THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

Committee on Identifying the Needs of the Forensic Sciences Community

Fingerprints

by Ed German
Certified Latent Print Examiner (IAI)
Fellow of The Fingerprint Society (UK)
Chief Warrant Officer Five (Retired), US Army

23 April 2007

This presentation is personal opinion and does not purport to represent the position or opinion of any entity of the US Government, or any organization with which the presenter was or is affiliated.

Latent Print Examination

1 - What is the scientific basis that informs the interpretation of the evidence?

2 - Overview of the fingerprint identification techniques …What is the state of the art?

3 - Where is research conducted?

4 - Where is it published?

5 - What are the major problems in the scientific foundation, methods, and practice?

6 - What research questions do you think need to be answered?

Fingerprints

1 - What is the scientific basis that informs the interpretation of the evidence?

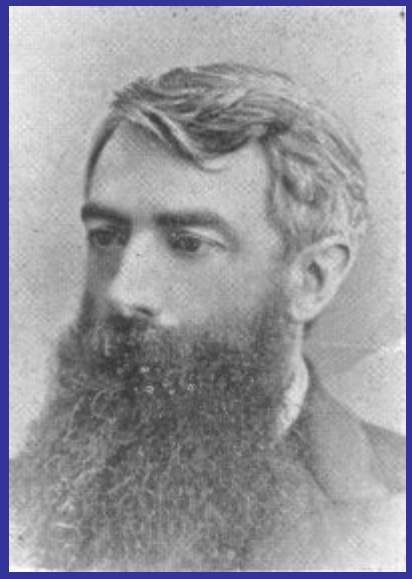
Fingerprints

1 - What is the scientific basis that informs the interpretation of the evidence?

Permanence and Individuality

Reliability of fingerprint examination is supported by the theories of biological uniqueness and permanence, probability modeling, and empirical data gained through over one hundred years of operational experience.

The comparison and individualization of two areas of friction ridge impressions are based on the examination of infinite combinations of ridge structure, individual ridge appearance, minutiae, spatial relationships, pores, and other details.

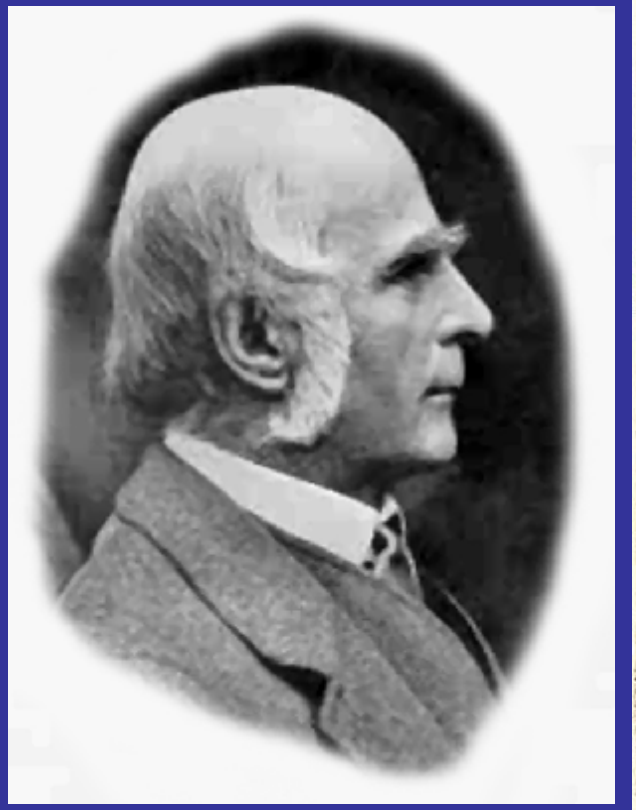


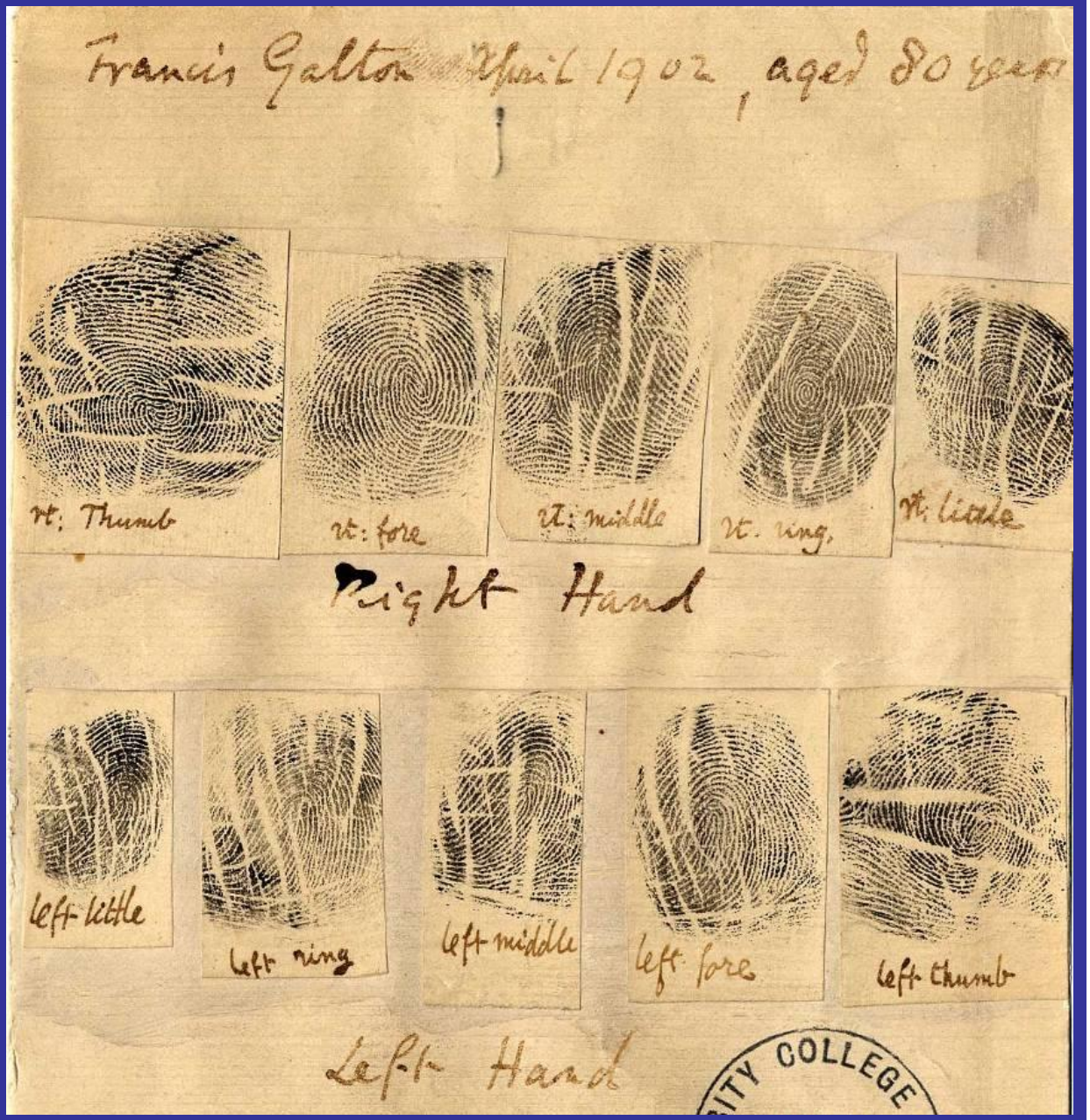
There can be no doubt as to the advantage of having, besides their photographs, a nature-copy of the forever-unchangeable finger-furrows of important criminals.

Fingerprint Research published by Dr. Henry Faulds, Nature, Oct 1880


ヘンリー・フォールズ住居の跡
ここは明治初年にあった築地居留地の18号地で
英国人医師ヘンリー・フォールズ(1843~1930)が明治7年
(1874)から同19年(1886)に至る滞日中に居住した所である
フォールズはスコットランド一致長老教会の宣教師として来日し
キリスト教布教のかたわら築地病院を開いて診療に従事し
また日本人の有志とはかって盲人の保護教育にも尽力した
彼はわが国で行なわれていた指印の習慣に興味をもちまた
発掘された土器に印象されていた古代人の指紋を発見しこれに
ヒントを得てここではじめて科学的な指紋の研究を行なった
明治13年(1880)10月英国の雑誌「ネーチュア」に日本から投稿した彼の
論文は科学的指紋法に関する世界最初の論文といわれその中で早くも
犯罪者の個人識別の経験を発表しまた指紋の遺伝関係にも言及してい
明治44年(1911)4月1日わが国の警察においてはじめて指紋法が採用
されてから満50年の今日ここゆかりの地に記念碑を建立しその
功績をたたえるものである


DR. HENRY FAULDS
PIONEER IN FINGERPRINT IDENTIFICATION
LIVED HERE
FROM 1874 TO 1886




Francis Galton April 1902, aged 80 years
rt: Thumb
rt: fore
rt: middle
rt. ring,
rt. little
Right Hand
left little
left ring
left middle
left fore
left thumb
Left Hand
COLLEGE

Fingerprints

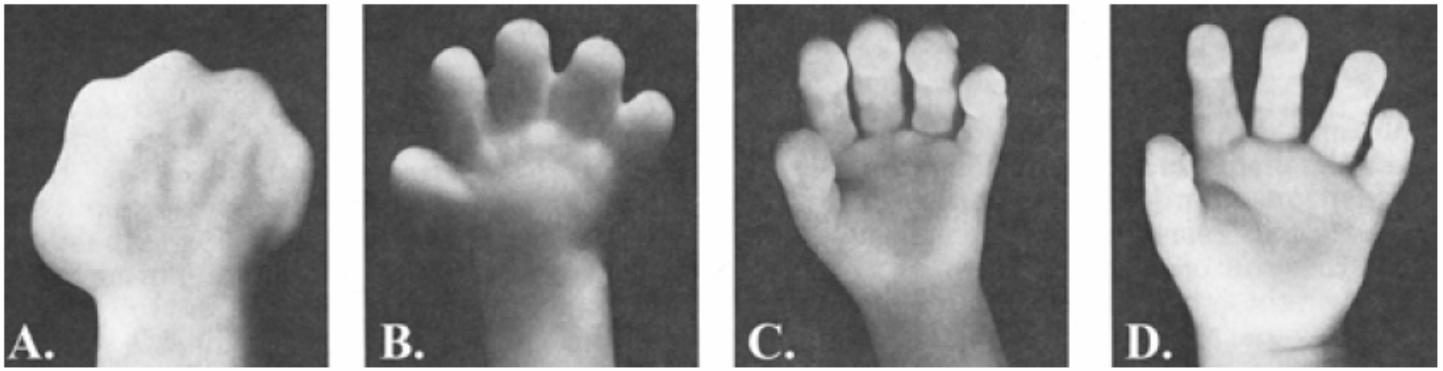
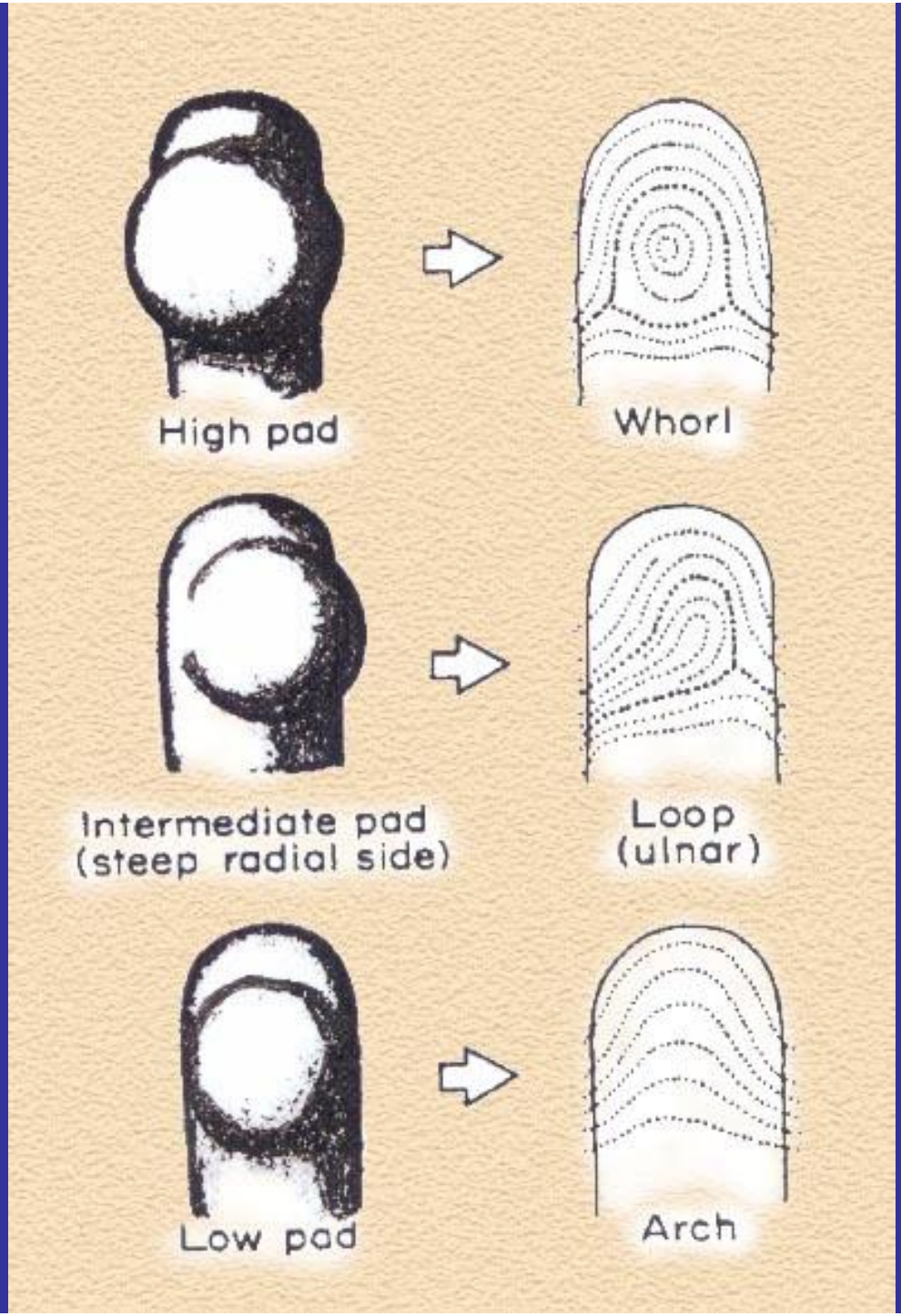
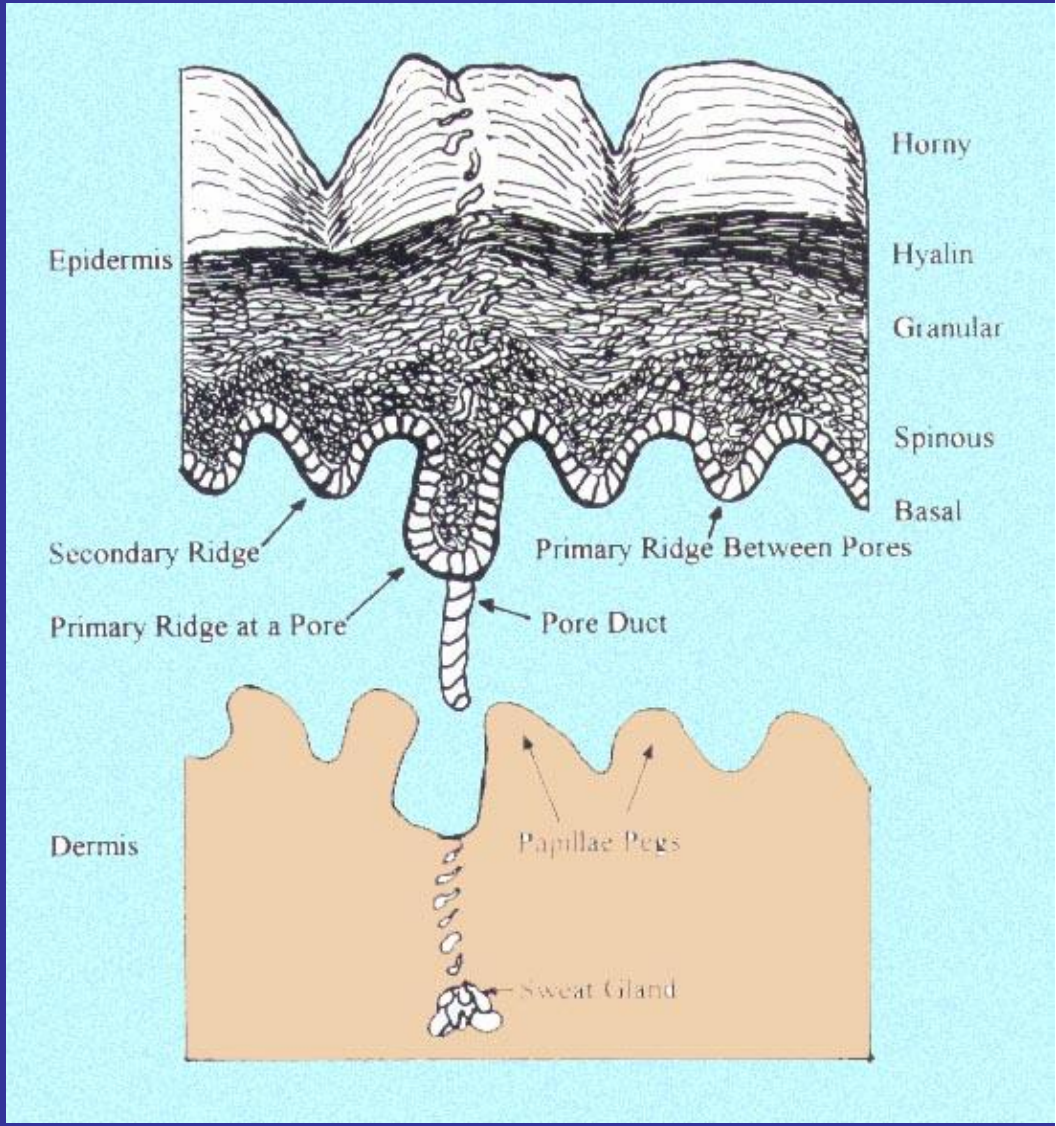


Figure 1

Growth of the hand progresses from paddlelike form (A 19.5 X), continues as the fingers separate (B 17.3 X), the volar pads become prominent (C 7.7 X) and achieves infantlike appearance (D 4.2 X). [Cummins, 1929].


High pad
Whorl
Intermediate pad
(steep radial side)
Loop
(ulnar)
Low pad
Arch

Fingerprints are formed during the third to fourth month of fetal development and, except for scars caused by permanent damage to the dermis or diseases such as leprosy, do not change throughout life.



D3 sl

ARMED FORCES

LEAVE THIS SPACE BLANK

USARECSTA FT JACKSON SC 29207

LAST NAME	FIRST NAME	MIDDLE NAME
GERMAN	EDWARD	RAYMOND

SIGNATURE OF PERSON FINGERPRINTED

x Edward Raymond German

SERVICE (use capitals or large pica)

ARMY NATIONAL AGENCY CHECK CENTER
DEFENSE INVESTIGATIVE SERVICE
POB 1083
BALTIMORE MD 21203

HEIGHT (Inches): 70"

DATE OF BIRTH: 20 Dec 53

PLACE OF ENLISTMENT, APPOINTMENT, ETC.: Charlotte NC

SERVICE NO./SSAN:

PLACE OF BIRTH: Jacksonville, IL

DATE OF ENLISTMENT, APPOINTMENT, ETC.: 31 Jul 75

COLOR OF EYES: Brown

LEAVE THIS SPACE BLANK

CLASS.

SCARS AND MARKS: Birthmark on right side

COLOR OF HAIR: Brown

REF.

SIGNATURE OF OFFICIAL TAKING FINGERPRINTS: Virginia [illegible]

WEIGHT: 175

DATE SIGNED BY OFFICIAL TAKING FINGERPRINTS: 31 Jul 75

SEX: M

1. RIGHT THUMB	2. RIGHT INDEX	3. RIGHT MIDDLE	4. RIGHT RING	5. RIGHT LITTLE
				
6. LEFT THUMB	7. LEFT INDEX	8. LEFT MIDDLE	9. LEFT RING	10. LEFT LITTLE
				

LEFT FOUR FINGERS TAKEN SIMULTANEOUSLY

LEFT THUMB

RIGHT THUMB

RIGHT FOUR FINGERS TAKEN SIMULTANEOUSLY

APPLICANT RECORD CARD

SEE REVERSE SIDE FOR FURTHER INSTRUCTIONS

TYPE OR PRINT ALL INFORMATION IN BLACK

LAST NAME NAM FIRST NAME Ed MIDDLE NAME

FBI LEAVE BLANK

SIGNATURE OF PERSON FINGERPRINTED

RESIDENCE OF PERSON FINGERPRINTED

PERSON TO BE NOTIFIED IN CASE OF EMERGENCY

NAME

ADDRESS

FINGERPRINTED BY

FINGERPRINTS SUBMITTED BY

DATE OF BIRTH DOB MONTH DATE YEAR

DATE FINGERPRINTED 23 AUG 05

SEX	RACE	HGT.	WGT.	EYES	HAIR	PLACE OF BIRTH POB

SOCIAL SECURITY NO.

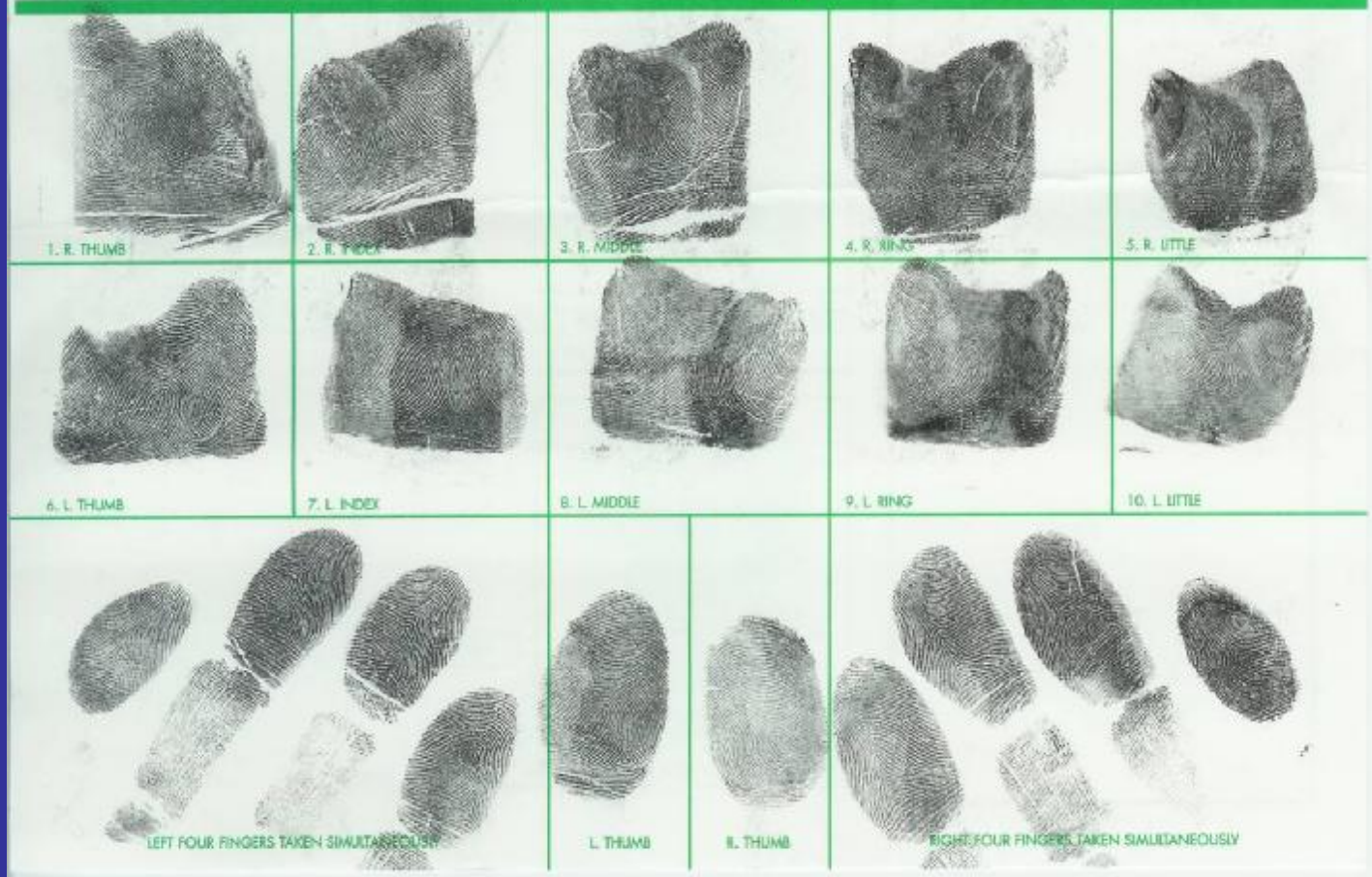
MISCELLANEOUS NO.

SCARS AND MARKS

LEAVE BLANK

CLASS

REF.




RIGH

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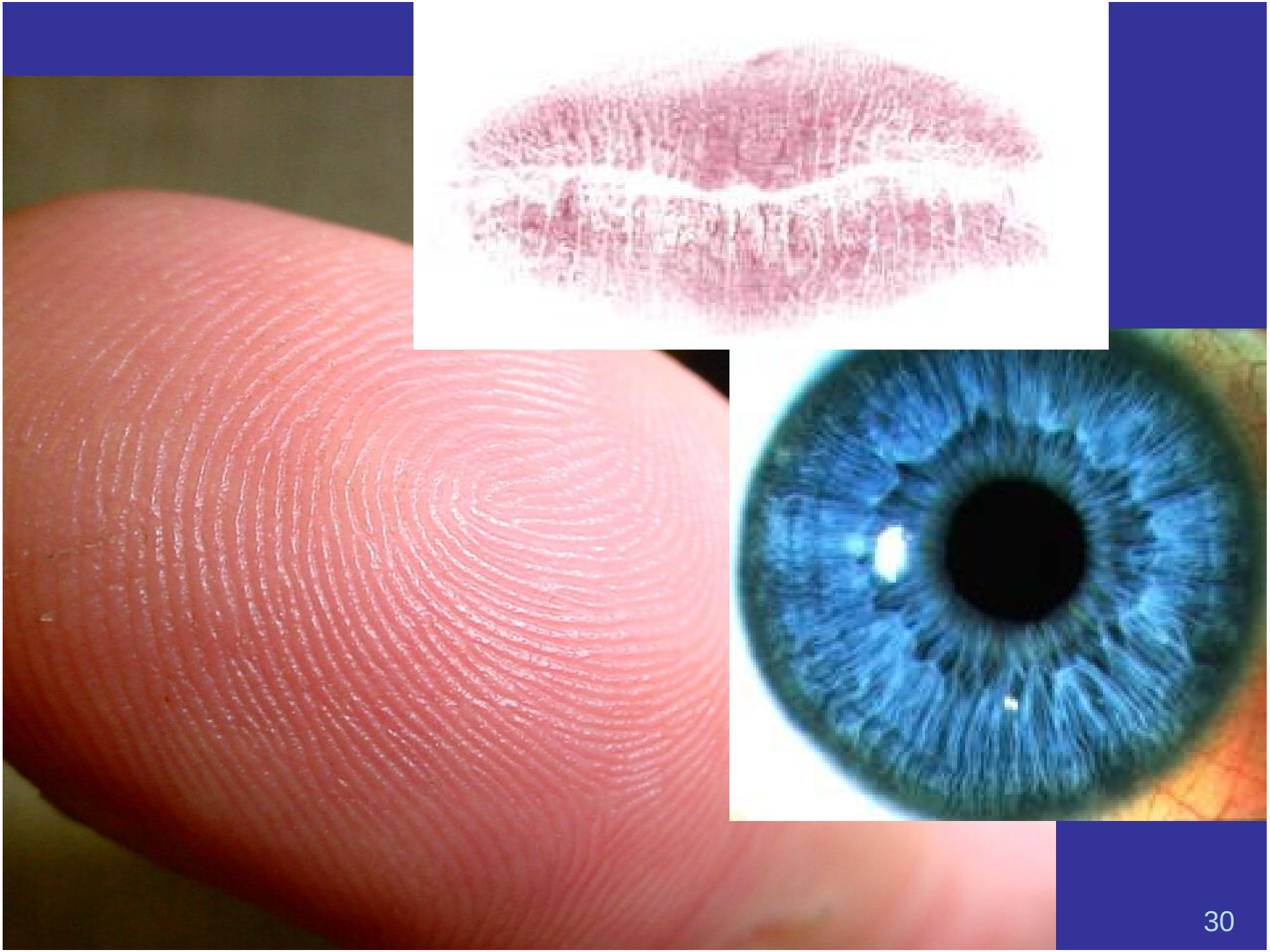
Fingerprints

2 - Overview of the fingerprint identification techniques …What is the state of the art?

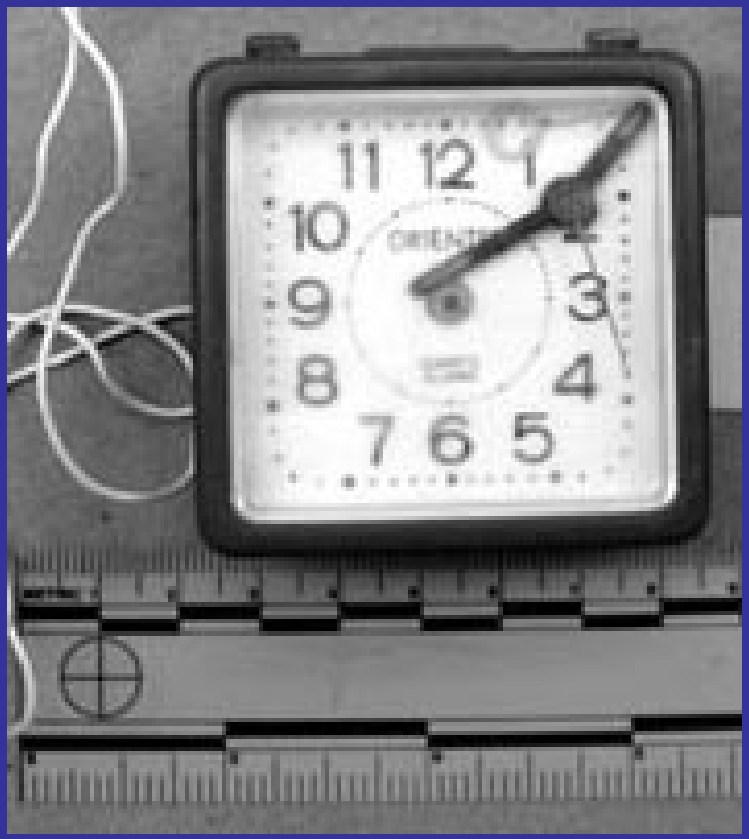
Fingerprints

2 - Overview of the fingerprint identification techniques …What is the state of the art?

- Latent Print detection / visualization and recording is very mature.
- Able to individualize small impressions.
- AFIS is mature for multiple finger comparisons.
- AFIS is advancing for partial finger and palm print comparisons …requires tremendous human expert resources.

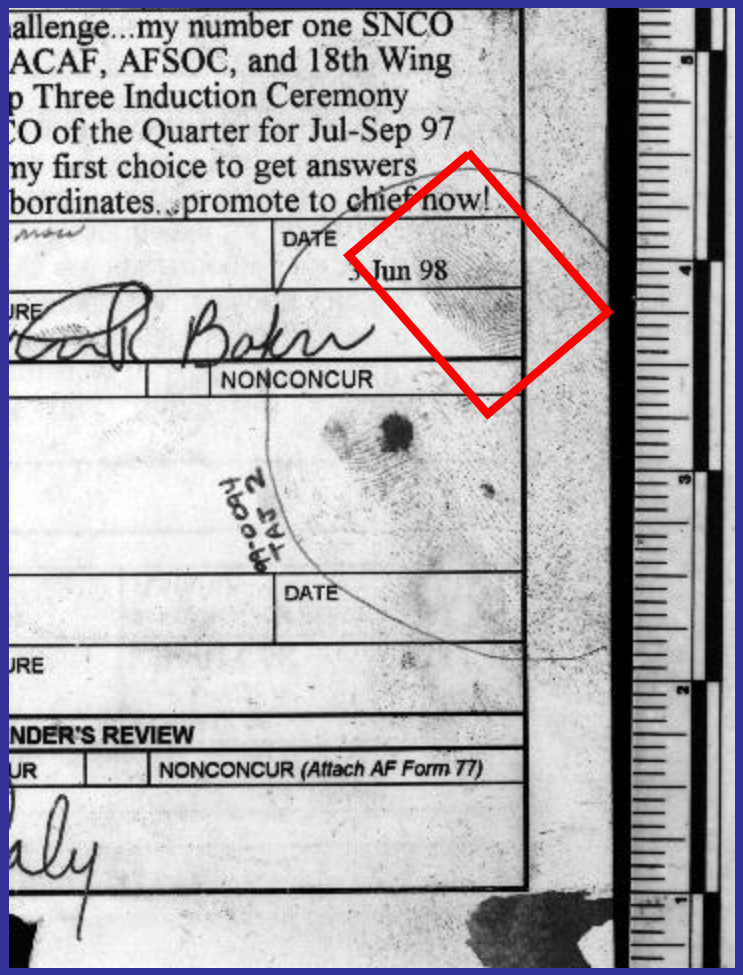


Fingerprints



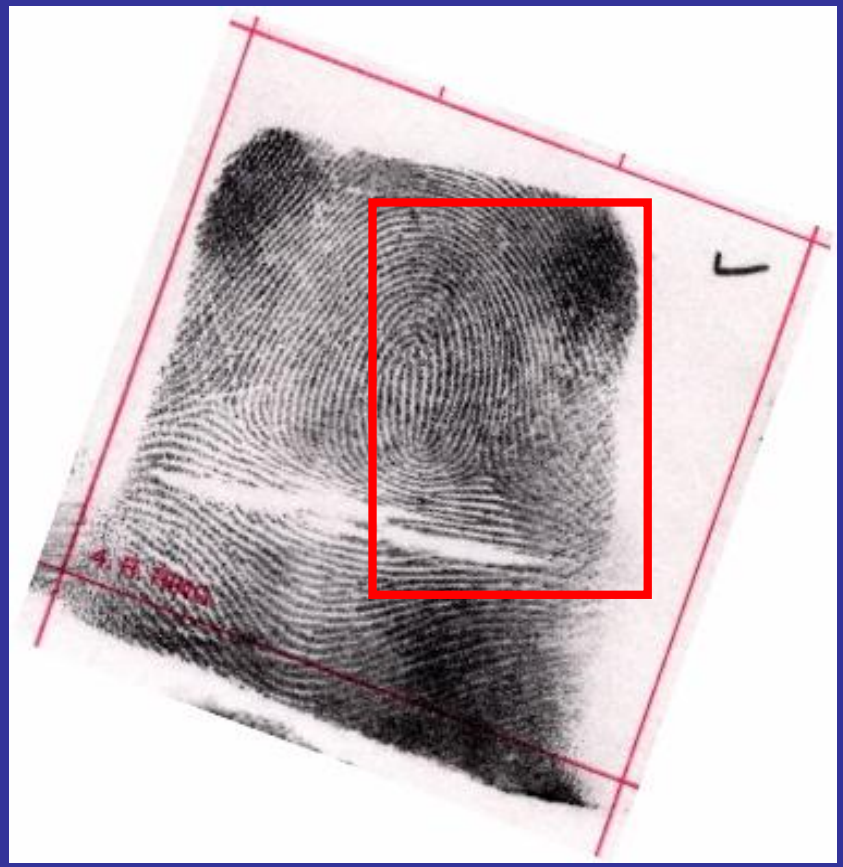
Alarm Clock from IED and close-up of fingerprint developed on inside of clock face cover.

Latent Fingerprint Adjacent to Questioned Signature

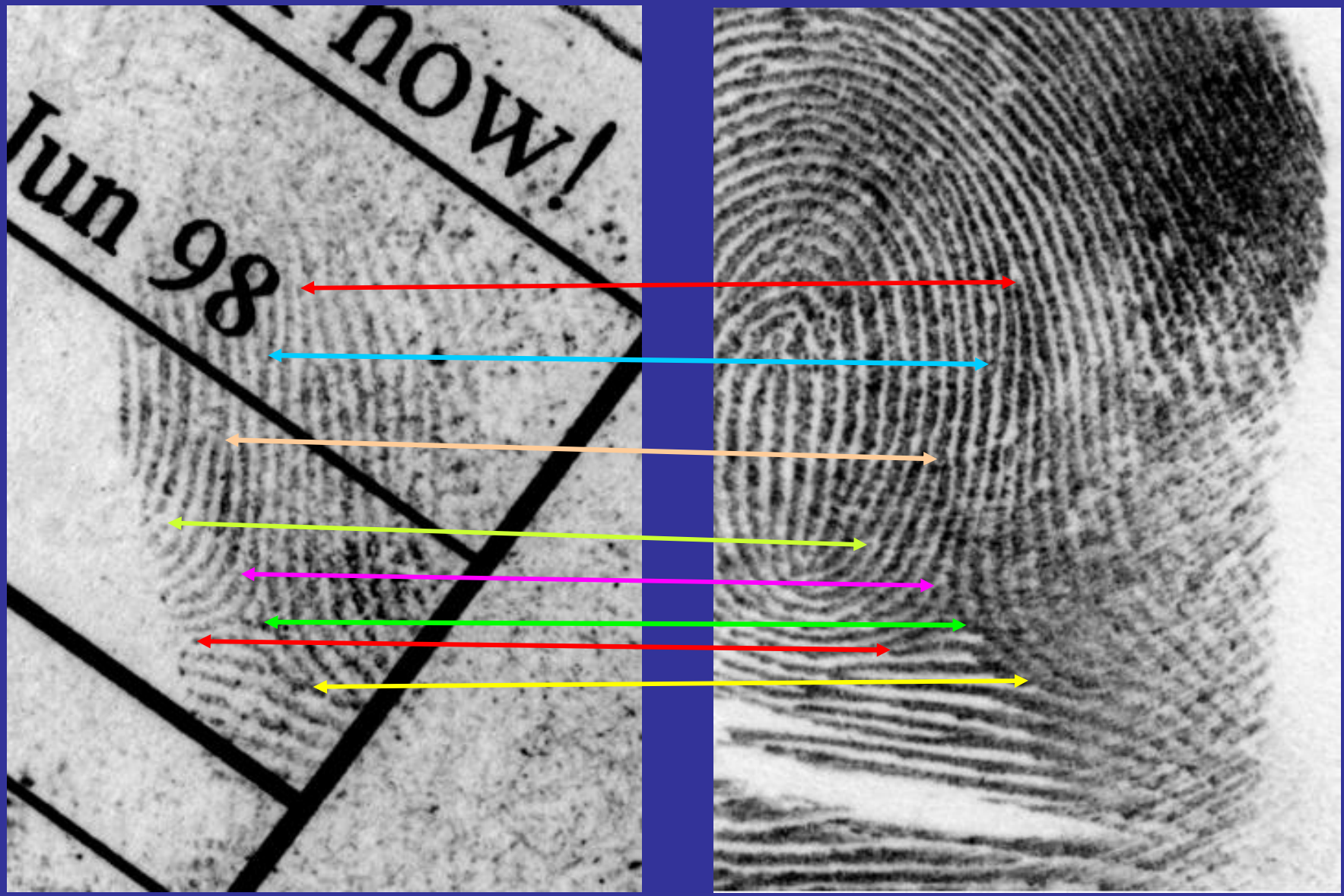


Suspect's Fingerprint Card

Right Ring Fingerprint



Latent and Record Comparison



Quality and Quantity

Quality and Quantity

LESS AREA – MORE NOISE

1

Quality and Quantity

LESS AREA – MORE NOISE

2

Quality and Quantity

LESS AREA – MORE NOISE

3

Quality and Quantity

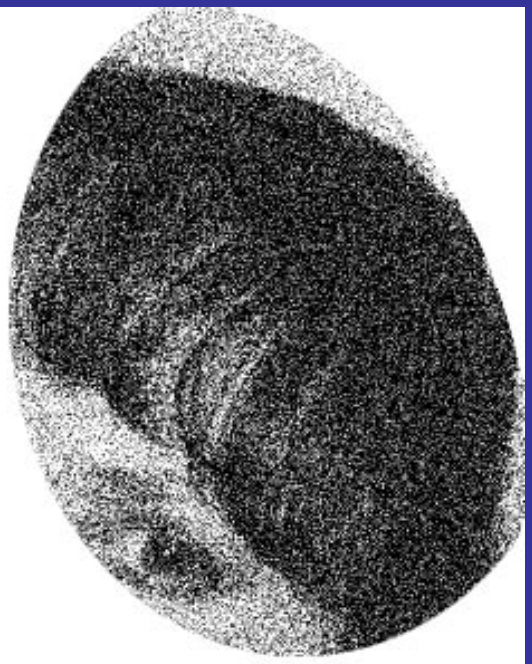
LESS AREA – MORE NOISE

4

Quality and Quantity

LESS AREA – MORE NOISE

5



Quality and Quantity

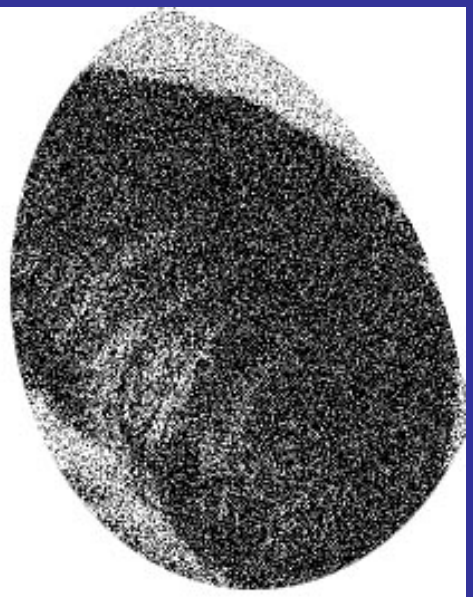
LESS AREA – MORE NOISE

5

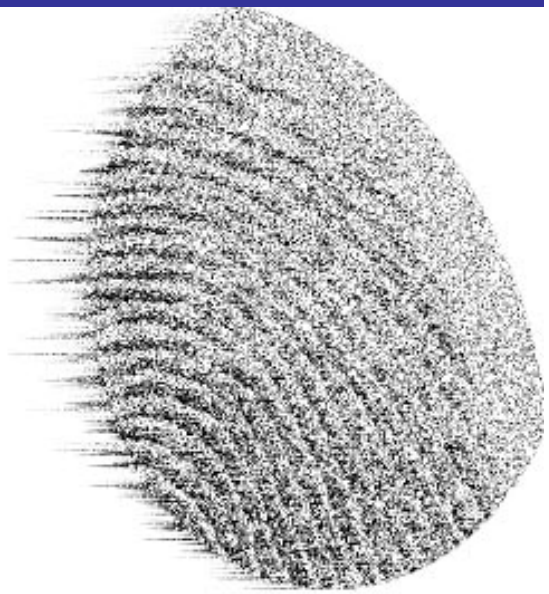
Enhanced

Quality and Quantity

LESS AREA – MORE NOISE



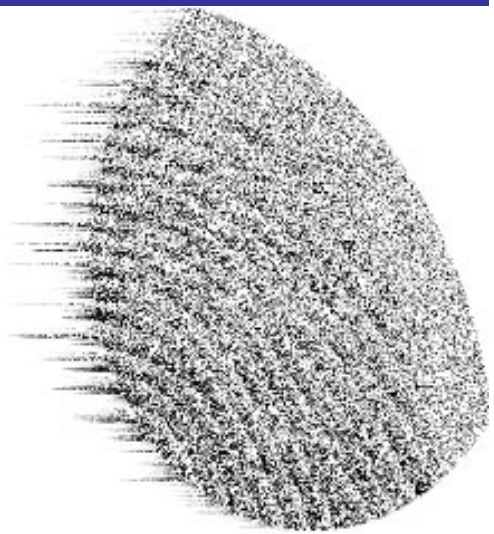
6

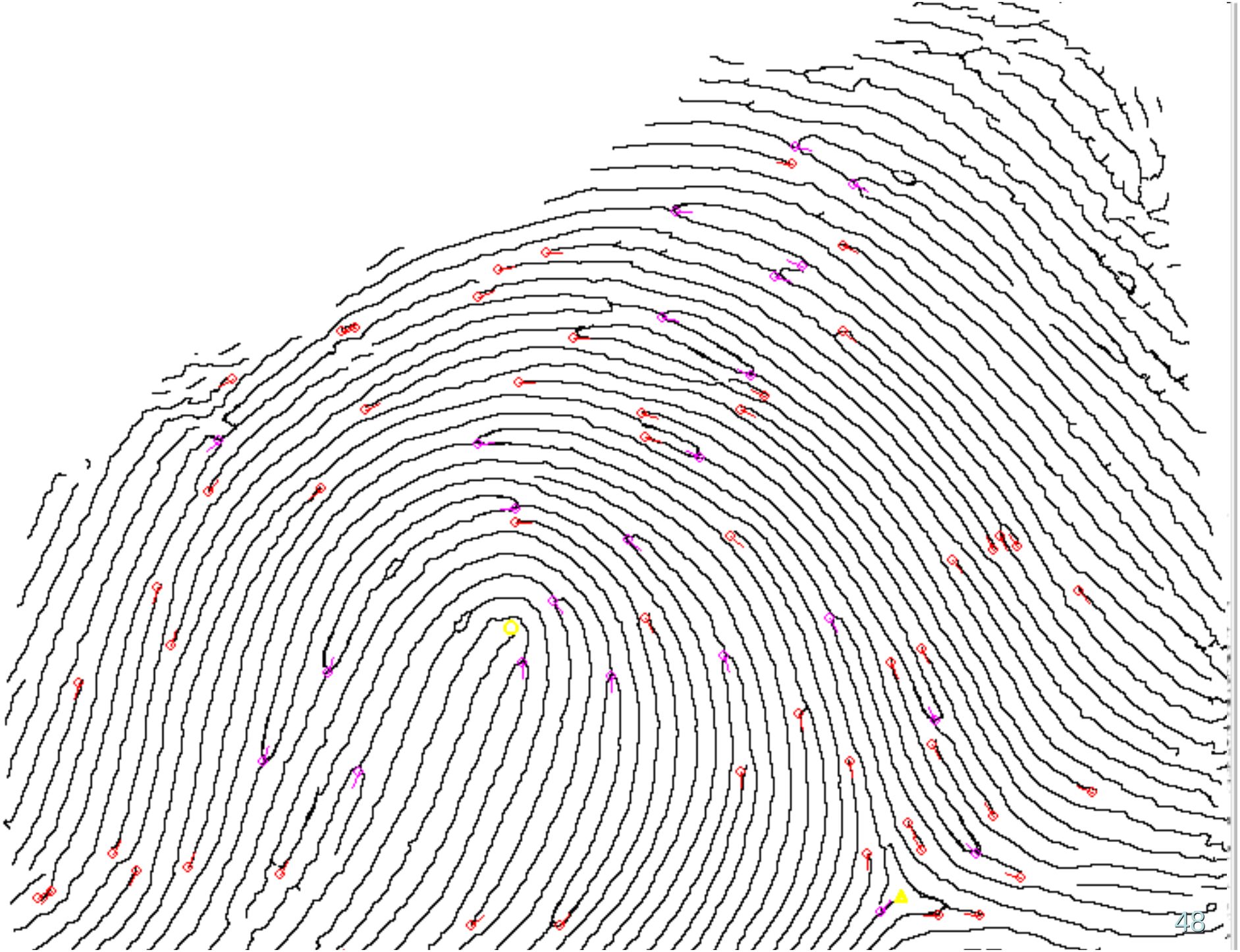


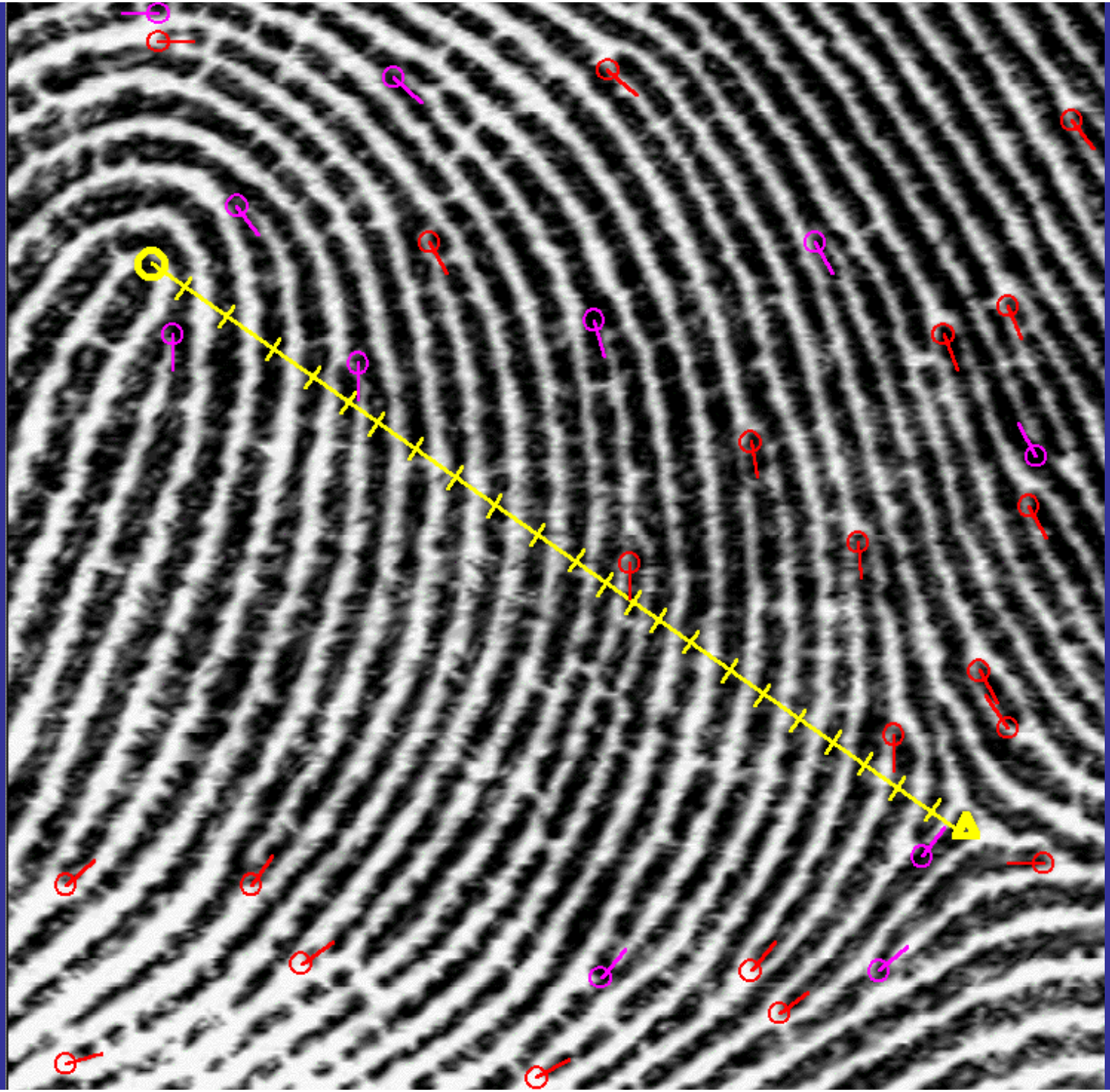
Quality and Quantity

LESS AREA – MORE NOISE

7



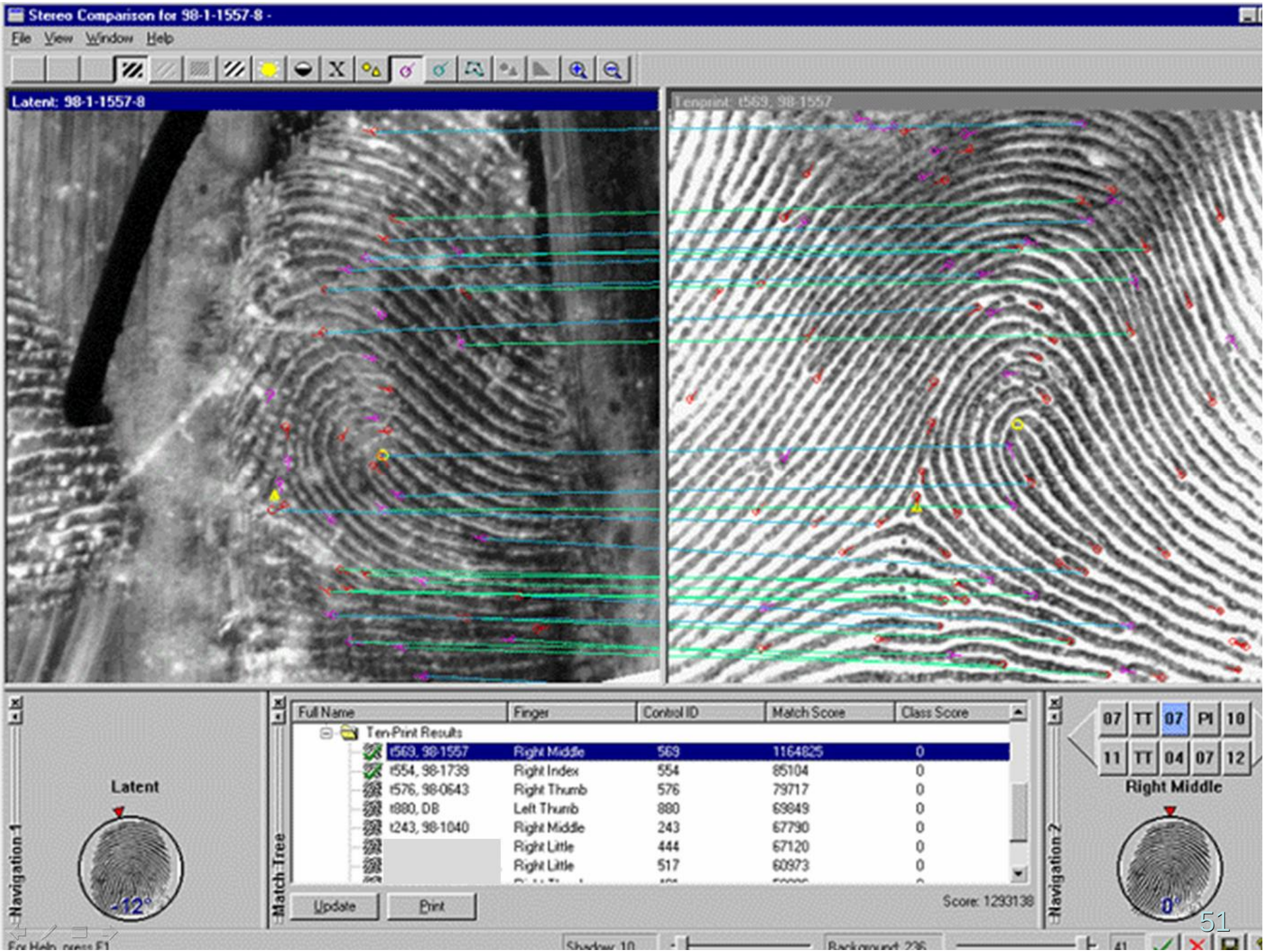




Match Results for Latent 98-1-1557-8

Ten-Print Results

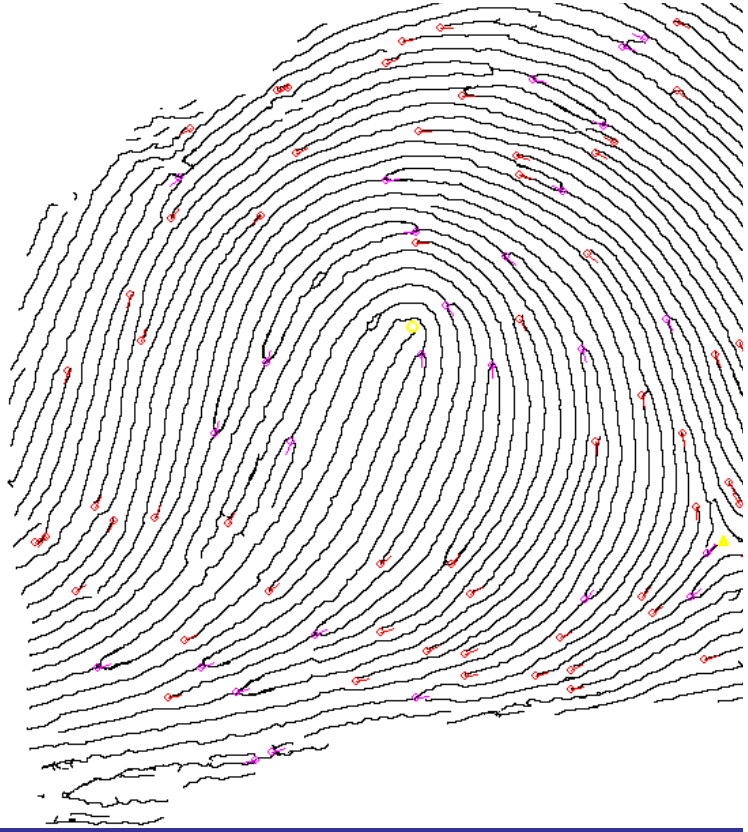
Full Name	Control ID	Match Score	Class Score
t569, 98-1557	Right Middle	1164825	569
t554, 98-1739	Right Index	85104	554
t576, 98-0643	Right Thumb	79717	576
t880, DB	Left Thumb	69849	880
t243, 98-1040	Right Middle	67790	243
[redacted]	Right Little	67120	444
[redacted]	Right Little	60973	517
[redacted]	Right Thumb	58086	491
[redacted]	Right Middle	57890	488
t653, 98-1892	Right Little	52680	653


Stereo Comparison for 98-1-1557-8 -
File View Window Help
Latent: 98-1-1557-8
Tenprint: t569, 98-1557
Navigation-1
Latent
-12°
Match Tree
Full Name
Finger
Control ID
Match Score
Class Score
Ten-Print Results
t569, 98-1557
Right Middle
569
1164825
0
t554, 98-1739
Right Index
554
85104
0
t576, 98-0643
Right Thumb
576
79717
0
t880, DB
Left Thumb
880
69849
0
t243, 98-1040
Right Middle
243
67790
0
Right Little
444
67120
0
Right Little
517
60973
0
Update
Print
Score: 1293138
Navigation-2
07 TT 07 PI 10
11 TT 04 07 12
Right Middle
0°
For Help, press F1

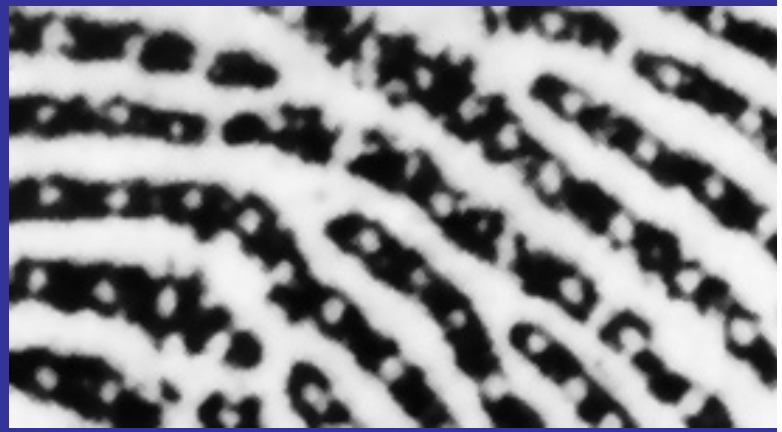
Level 1 Information - Pattern or general ridge flow as represented in the skeleton at right.

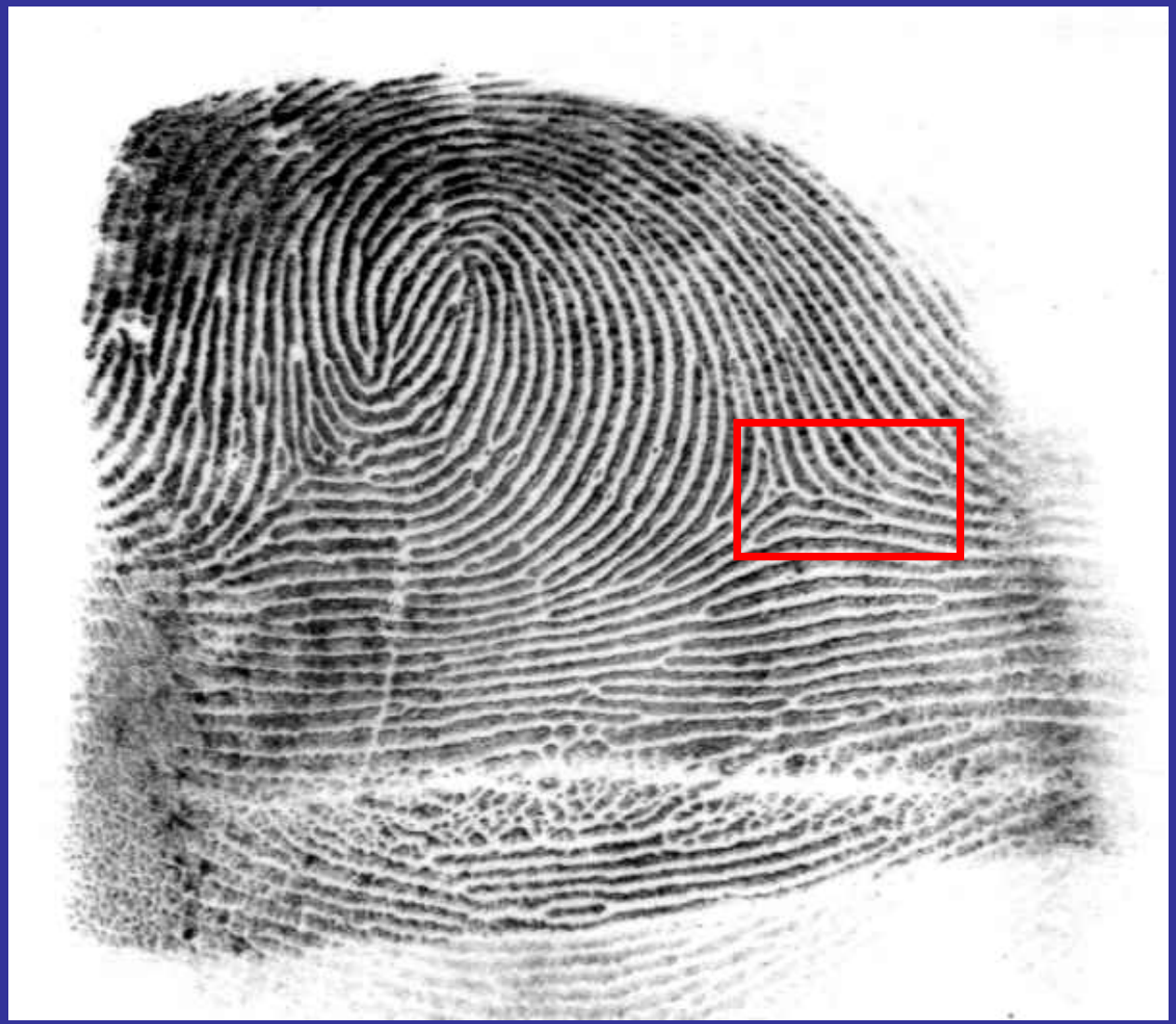
Level 2 Information - Galton Points such as ridge endings, bifurcations and dots as represented in the skeleton at right.

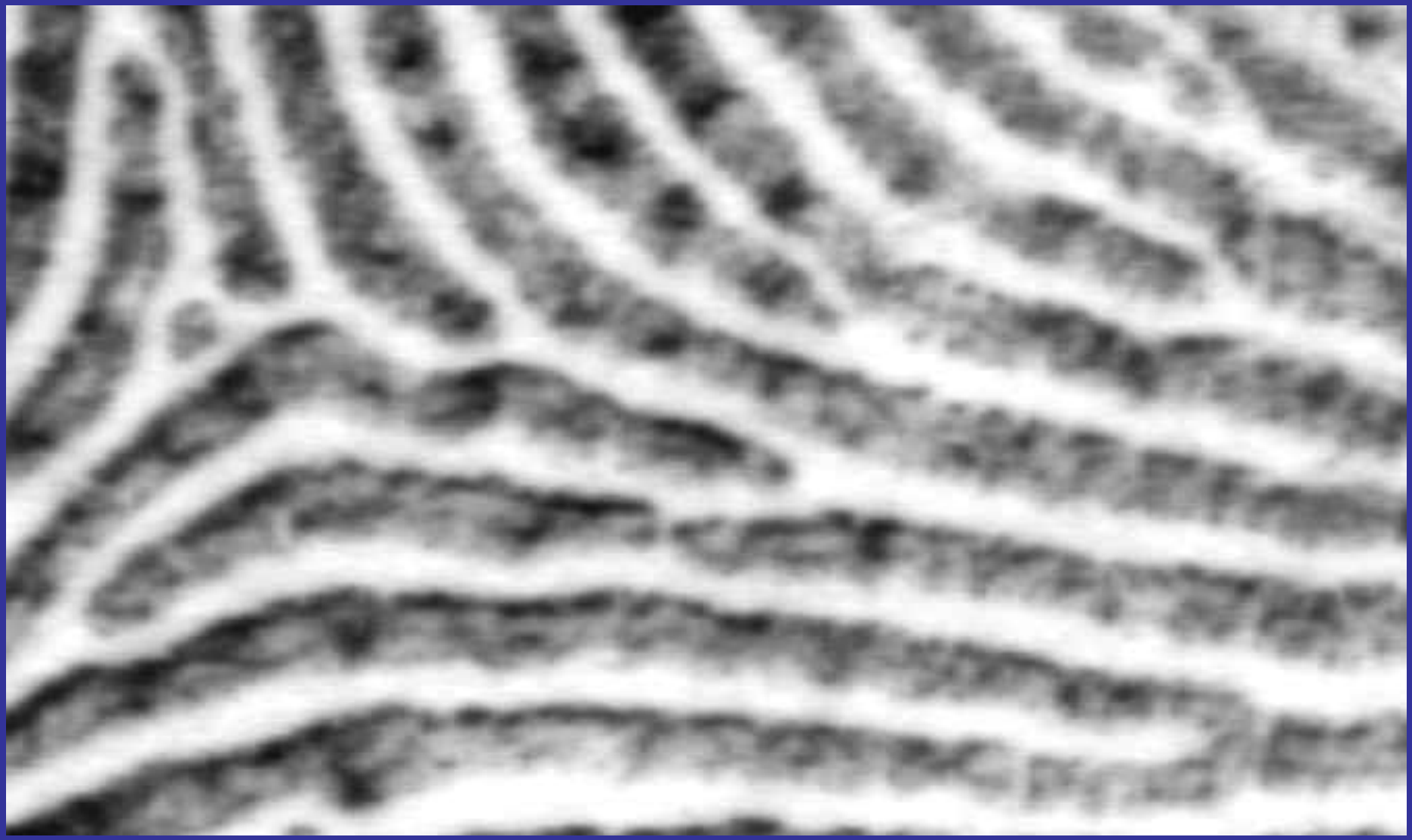
Latent Print Examiners do NOT base friction ridge identifications on just Level 1 and 2 information.

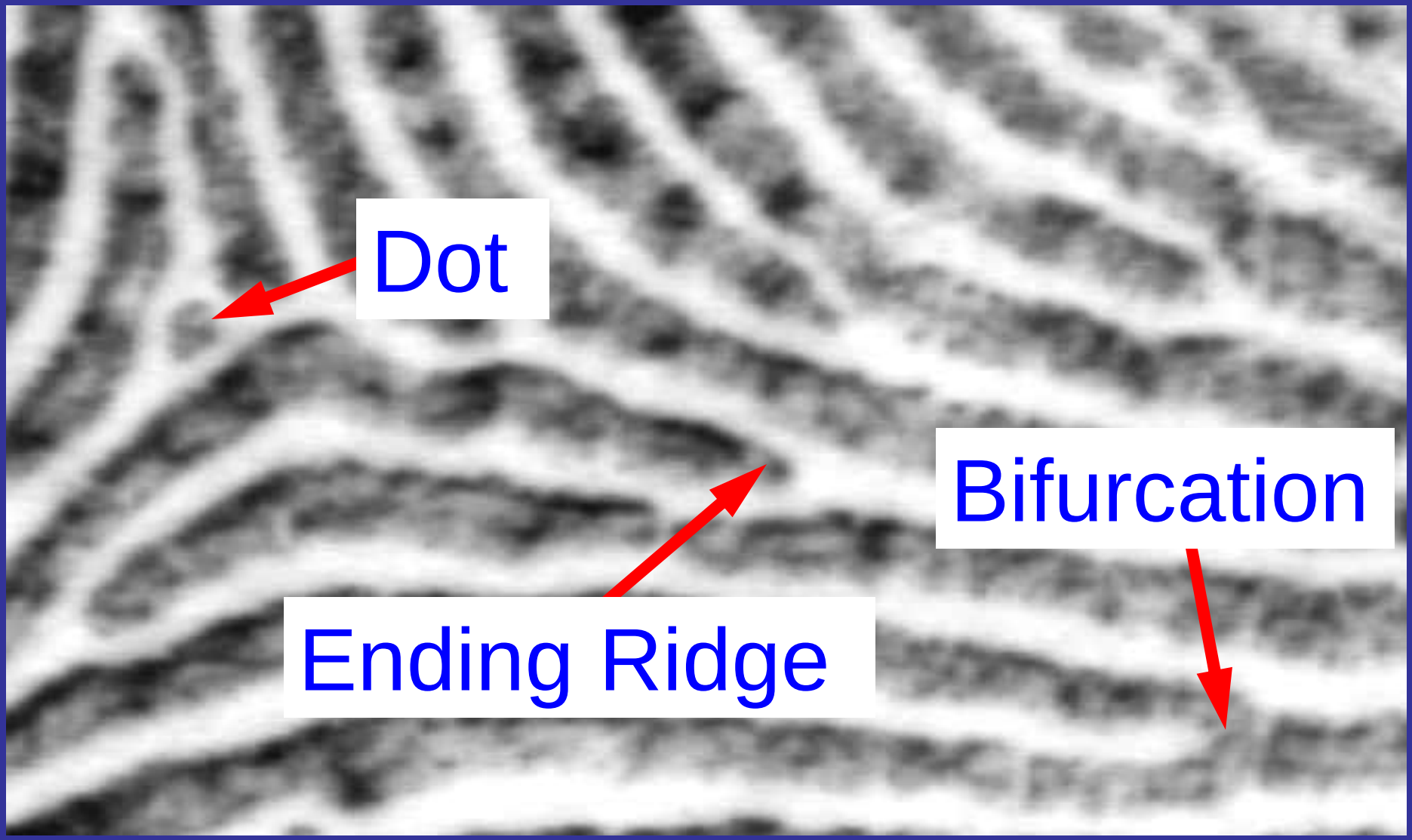


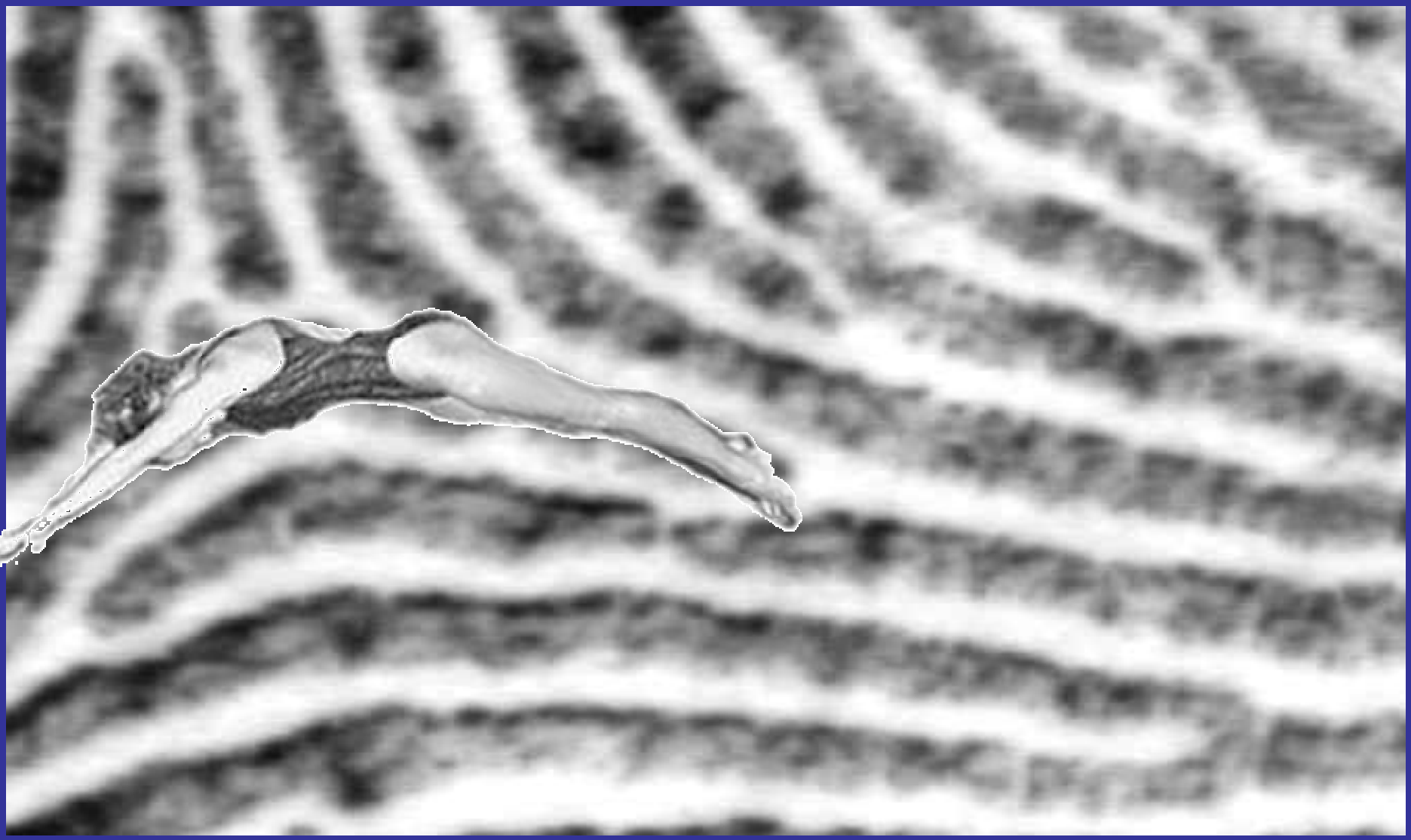
Level 3 Information - Ridge path, shape, pores and other information upon which Latent Print Examiners base friction ridge identifications, as represented in the image at right.

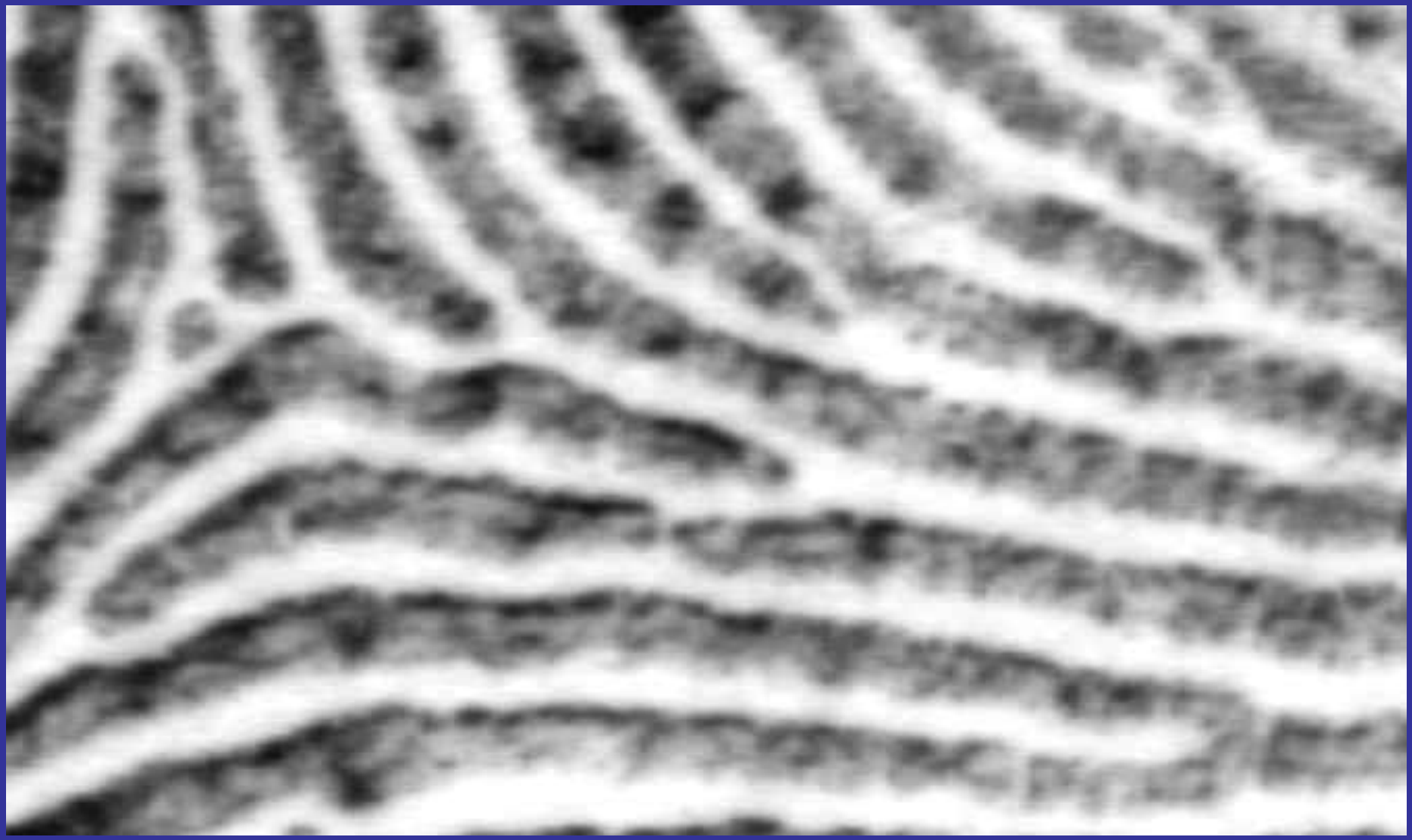







Dot
Bifurcation
Ending Ridge





Fingerprints

3 - Where is research conducted?

- Forensic Laboratories (US and Foreign)
- University Laboratories (Texas Tech, WVU, more…)
- National Laboratories (ORNL, LNLL, PNNL, etc.)
- Private Industry (AFIS Manufacturers)
- Other…

Fingerprints

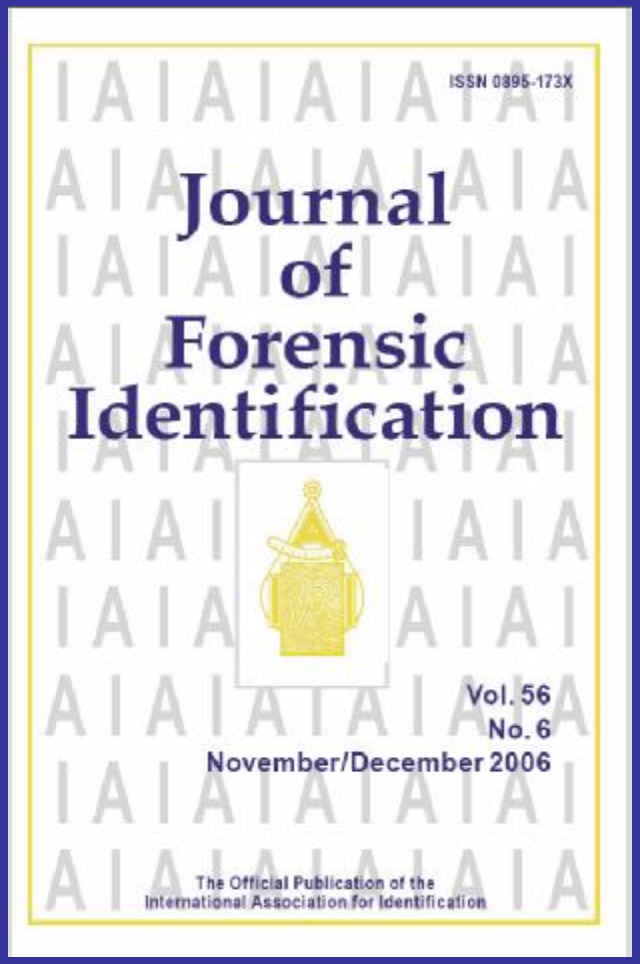
4 - Where is research published?

Fingerprints

Fingerprints

- International Association for Identification
  - Established in 1915;
  - Has over 5,000 Parent Body members;
  - Over 50 National, State and Regional Divisions of the IAI publish various Journals or Newsletters;
  - Over 1,000 members attend the Annual Educational Conference;
  - AAFS splintered from from IAI in 1948;
- The Fingerprint Society
  - Established in 1974;
  - Members in over 30 countries;
- Other organizations native to individual researchers…

Fingerprints



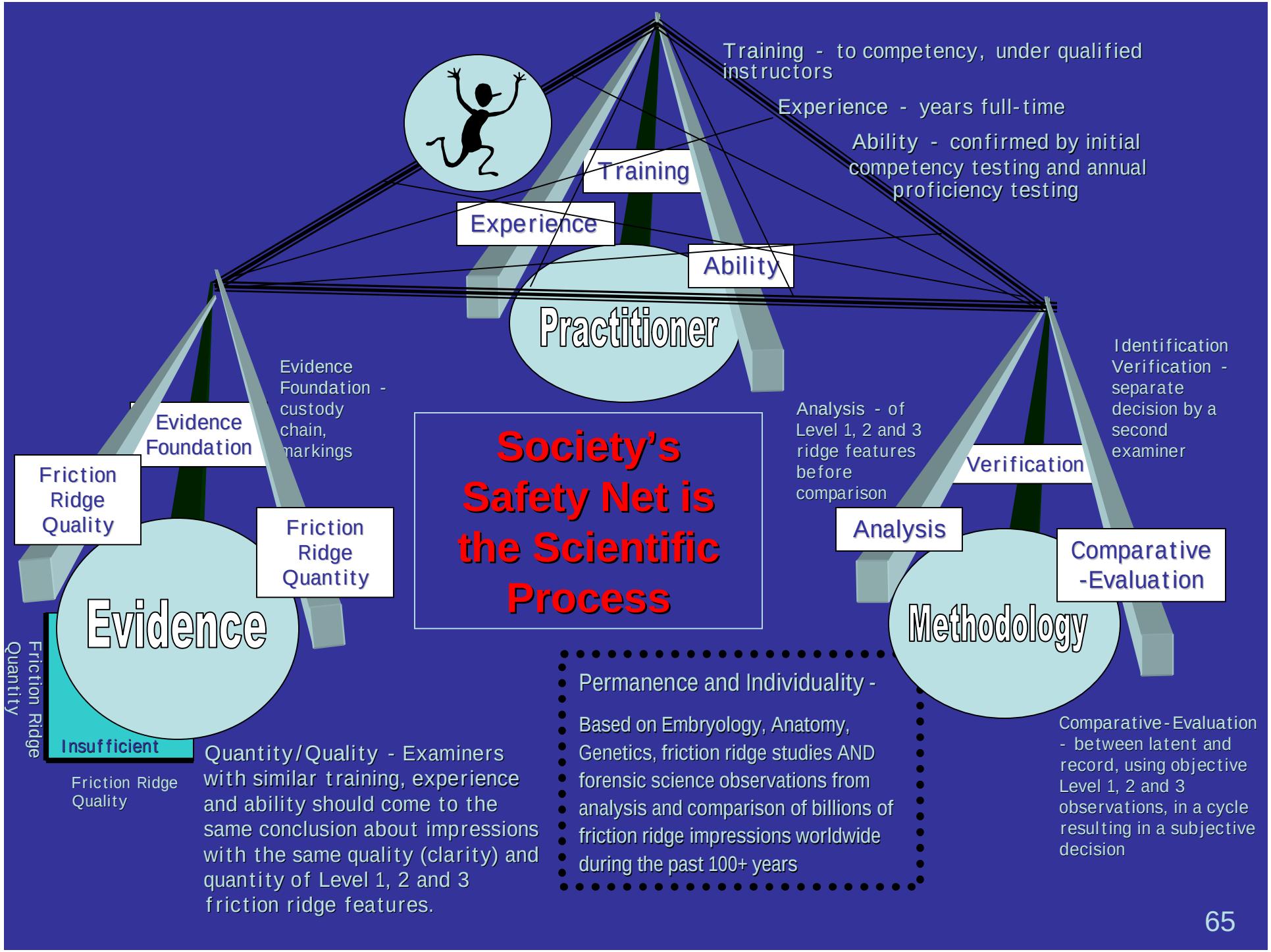
1933-2006 Electronic Archive of IAI Publications

(Primarily Fingerprint Oriented)

25,264 indexed pages PDF Archive on 3 CDs (instantly searchable)

Fingerprints

5 - What are the major problems in the scientific foundation, methods, and practice?


Training - to competency, under qualified instructors
Experience - years full-time
Ability - confirmed by initial competency testing and annual proficiency testing
Training
Experience
Ability
Practitioner
Evidence Foundation - custody chain, markings
Evidence Foundation
Friction Ridge Quality
Friction Ridge Quantity
Evidence
Friction Ridge Quantity
Insufficient
Friction Ridge Quality
Quantity/Quality - Examiners with similar training, experience and ability should come to the same conclusion about impressions with the same quality (clarity) and quantity of Level 1, 2 and 3 friction ridge features.
Society's Safety Net is the Scientific Process
Permanence and Individuality -
Based on Embryology, Anatomy, Genetics, friction ridge studies AND forensic science observations from analysis and comparison of billions of friction ridge impressions worldwide during the past 100+ years
Analysis - of Level 1, 2 and 3 ridge features before comparison
Identification Verification - separate decision by a second examiner
Verification
Analysis
Comparative -Evaluation
Methodology
Comparative-Evaluation - between latent and record, using objective Level 1, 2 and 3 observations, in a cycle resulting in a subjective decision

Fingerprints

5 - What are the major problems in the scientific foundation, methods, and practice?

A. Absence of mandatory national expert certification with annual proficiency testing.

B. Absence of standardized national training to competency program for fingerprint experts.

C. Absence of sufficient fingerprint expert training facilities and programs (shortage of experts …many crimes not processed).

D. Absence of sufficient funds for needed research.

Fingerprints

6 - What research questions do you think need to be answered?

A. Absence of comprehensive statistical modeling using all friction ridge detail present (to support latent print individualization and accurate qualified conclusions).

B. AFIS technology immature for single and partial finger comparisons (often low resolution and never uses all detail). Lights-out IDs for most latent prints would dramatically increase crime solving.

Questions?

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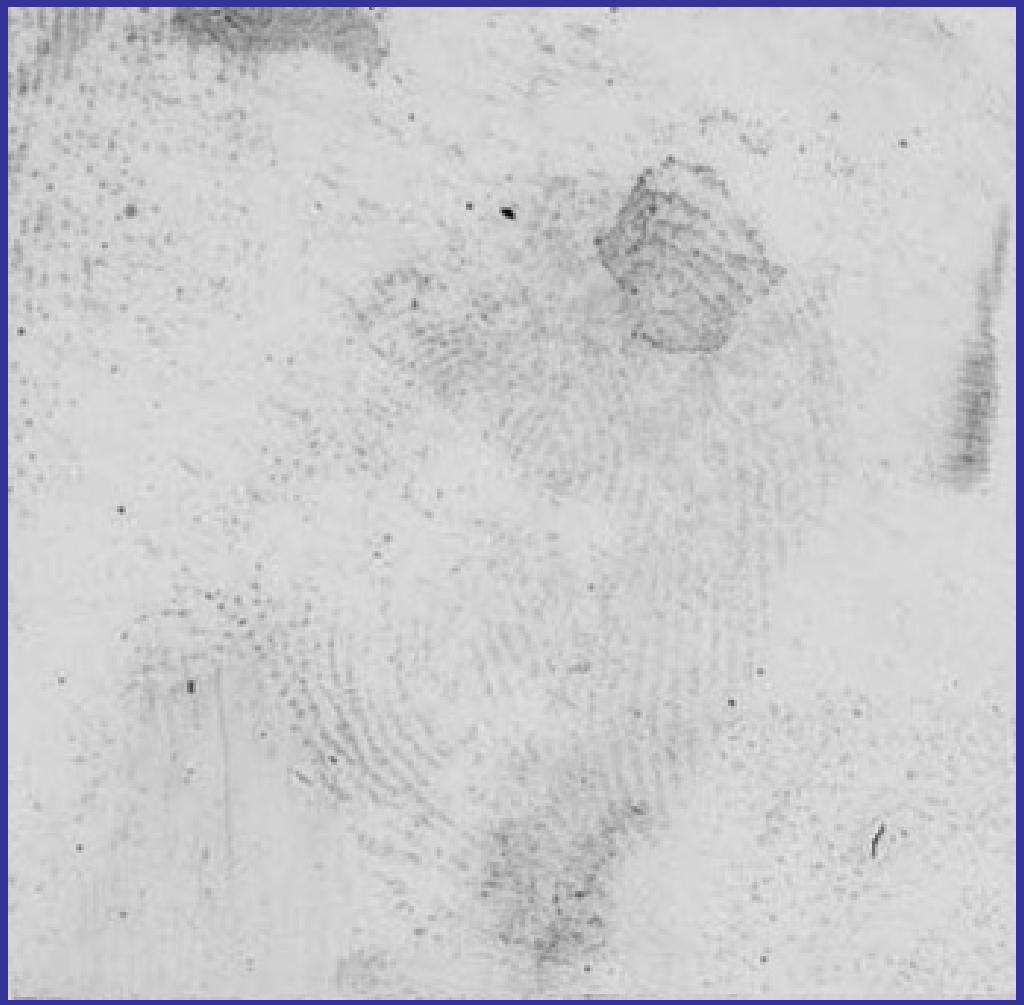
PO Box 1600
Newington VA 22122-1600

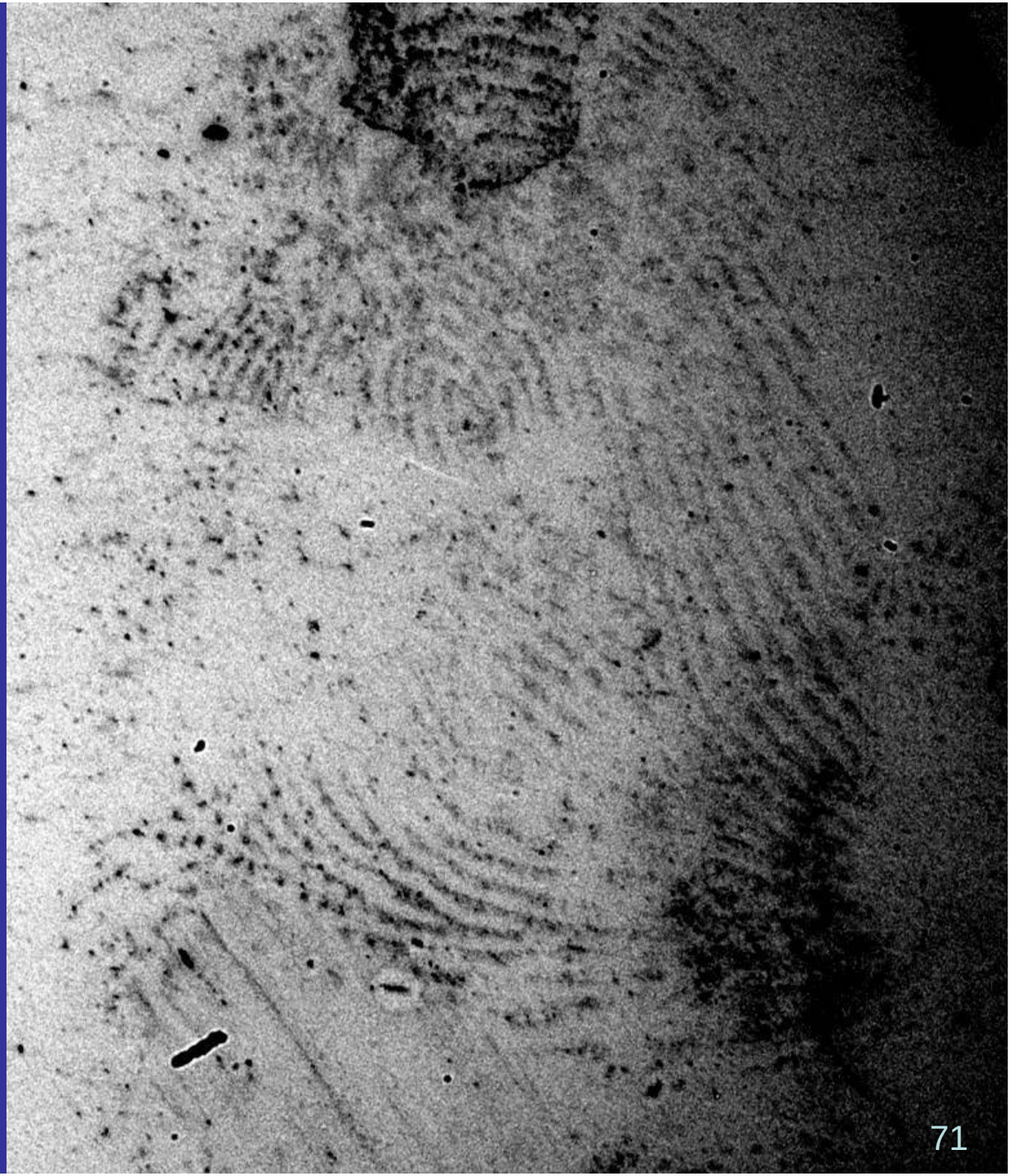
Email ed@onin.com
www.onin.com/ed

BACKUP
SLIDES
AFTER
HERE

Specimen Received from Iraq

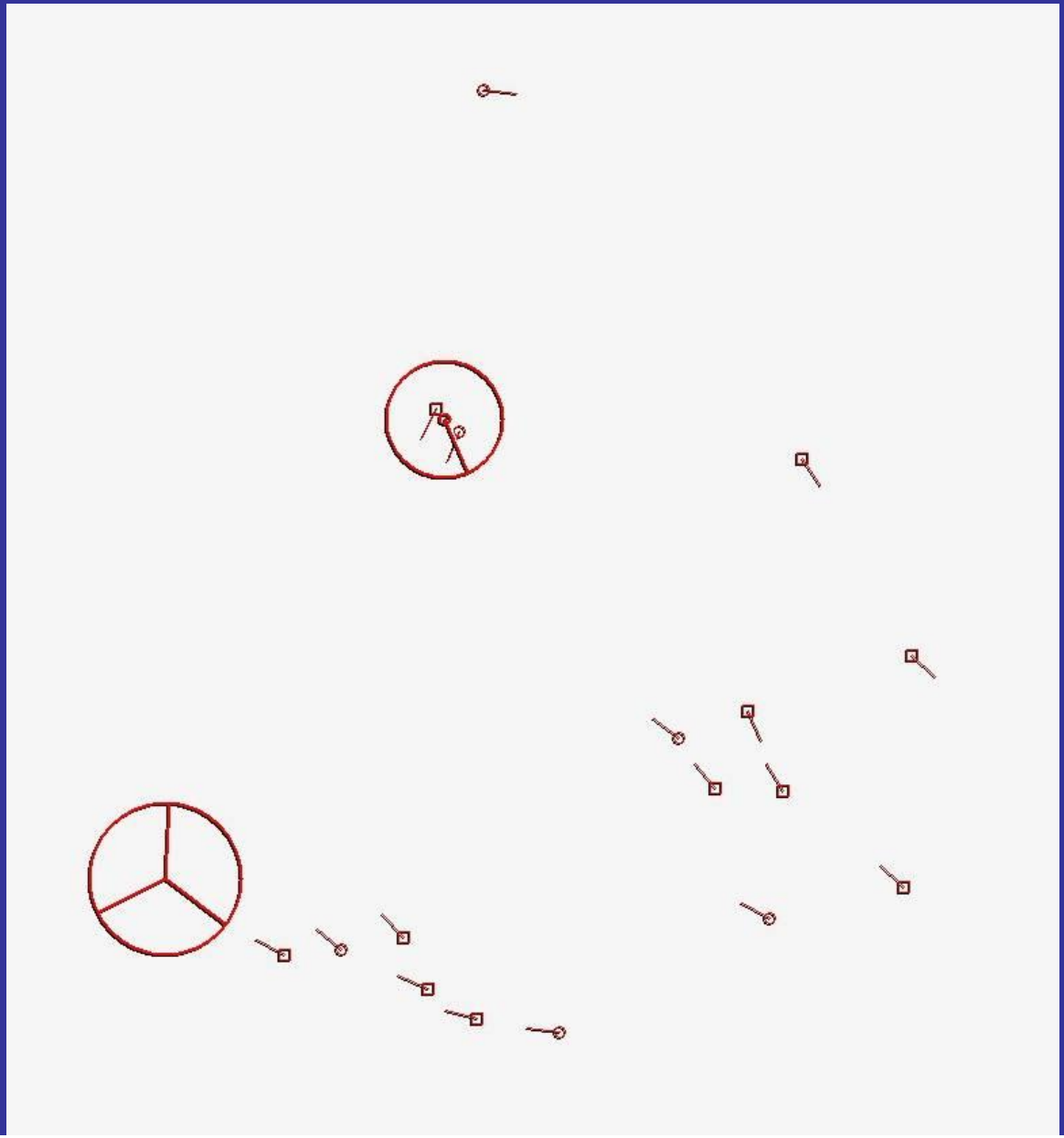


Enhanced Close-up of Print

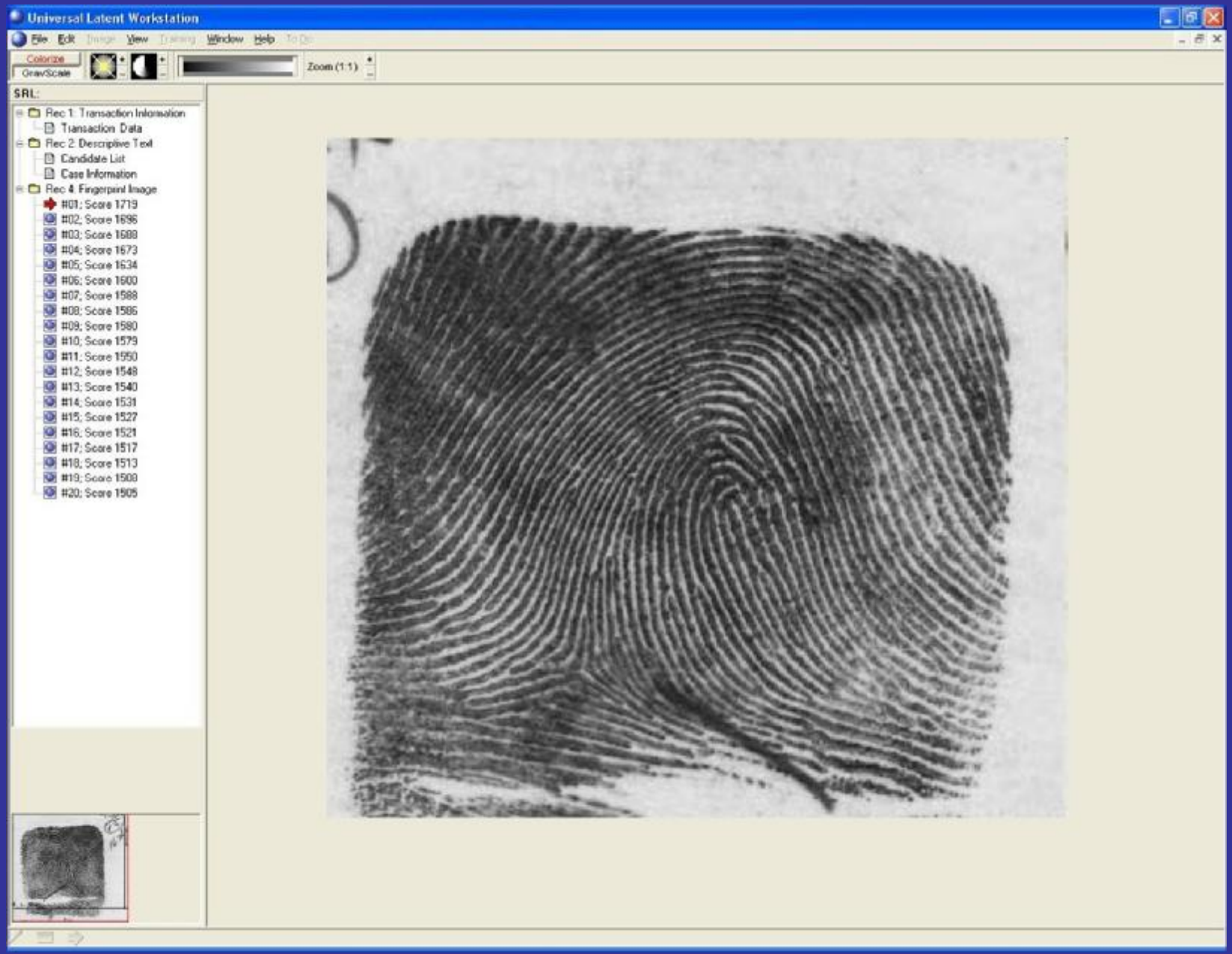


Latent Print Image with Minutiae

Latent Print Minutiae Only



Sample AFIS Candidate List



Elimination or Identification?

Elimination or Identification?

Elimination or Identification?

Elimination or Identification?

Elimination or Identification?

Elimination or Identification?

Elimination or Identification?

Elimination or Identification?

Elimination or Identification?

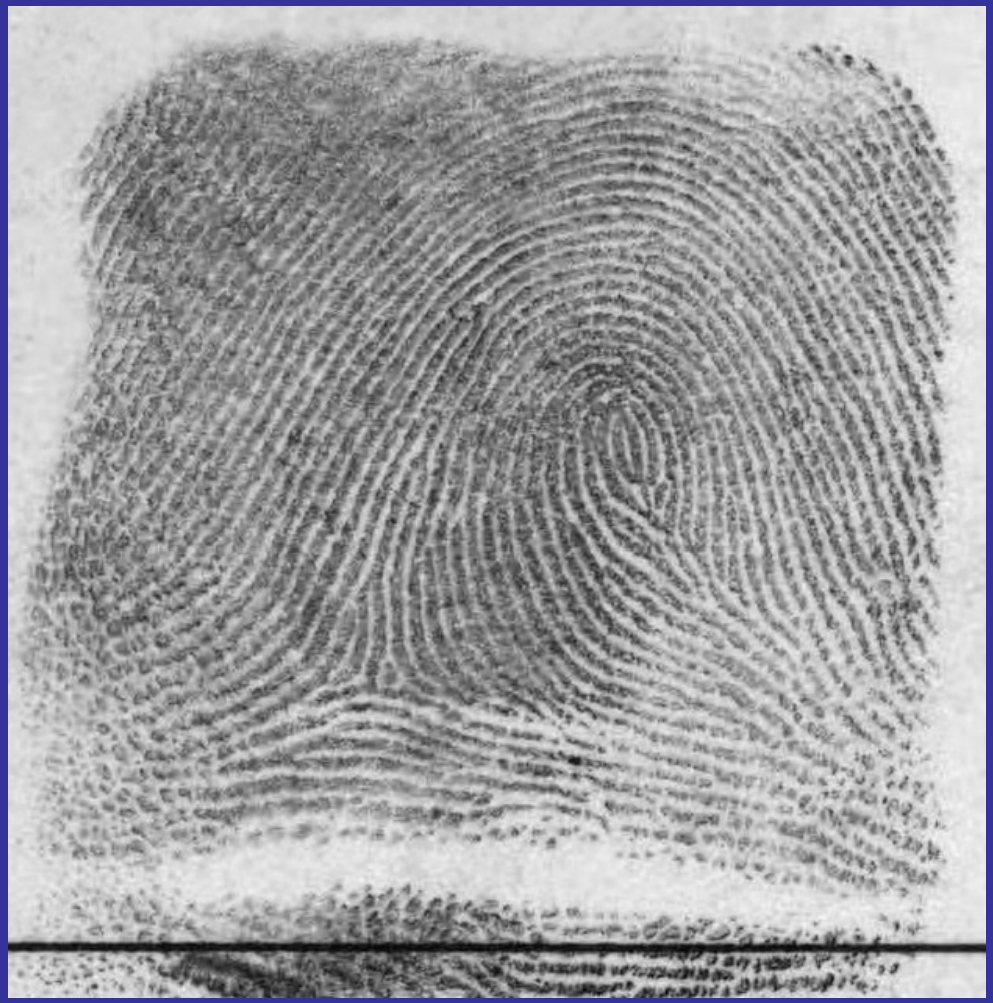
Elimination or Identification?

Elimination or Identification?

Elimination or Identification?

Elimination or Identification?

Elimination or Identification?



Elimination or Identification?

Elimination or Identification?

Elimination or Identification?

Elimination or Identification?

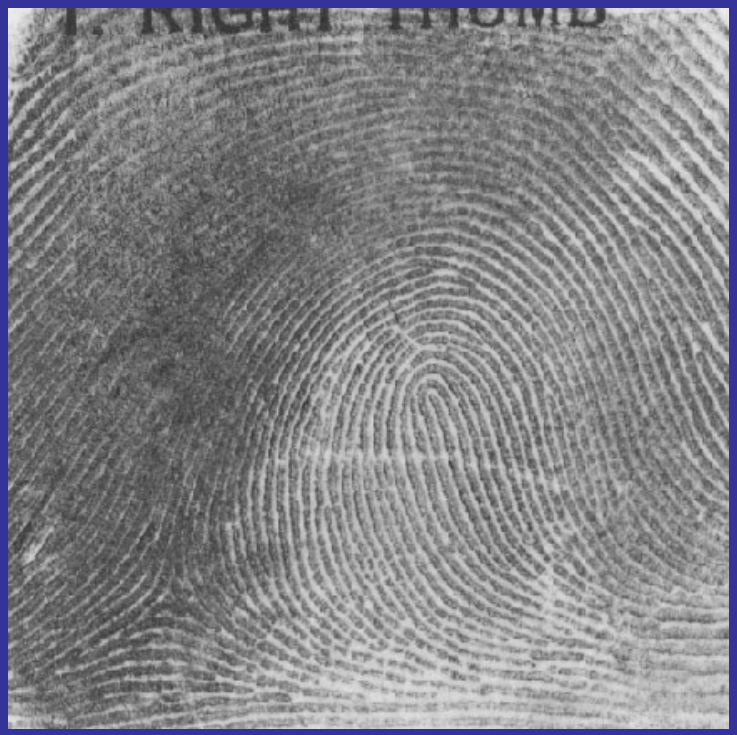
Elimination or Identification?

Elimination or Identification?

Level 1 Friction Ridge Detail

…discernible at 150 ppi & 500 ppi

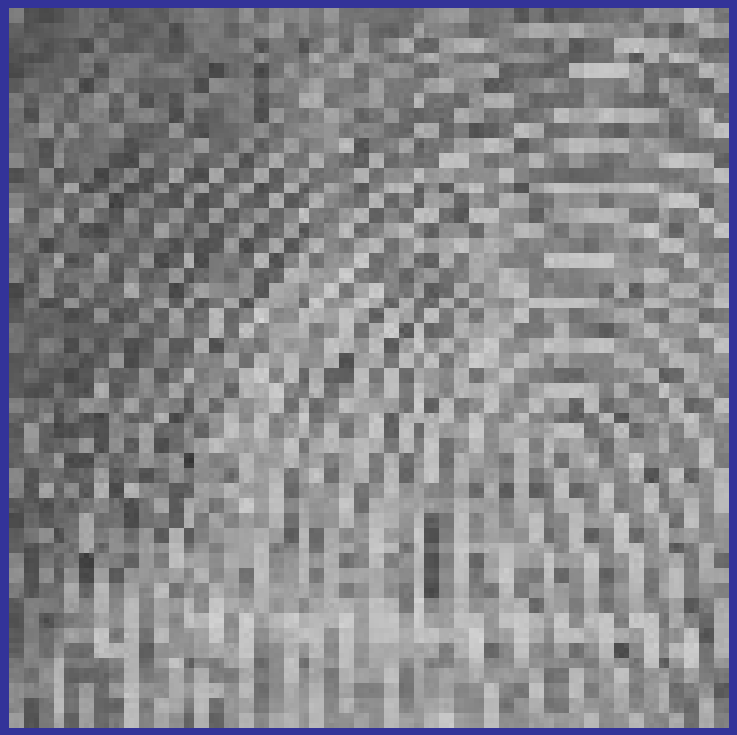
150 ppi



500 ppi

Level 2 Friction Ridge Detail

…bad at 150 ppi, discernible at 500 ppi



150 ppi

500 ppi

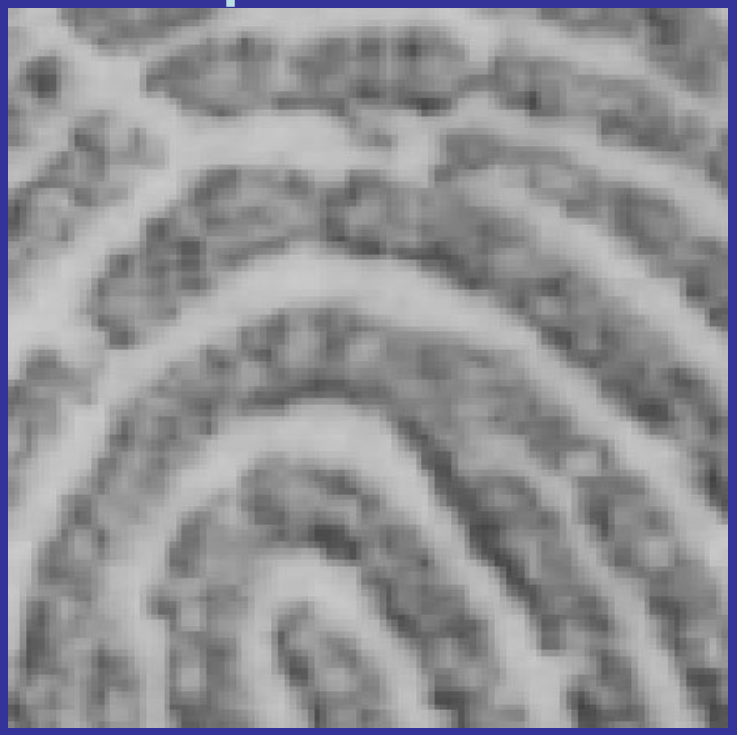
Level 1 and 2 Friction Ridge Detail

… discernible at 500 ppi and 1200 ppi

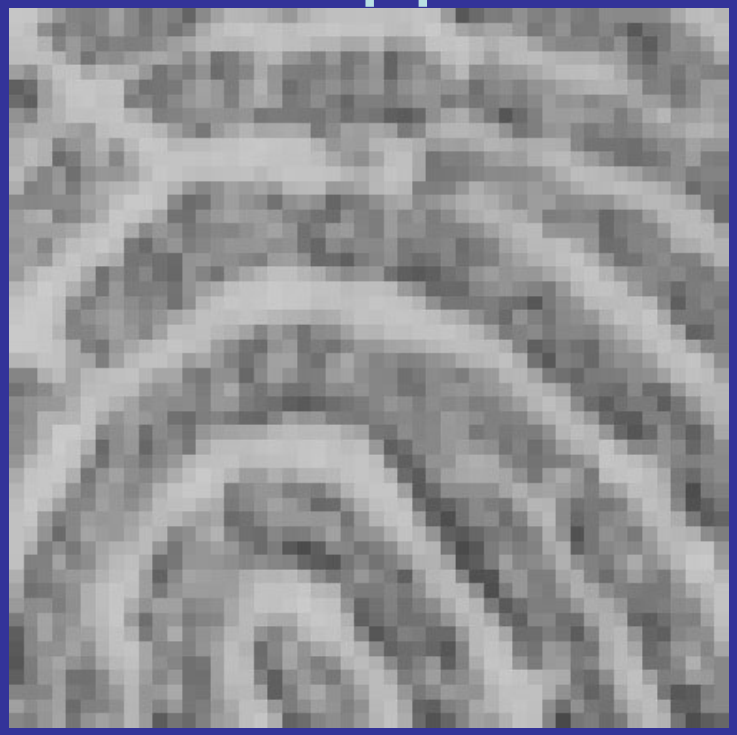
500 ppi

1200 ppi

Level 3 Friction Ridge Detail
… poor resolution at 500 ppi

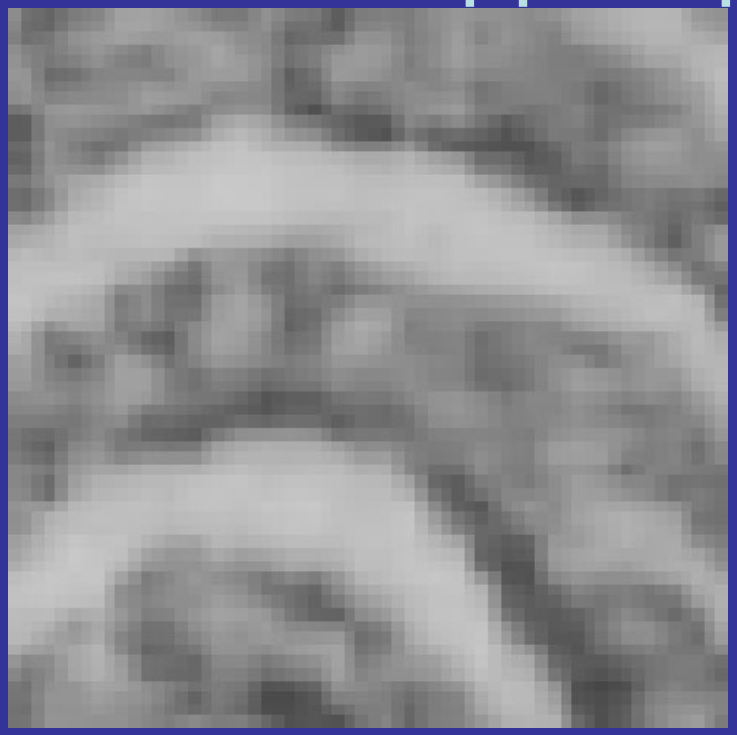


1200 ppi

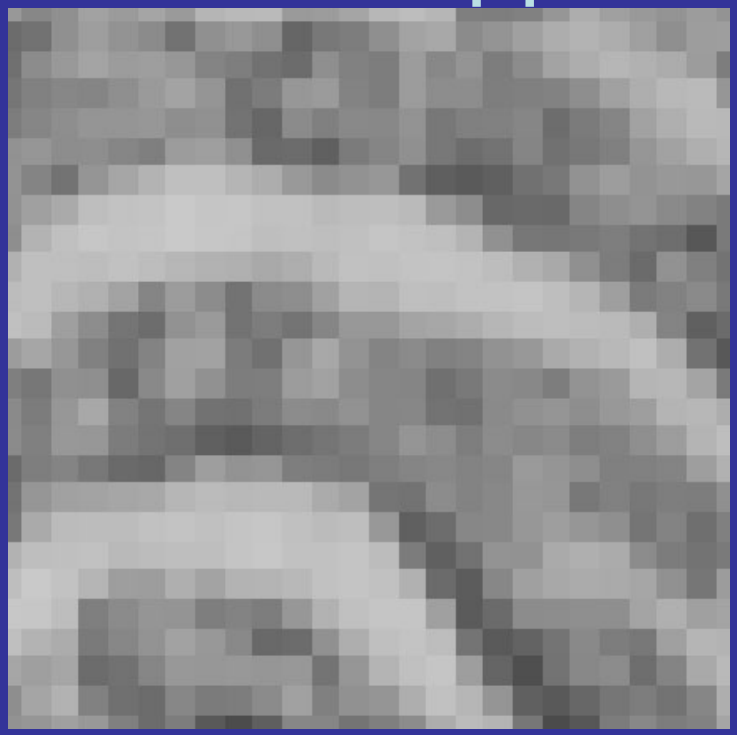


500 ppi

Level 3 Friction Ridge Detail
… 1200 ppi superior to 500 ppi

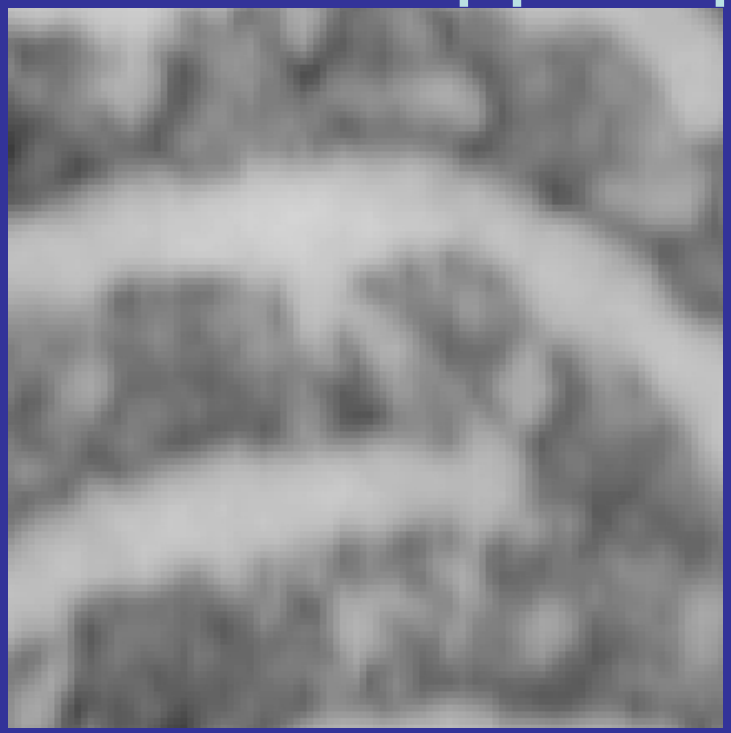


1200 ppi

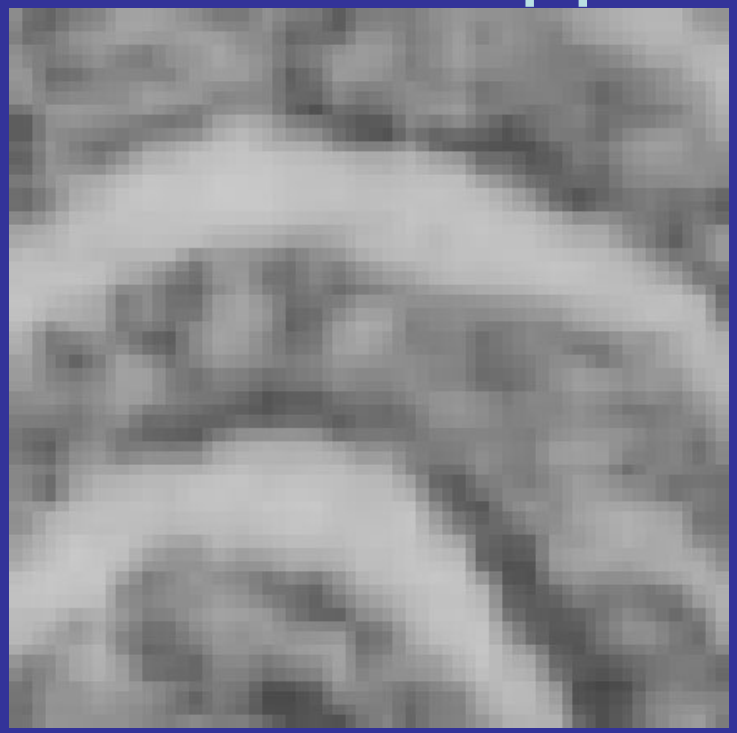


500 ppi

Level 3 Friction Ridge Detail
… 2400 ppi superior to 1200 ppi



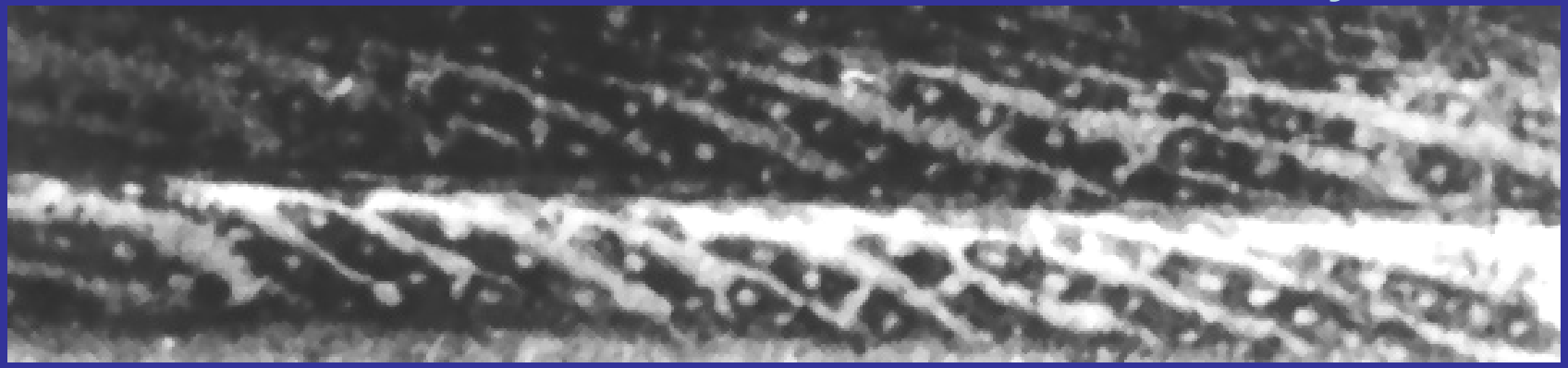
2400 ppi



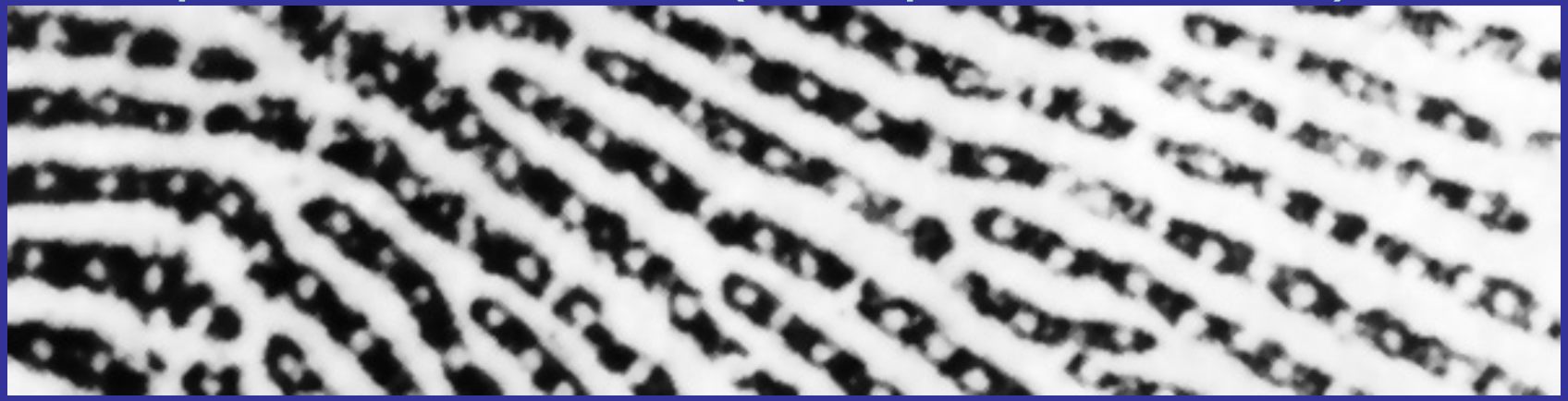
1200 ppi

Two Prints from the Same Person?

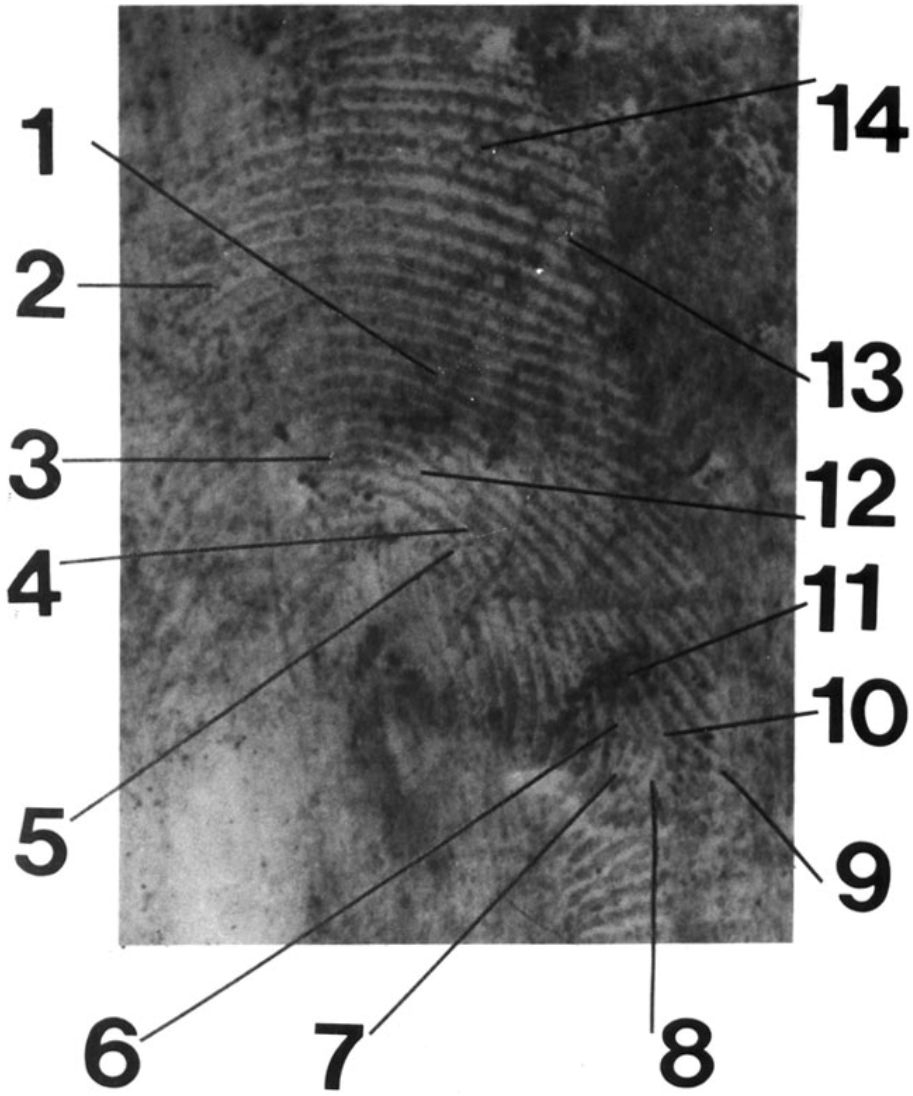
Latent Print on electrical cord from robbery

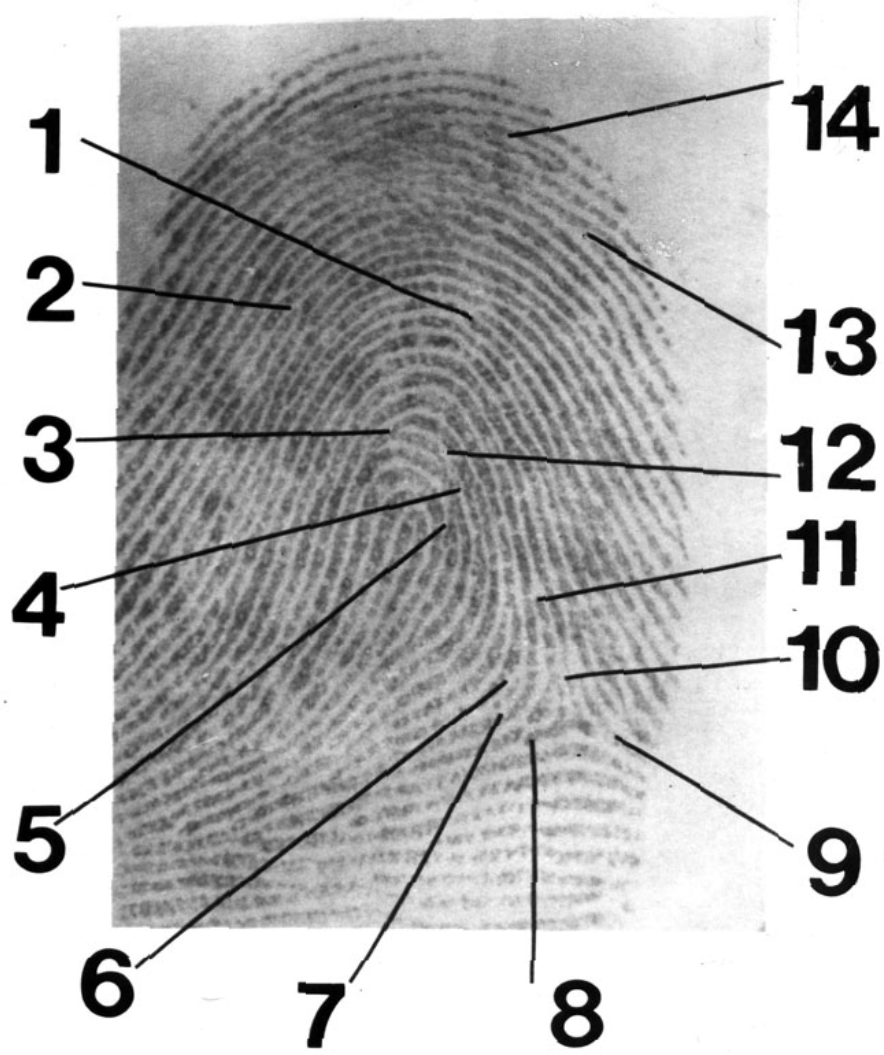


Suspect's Inked Print (from police records)

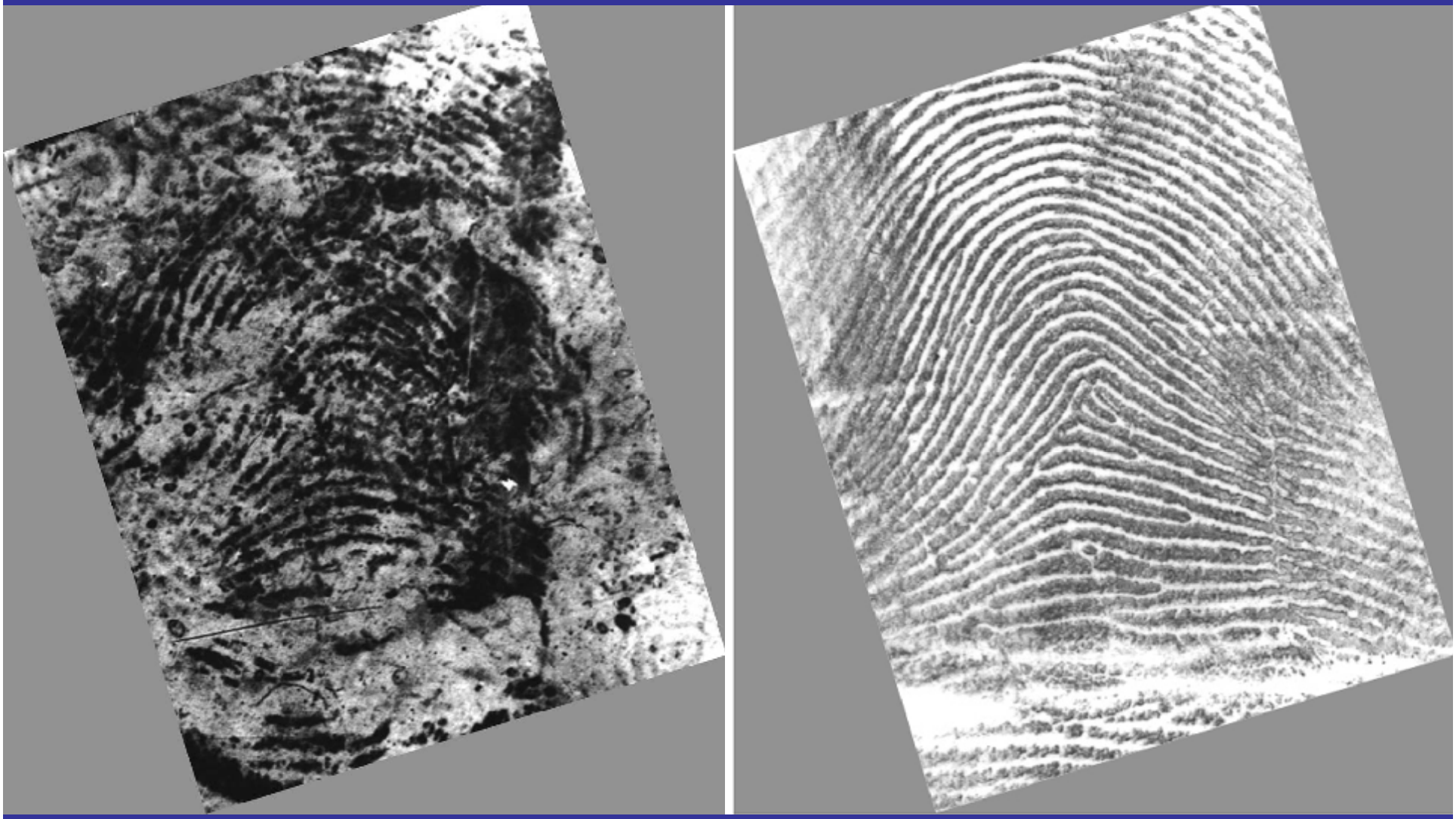


Two Prints from the Same Person?



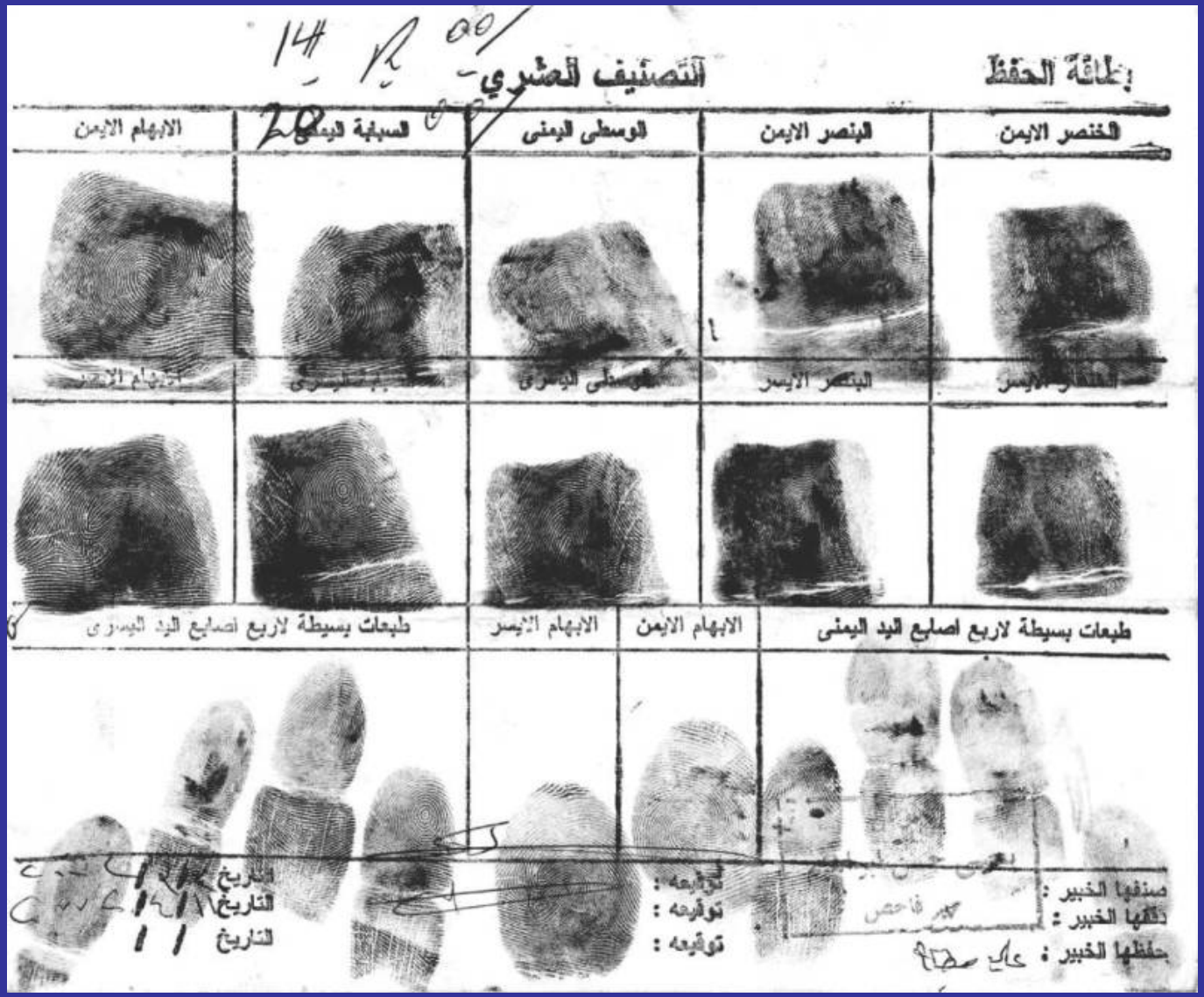


Two Prints from the Same Person?



Attempting to merge typical fingerprint biometric systems with typical forensic operations causes square peg to round hole problems...
Cooperation is more important than ever.

Legacy Data


بطاقة الحفظ
التصنيف العشري
الخنصر الايمن
البنصر الايمن
الوسطى اليمنى
السبابة اليمنى
الابهام الايمن
طبعات بسيطة لاربع اصابع اليد اليمنى
الابهام الايمن
الابهام الايسر
طبعات بسيطة لاربع اصابع اليد اليسرى
صنفها الخبير :
دققها الخبير :
حفظها الخبير :
توقيعه :
توقيعه :
توقيعه :
التاريخ
التاريخ
التاريخ

Speaker's Employment History

Over 35 years experience in fingerprint work.

- Local police - 3 years in Tennessee and North Carolina as Police Officer, Crime Scene Technician and Latent Print Examiner;
- State Police - 3 years as Forensic Scientist, supervised state-wide fingerprint program when Illinois became first ASCLD/LAB accredited crime lab in America;

Speaker's Employment History (Cont.)

- Private industry - Two years with laser company in Silicon Valley, conducted laser evidence detection training in over 30 federal, state and local labs throughout America;
- US Federal Agencies - 27 years
  - Served in overseas US Government forensic laboratories 7 years (Asia and Europe);
  - Retired as number-two ranking Army CID Special Agent worldwide in 2005;
  - Currently GS-15 US Government employee;

Speaker's Testimony and Certifications

Expert testimony over 100 times in US and overseas including 16 American states and one US territory;

Testified in first Daubert fingerprint hearing (1999);

Certified as Latent Print Examiner by International Association for Identification (IAI) since 1978;

Certified by US Army as Latent Print Examiner 1976-2005;

Speaker's Professional Memberships

Member of IAI since 1977; member of IAI Latent Print Certification Board 1983-88; Chair of IAI Fingerprint Committee 1998-99; Chair of IAI AFIS Committee 2000-2002 (current member);

Fellow of The Fingerprint Society since 1979;

Founder of Nihon Kanshiki Gakkai (Japan Identification Society) 1989;

Member SWGFAST since 1996; Chair of SWGFAST Quality Assurance Committee 1996-98; Chair of Friction Ridge Automation Committee 1998-99 and 2004-05;

Member or Midwestern Association of Forensic Scientists 1982-1992; Latent Print Section Coordinator of MAFS 1983-85;

Speaker's Research

Participated in original research:

- Cyanoacrylate (superglue) fuming - 1979-81;
- Laser enhancement of fingerprints - 1980-83;
- Computer image enhancement of fingerprints – 1982-87;
- Reflected (Shortwave) UV Imaging Systems for fingerprints – 1986-89;

Speaker's Publications

- Technical articles published in Journal of Forensic Identification; Identification News; Fingerprint Whorld; FBI Crime Laboratory Digest; US Government Fingerprint Symposium Proceedings; US Army Crime Laboratory Newsletters;
- Contributed content to two forensic text books;
- Authored fingerprint chapter for McGraw Hill Encyclopedia of Science and Technology;
- Since 1994, have maintained the largest and most popular Internet reference source for fingerprint information - Google "fingerprints" to reach www.onin.com