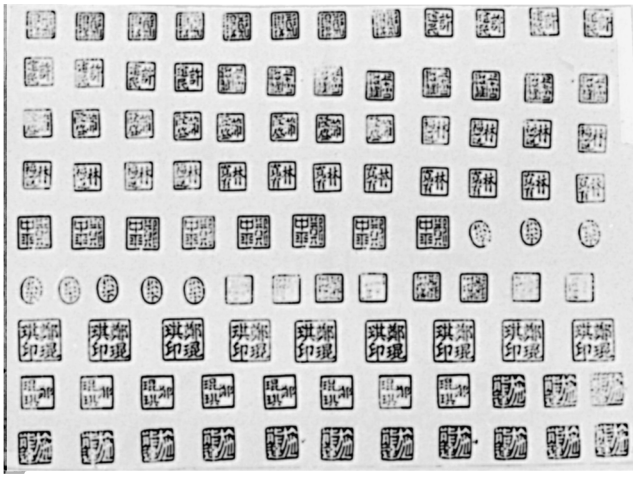
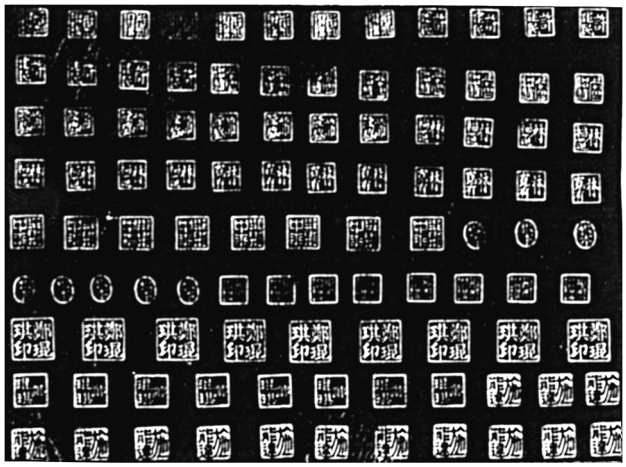


FIG. 3—*A Chinese seal which is carved by semi-automatic carving machine.*

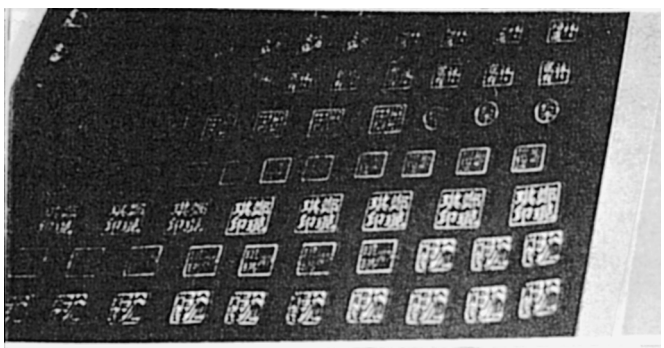
FIG. 4—*Two Chinese seals made by automatic carving machine. Arrows show the characteristic carving needle exertion position and framing lines and angles in these types of seals.*



(a) Black-and-white impressions of the twelve Chinese seals. Seven to ten impressions were obtained from each Chinese seal, and the one with the best quality will be used as the original impression.



(b) Negative produced by the scanner.



(c) Negative is place on top of the photopolymer plate and both are exposed together to the light source for 50 seconds.

(d) Seal on left is a replicate that is cut from the photopolymer plate and adhered onto the surface of the wooden block. Seal on right is the original seal.

FIG. 5—*Replication process using photopolymer reflex plate.*

share the same negative as the original. Cut the photopolymer replicate seals to the size of the noncarved wooden blocks and adhere them onto the surfaces to facilitate their stamping for comparison with the original seals (Fig. 5*d*). Freely and naturally imprint the 24 replicate seals and the 12 original seals onto a sheet of A4 paper. There are 36 impressions in total, of which 12 are from the original seals and 24 from the two sets of replicate seals (Fig. 6).

Enlarge all 36 impressions photographically for a clear side-by-side comparison. The authors used a 400% enlargement, which was found to be sufficient for displaying all the essential features. The identifying characteristics include marks or properties of the framing lines, and features such as formation angle, dimension, discontinuation, and shape of the strokes of the Chinese characters. A comparison was made between the two sets of replicate impressions and between the original and replicate impressions with the same design.

Results

When comparing the two sets of replicate seal impressions, significant similarities were found (Fig. 7). This was anticipated as both sets of replicate seals originated from the same negative. It would be very difficult to differentiate these types of replicate seal impressions from each other since they bear the same class and individual characteristics.

When the original impressions were compared with their corresponding replicate impressions, both similarities and dissimilarities in identifying characteristics were noted (Fig. 8). The distinguishing features were found to be the broadened strokes and lines, the difference in print density, and the fineness of stroke morphology.

Discussion

Upon imprinting, the pressing action renders the ink to spread; this results in the strokes on the impressions being broader than they are on the seals. This phenomenon can be observed in all kinds of seals or stamps that are cut in relief, regardless of the composing materials (Fig. 9). For those processes that use seal impressions on sheets of paper for replication, the feature of broader strokes/lines will inevitably be incorporated into the final replicate seal. When this replicate seal is used for imprinting, the strokes/lines will again be further broadened.

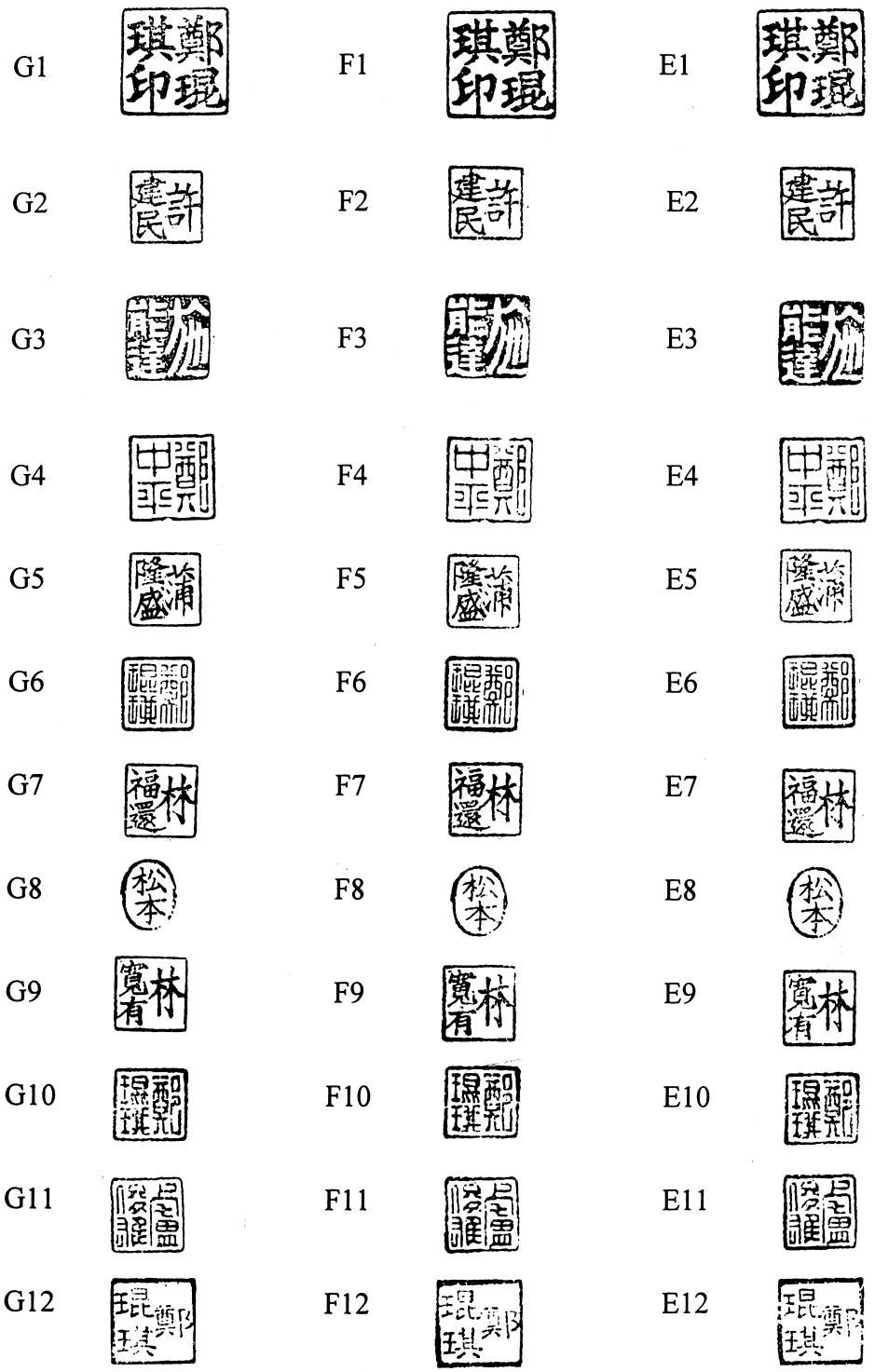


FIG. 6—*Twelve original seal impressions G1 to G12 and 24 replicate seal impressions F1 to F12 and E1 to E12 for identifying characteristic comparisons. (For the original seals, G1 and G8 are made of plastic; G3, G6, and G12 of cow's horns; G2, G4, G5, G9, and G11 of wood; G10 of crystal; and G7 of ivory.)*

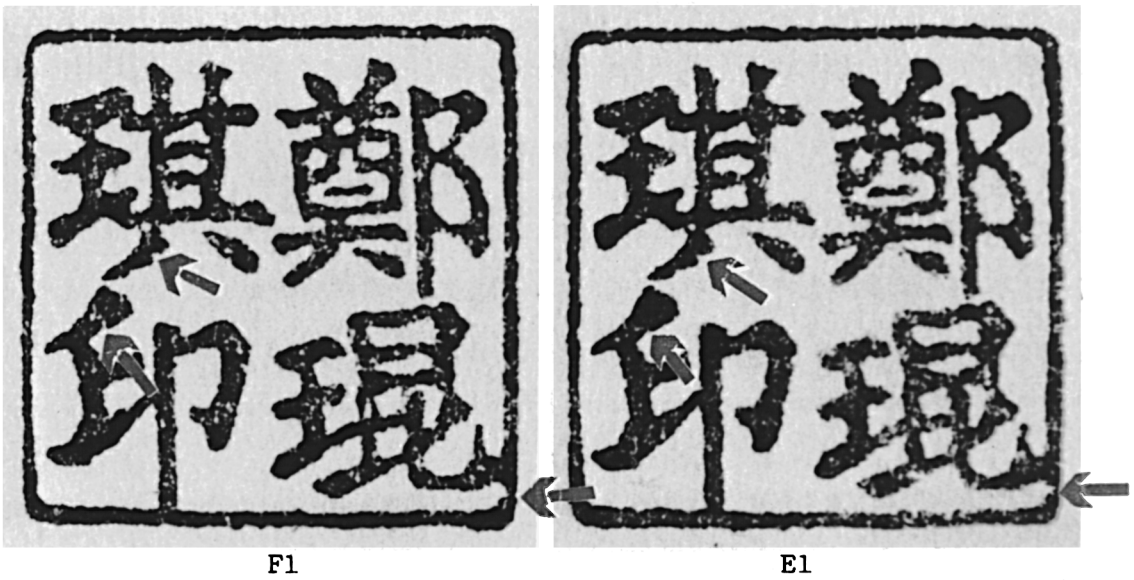


FIG. 7—*Arrows show significant similarities between the replicate seal impressions E1 and E1.*

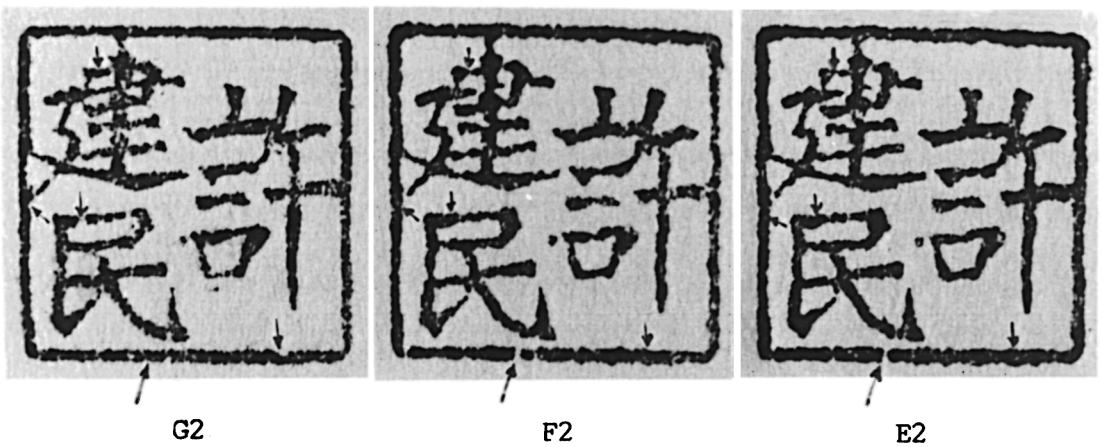


FIG. 8—*Arrows indicate dissimilarities that could be used for differentiation between original impression G2 and replicate impressions F2 and E2.*

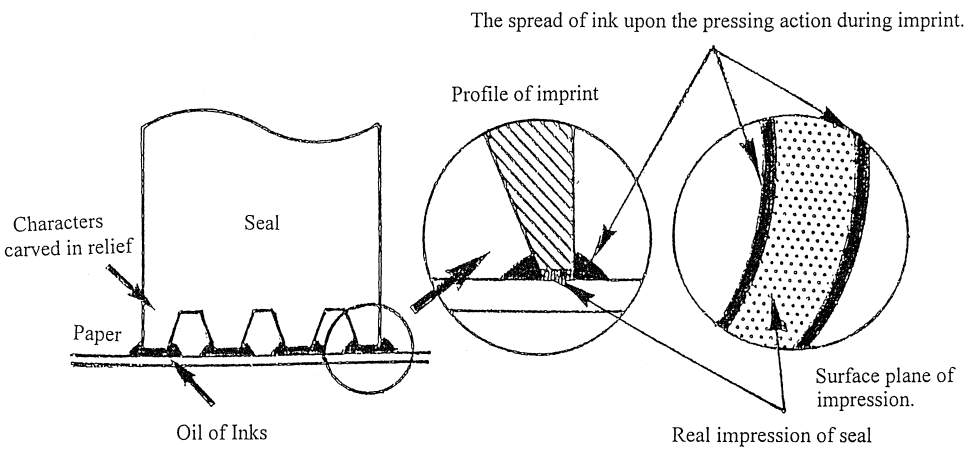


FIG. 9—*Ink spread upon pressing action, leading to stroke broadening in the impressions.*

Due to their flexographic nature, strokes broadening in photopolymer replicate seal impressions are found to be more profound than others—for example, than those of the photoprinted zinc replicate seals. This occurrence contributes to a change in print density which can be used as a key for differentiation. For photopolymer replicate seals in relief, as the text area is the printed area, the stroke broadening will cause the print density of the impressions to be higher than those of the genuine ones. For photopolymer replicate seals in intaglio, the nontext area of the seal is the actual printed area. The larger area in reflex renders the ink rejection property of the photopolymer more explicit, which adversely affects the ink penetration of the paper. Underabsorption of ink will occur and the resulting print density of the impression will reduce (Fig. 10).

Other than the print density, another distinguishing feature is the fineness of the stroke morphology. Figure 11 depicts the blunt and rounded starting and ending of strokes in the photopolymer replicate seal impression, which should be fine and sharp in the original impression. The fine or detailed attribute of the stroke is found to be lost in the photopolymer replicate seal impression. To identify the difference in detail and fine characteristics, enlarging both the questioned and specimen impressions to the same degree and overlapping them for examination will be helpful (Fig. 12).

The loss of fineness in replication reflects the limitation of photopolymer plate in reproducing fine details. However, it should be noted that a good control of the exposure time and an enlargement of the genuine impression upon scanning followed by a reduction back to its normal size might alleviate the problem.

The exposure time of the negative and photopolymer plate and the developing time of the photopolymer plate affects the quality of the photopolymer replicate seals. The breadth of the stroke/line on the photopolymer plate is directly proportional to the exposure time. An underexposure constitutes defective stroke formation whereas an overexposure renders the stroke/line to be broader. Fifty to 55 s was found to be the optimum exposure time. For the developing time, the duration affects the depth of the printed surface. The depth is generally greater with a longer developing time before the depth limit is reached. For the Tokyo Ohka MF94H photopolymer plate we used, the thickness is 0.94 mm and the limit to the printed surface depth is 0.70 mm. The depth will not increase further beyond this limit. An underdeveloped seal implies a lower angle of coincidence, which might be distinguishable from its seal impression (2).

Like other stamps, factors such as the incident angle and the magnitude of pressure used upon imprinting, the degree of inking, and the type and absorbency of the paper affect the clarity or qual-

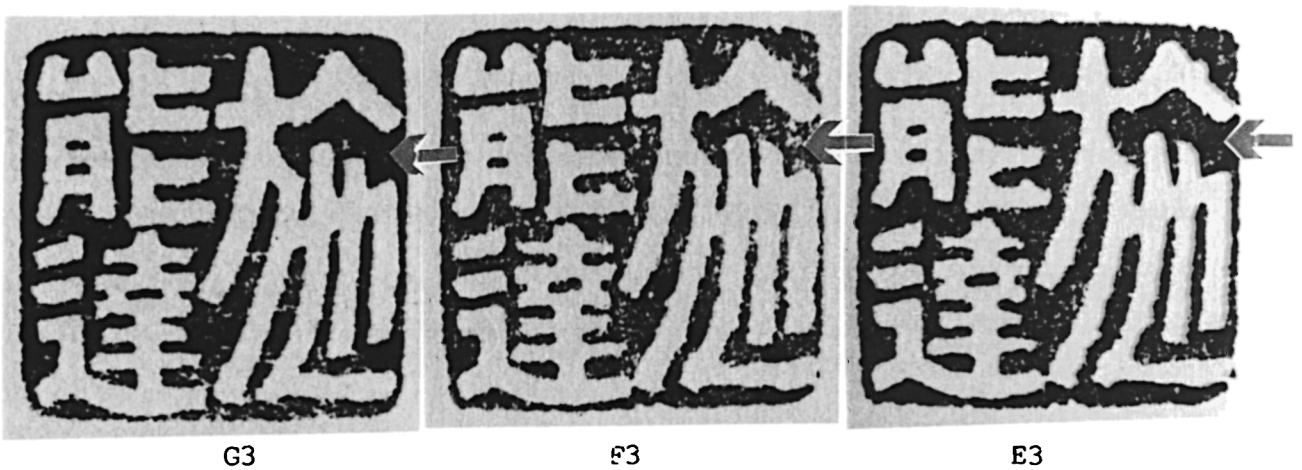


FIG. 10—*When compared with the original impression G3, photopolymer intaglio seal impressions F3 and E3 are of lower print density and the ink is more unevenly distributed.*

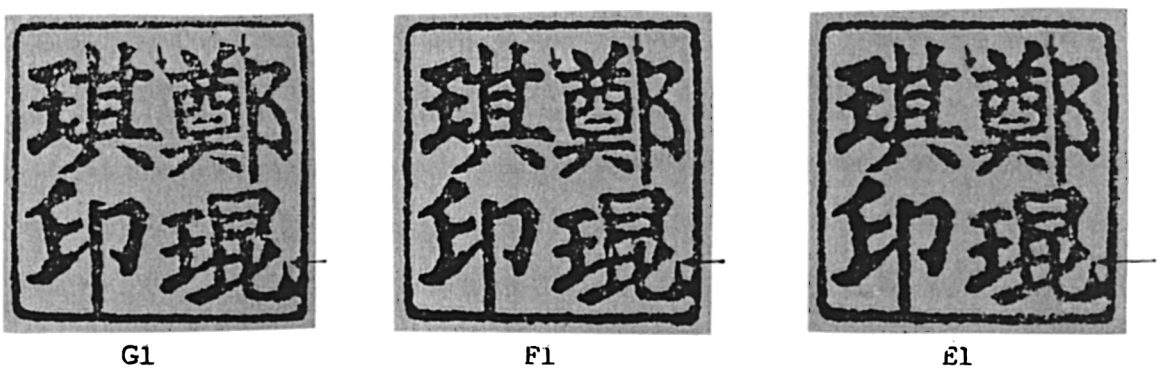


FIG. 11—*Arrows indicate the blunt and rounded starting and ending of strokes in F1 and E1, which should be fine and sharp in the original impression G1.*

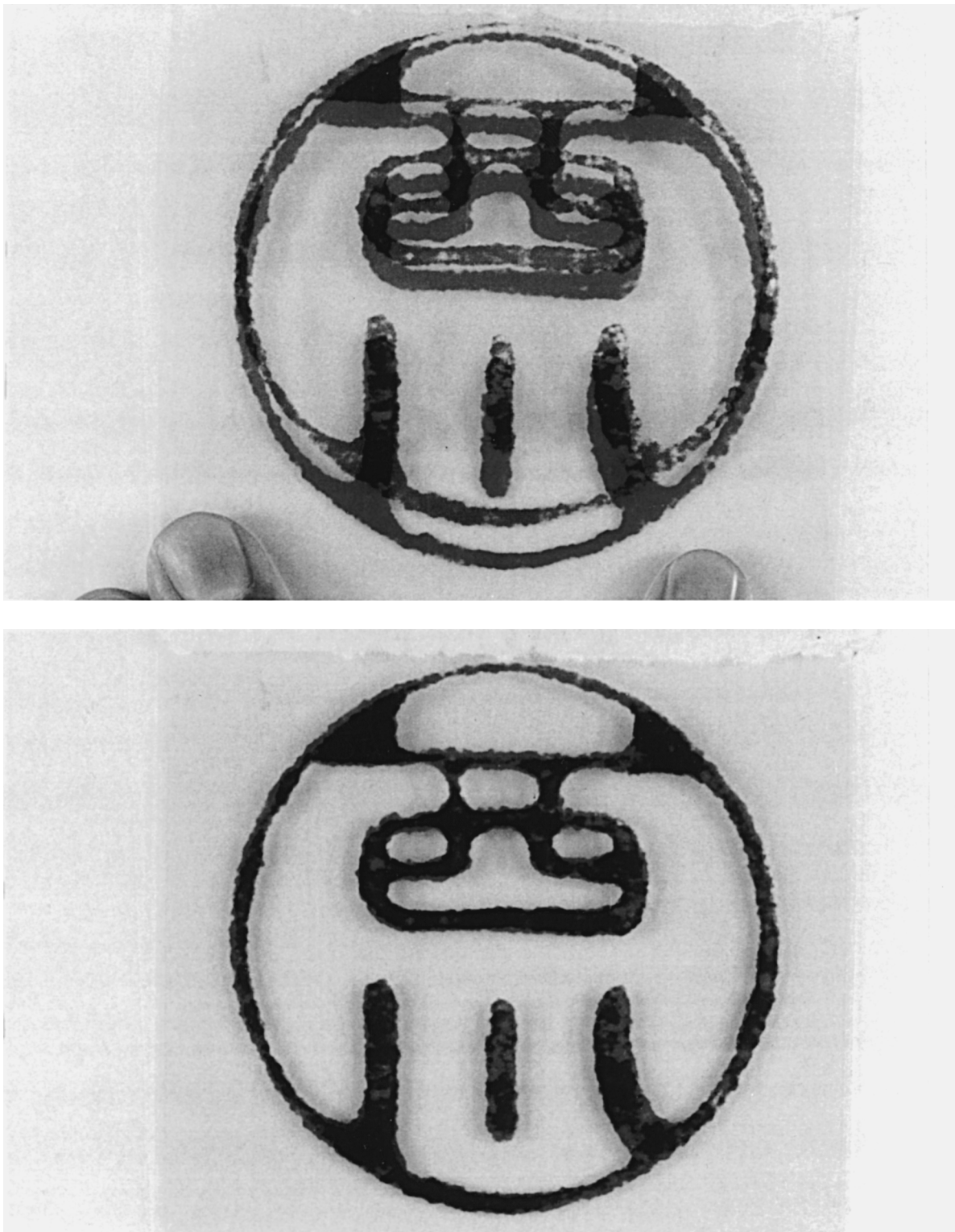


FIG. 12—*Impression on the top is the questioned one while that underneath is the specimen. They are enlarged to the same degree and then placed together for examination.*

ity of Chinese seal impressions and shall be considered as the natural variation (3). Besides these, the physical properties of the composing materials shall also be taken into account. Wood expands with an increase in temperature and this leads to strokes broadening. For cow's horns, plastic, and stone, they exhibit insignificant physical changes with temperature and are thus more suitable for using as Chinese seals. It is interesting to note that crystal and stone are relatively less popular among the Chinese community due to their hardness, which is unfavorable for carving.

To reach a conclusion, the determination of the range of variations becomes crucial. There are times at which only questioned and specimen impressions are available for examination. Conclusions of elimination may be reachable should there be significant differences in identifying characteristics and a sufficient quantity of impressions for examination. However, when the class and identifying characteristics are the same, it would be wise for document examiners to insist on the submission of the seal itself for microscopic examination and for the determination of its carving method—hand-carved or machine-carved (2).

Conclusion

The keys to differentiate forged photopolymer seal impressions from the genuine Chinese seal impressions that are based on print density and stroke morphology are as follows.

For seal impressions in relief, the strokes/lines are broader than they are in the genuine impressions. The starting or ending strokes are blunt and rounded instead of being fine and sharp. The print density is higher than that in the genuine one.

For seal impressions in intaglio, the nontext area, which is the print area and is in relief, is relatively large, and hence the ink rejection property of the photopolymer is more explicit. The reduction in print density is a distinctive feature for this kind of seal.

When examining the genuine and forged seal impressions, natural variations upon imprinting the seals have to be considered. This comprises factors such as the incident angle of the seal and the magnitude of pressure used upon imprinting, the degree of inking, the type and absorbency of the paper, and the physical changes the seal materials have undergone. To ascertain any observed difference to be an actual natural variation and to reach a conclusion, a sufficient quantity of questioned and specimen impressions and the submission of the seals for examination are the prerequisites. Document examiners shall insist on this for a fruitful examination.

In differentiating between two photopolymer replicate seals, it is demonstrated to be difficult as they bear significantly similar class and individual characteristics.

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Additional information and reprint requests:
Kun-Chi Cheng, M.Sc.
Forensic Document Examiner
Investigation Bureau, Ministry of Justice
P.O. Box 3562 Taipei, Taiwan, R.O.C.