Jack Cantin Search confidential interim report

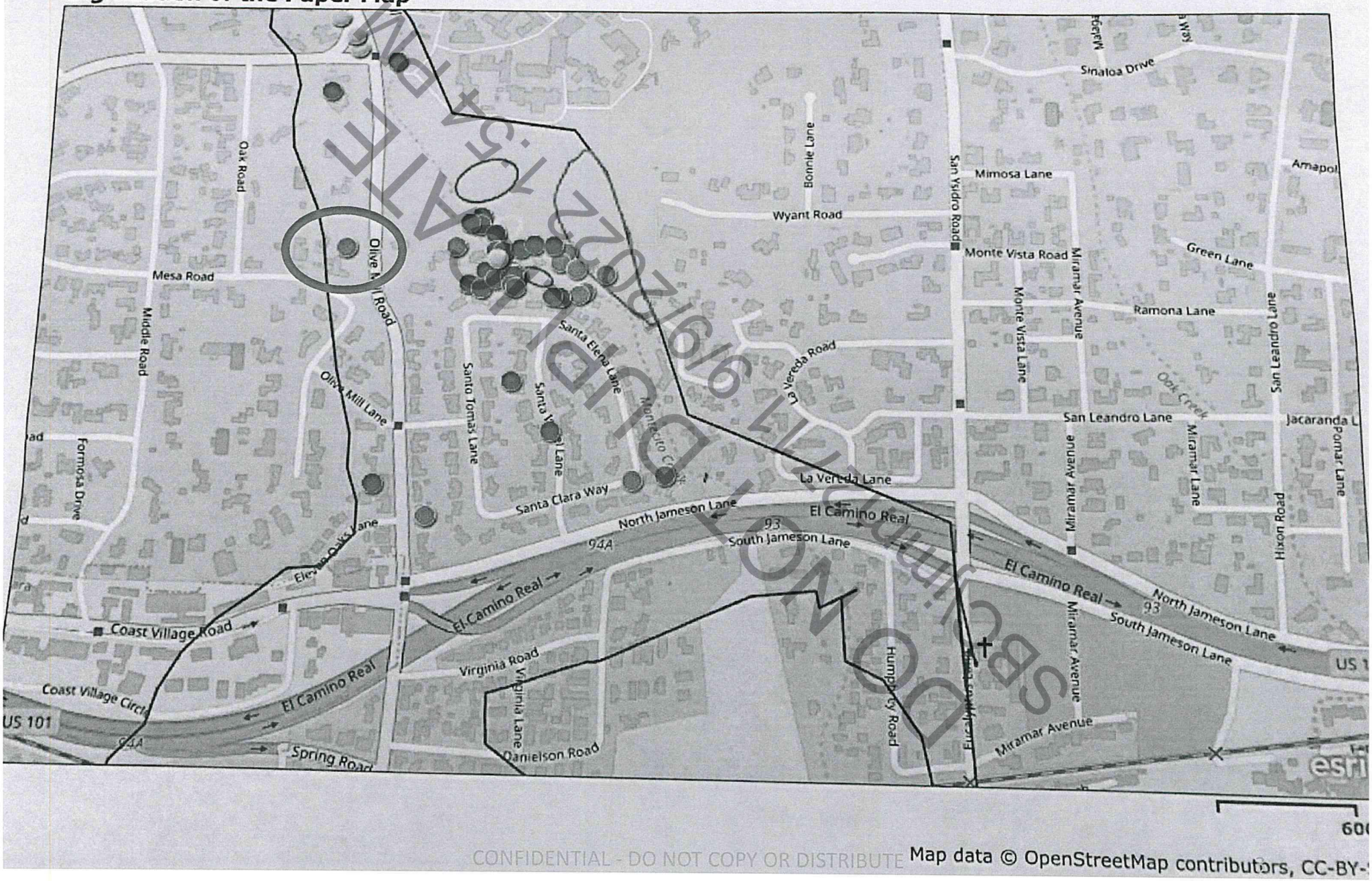
PL Walker Bioarchaeology and Forensic Bone Lab,

Department of Anthropology

UC Santa Barbara

Search Area: 110 Acres

Digitization of the Paper Map



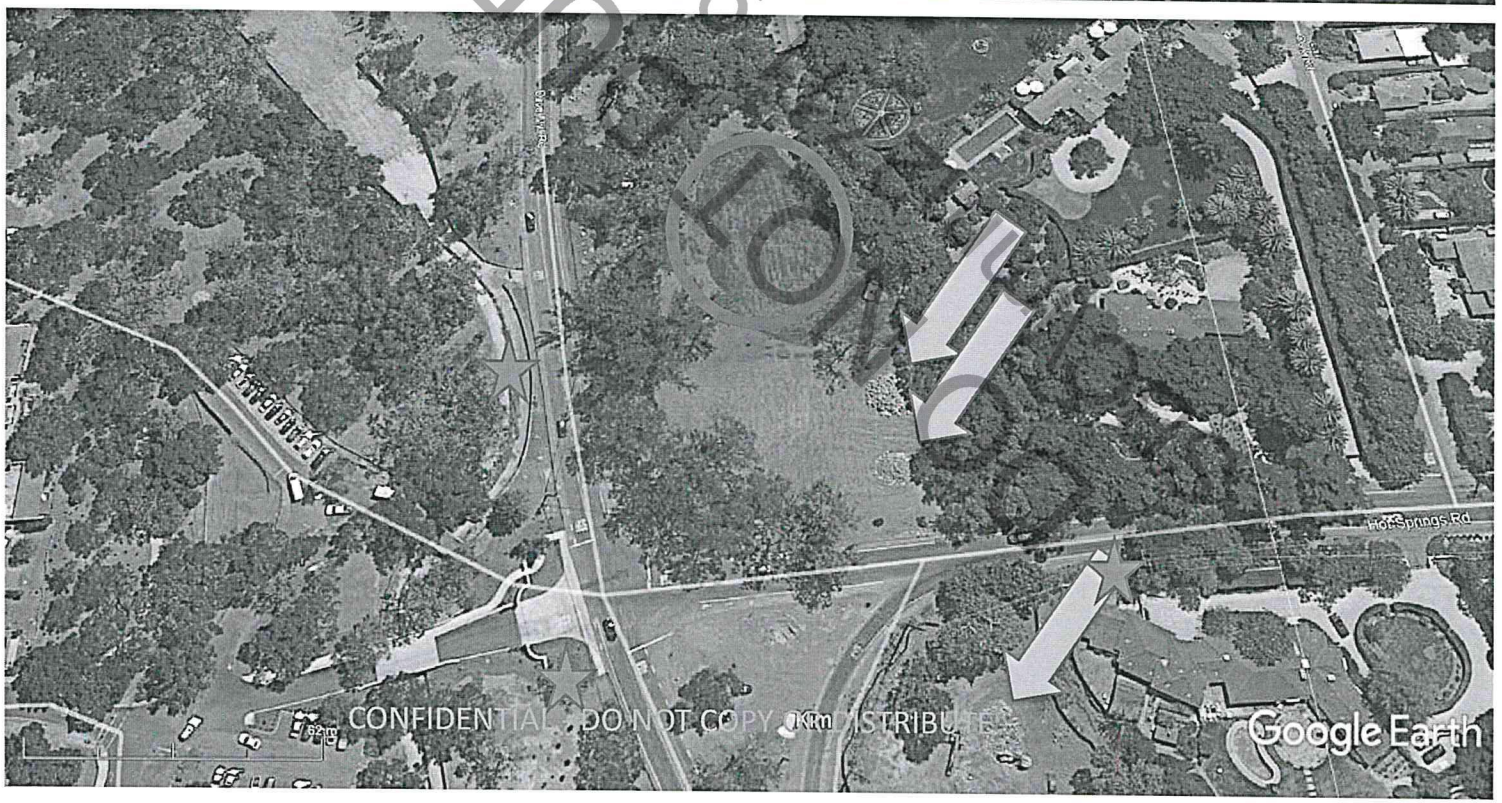
Understanding Context

Fotos from Just Before Disaster Thru 2021

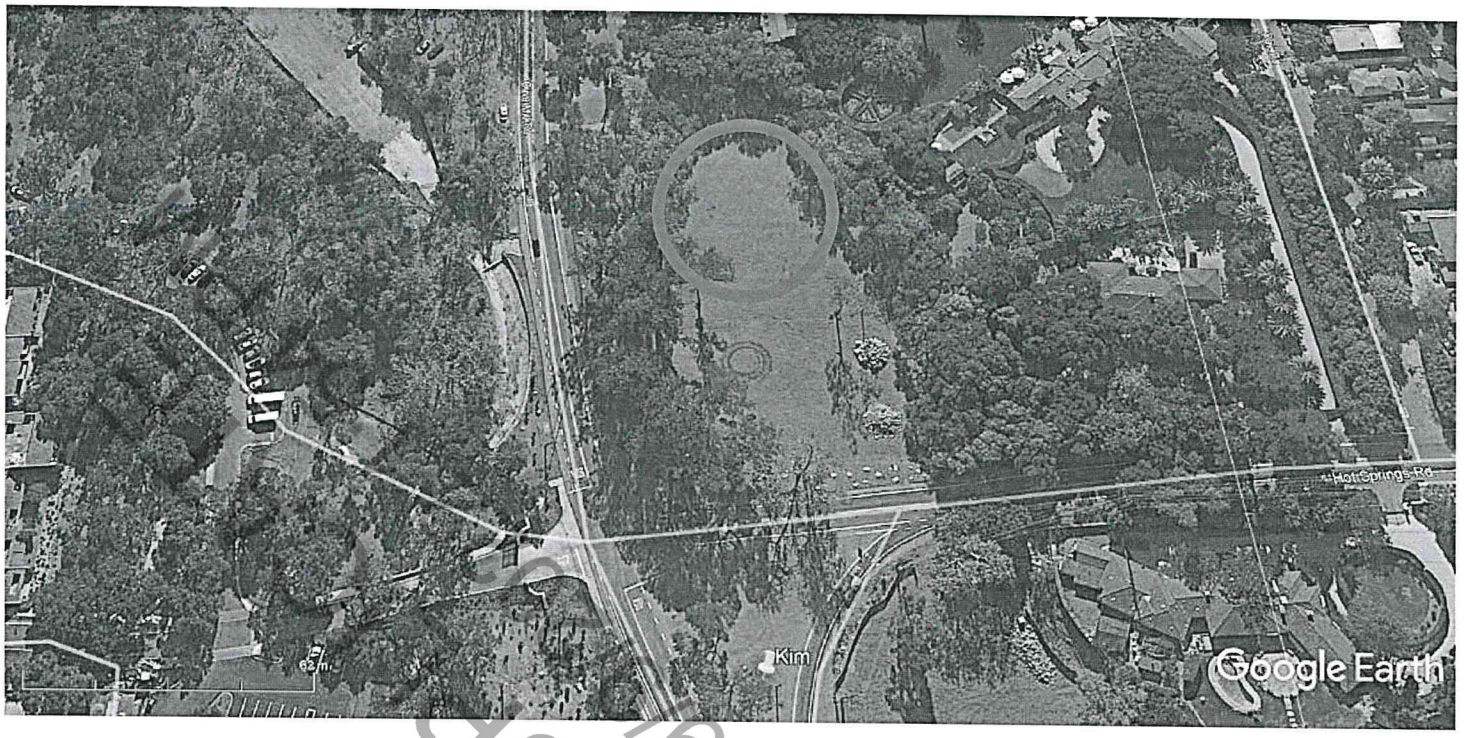
Area of Interest before disaster

FEB
2018

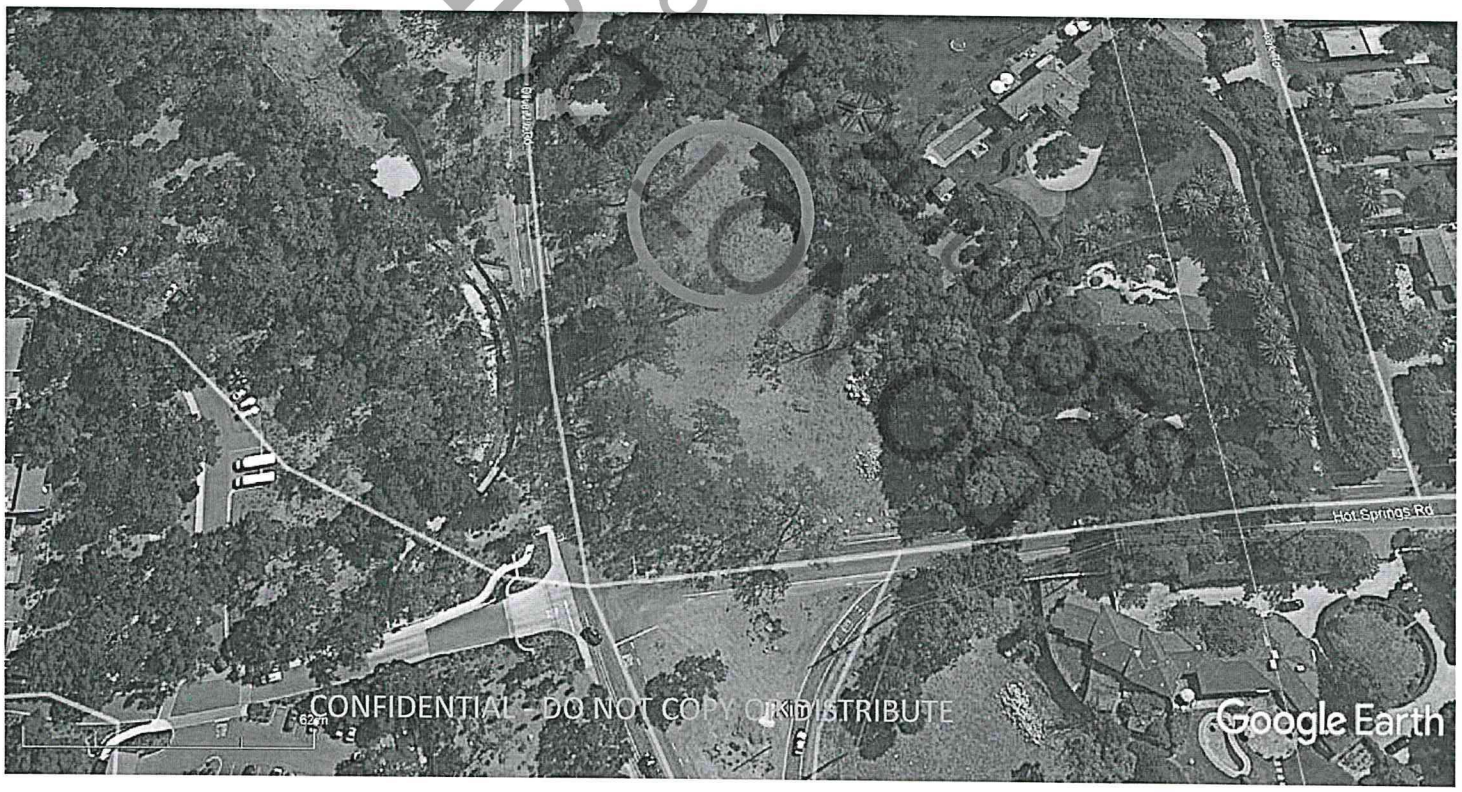
SEPT
2018



APR
2019



NOV
2019



JUNE
2020

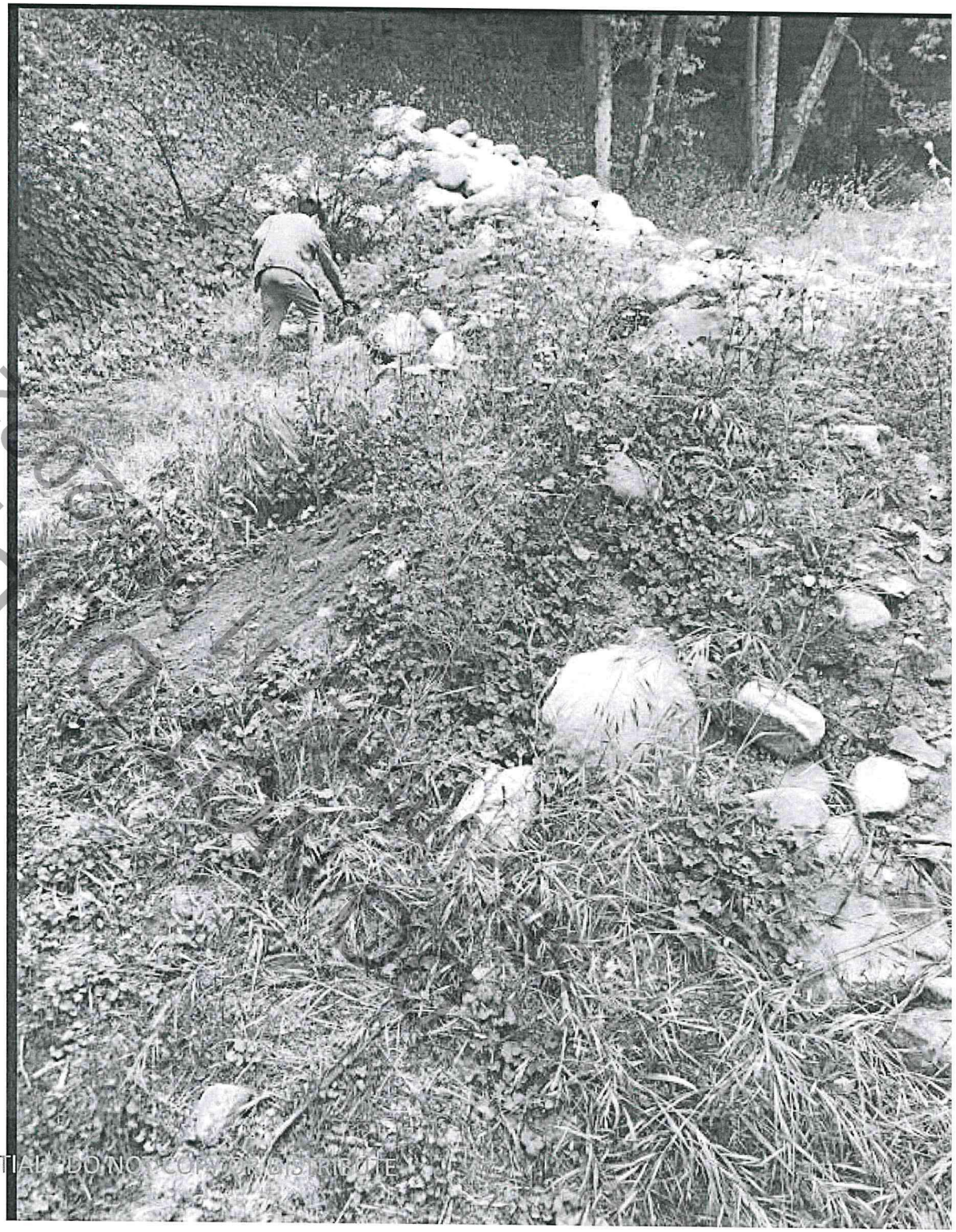
JUL
2020

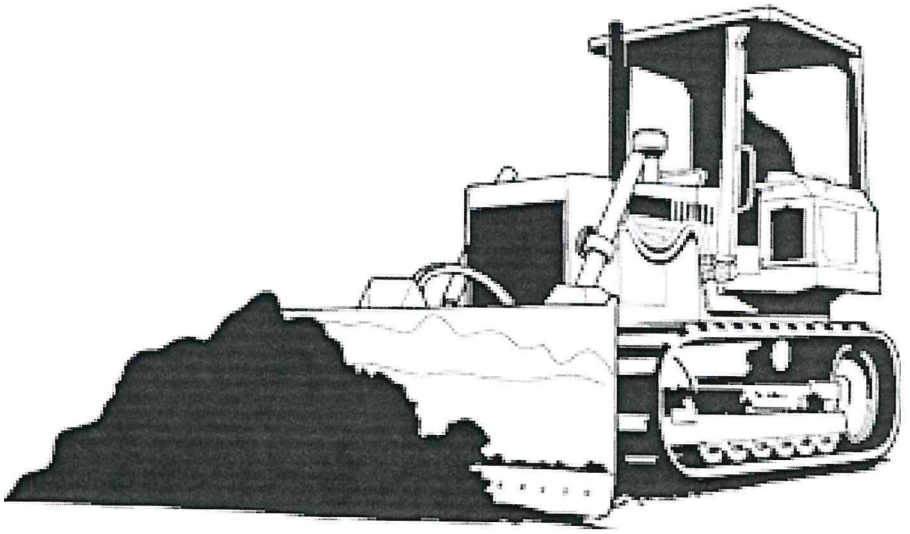
Current Search Area 2021

Margolis: "Mound came from north of Hot Spring Rd"

Debris Mounds

SEARCH DOG





Mound A
Boulders

Mound B
Boulders

Mound 3

Mound 4

Mound 1

Mound 2

north

Mounds 1 & 2

Loose Sandy-Silty Loam – Top Soil

Artifactual Evidence (or Lack Thereof)

NOTHING INDICATES THIS CONTEXT IS HISTORIC OR PREHISTORIC (CHUMASH)

-NO SHELLS
-CHUMASH DID NOT SETTLE THIS FAR INLAND

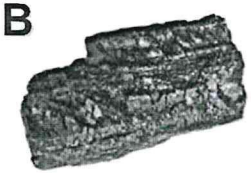
-ALL ARTIFACTS SUPPORT HYPOTHESIS THAT DEPOSITION IS ONLY A FEW YEARS OLD

Artifacts from the room where Jack was sheltering

Recent Deposits

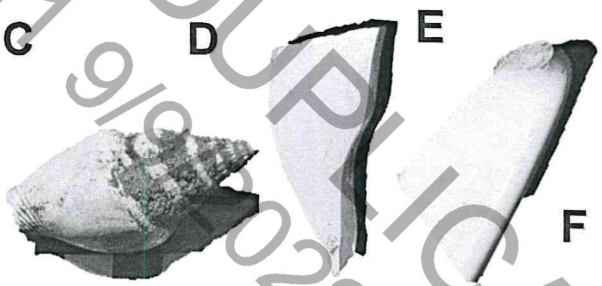
A

B



Artifacts associated with the Cantin Home

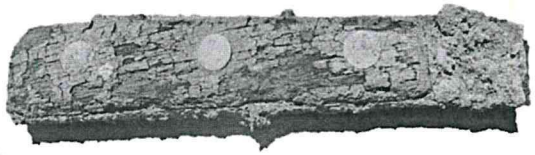
C D E



G

H

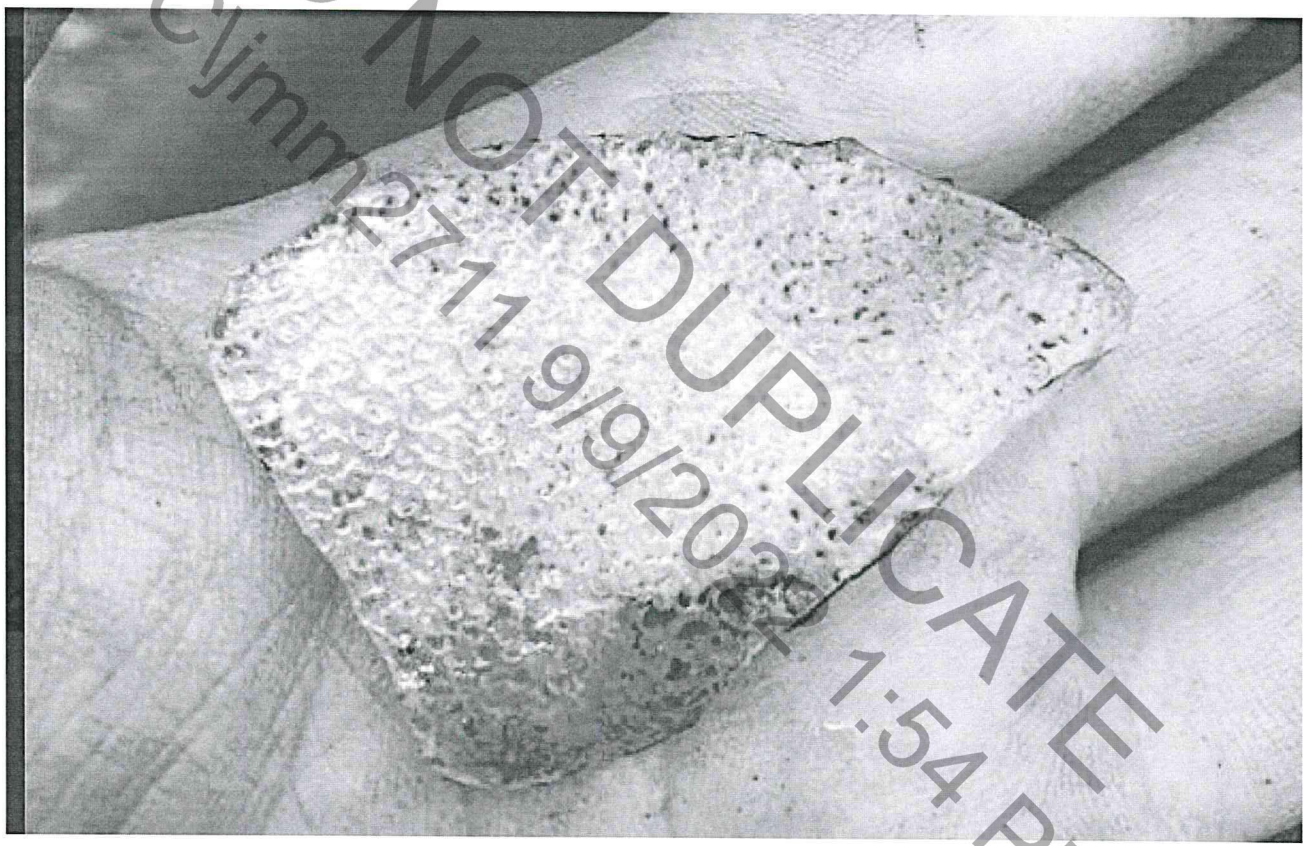
F



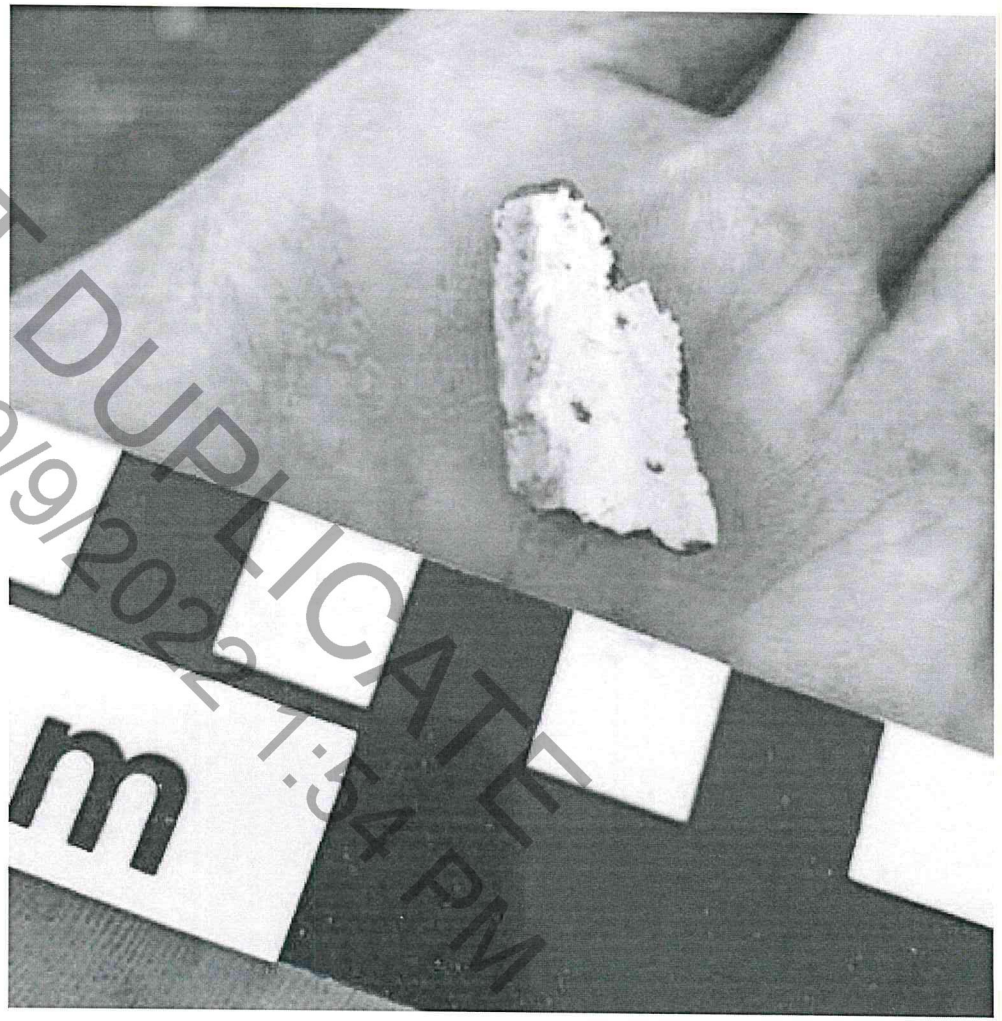
Elastic Band – Cotton Blend Briefs

Recent

Privacy Glass

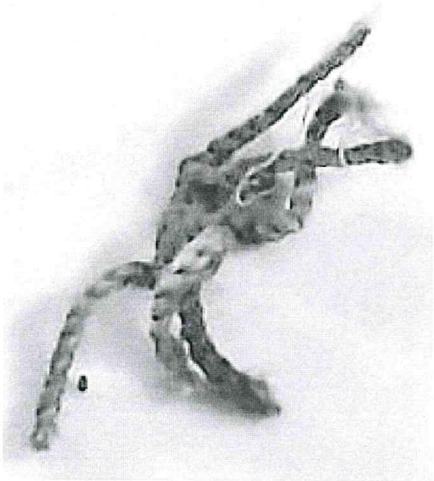


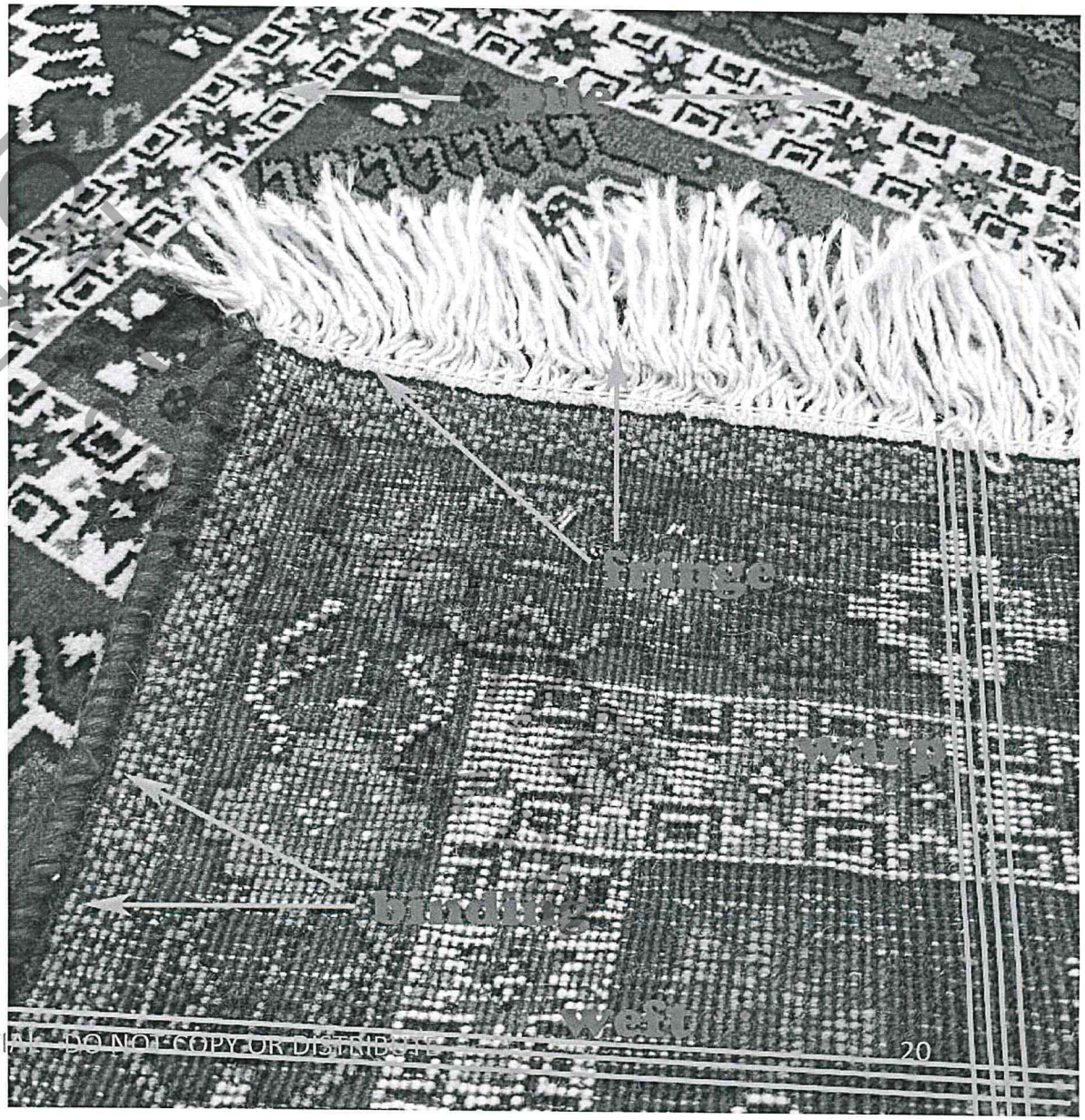
Bathroom Tile



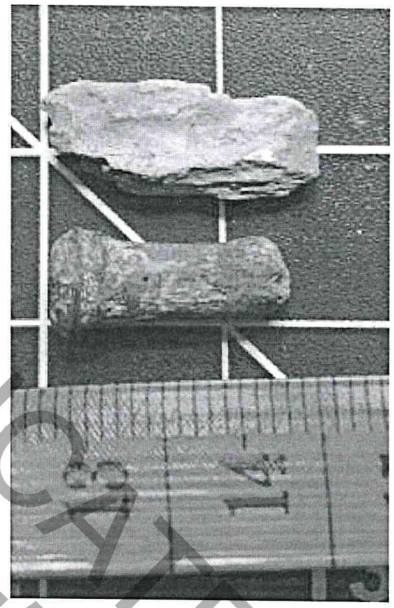
Oriental Rug

- Sheep's Wool Warp & Weft
- Cotton Backing
- Blue and Red Tints
- Persian or Balochi Weaving Style





Discovery of Possible Human Remains



Snow Report

- Background – SBPD outside consultant
- Conclusions – "not bone" or "not human" or "if human, then ancient"
- Critique –methods, context, images
- Alternative : UCSB Analysis

Snow Report -Critique

Problematic

Image manipulation

Non-sequitors

A cross section of a typical human long bone is shown below (Figure 5). Note the hollow medullary cavity as opposed to the solid pith center of the object shown in Figure 3. Also note the absence of medullary rays and cambium that are present in Figure 4.

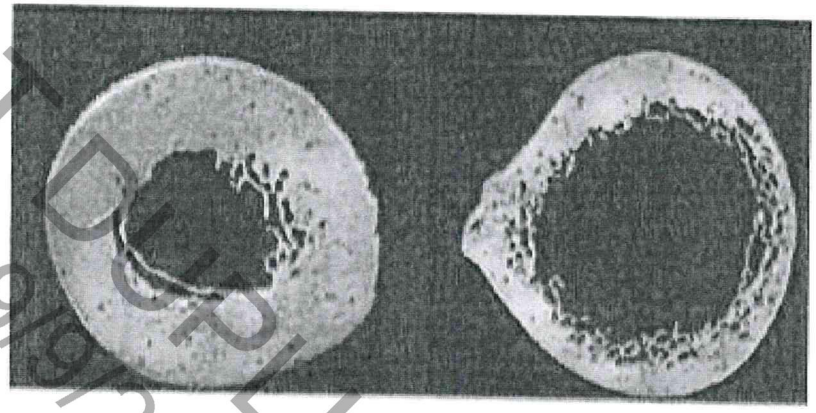


Figure 5. Cross section of a human long bone showing hollow medullary cavity and absence of medullary rays.

Conclusions:

STOCK FOTO – not actually from sample & nothing to do with the case

Snow Report Critique

Problematic image manipulation & omissions

(rose stem cross section)

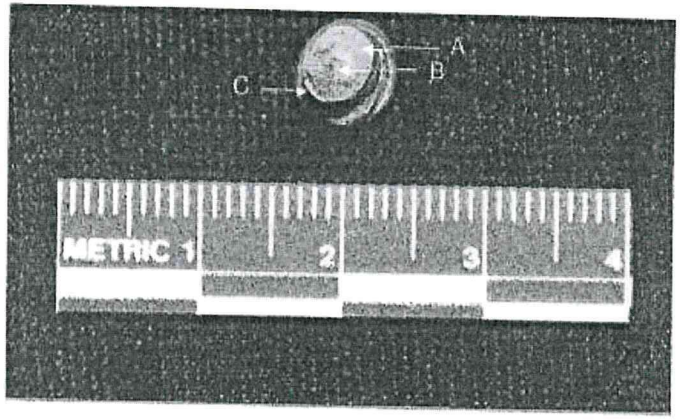


Figure 3. Superior view of one of plant stem contained in a plastic bag from the Santa Barbara Sheriff's Office Coroner's Bureau.

An example of a woody plant stem (Figure 4) closely resembles the objects sent by the Santa Barbara Sheriff's Office Coroner's Bureau. The photo below shows the medullary rays, pith, and cambium, none of which have counterparts in the human skeleton.

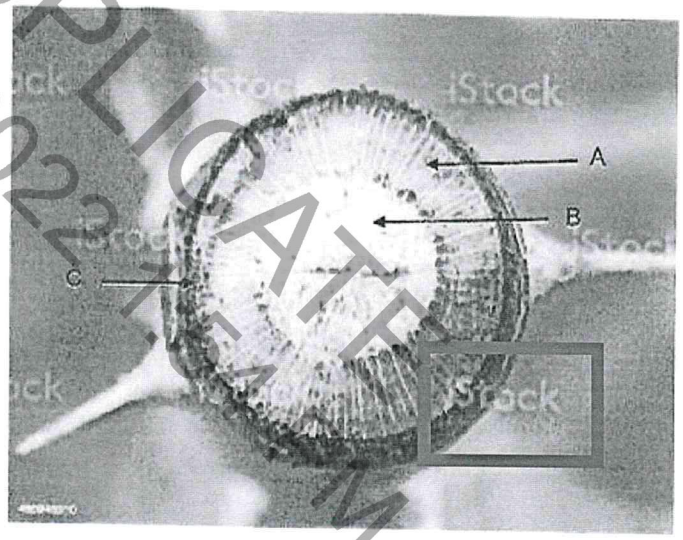


Figure 4. Cross section of woody plant stem showing medullary rays (A), pith (B), and cambium (C).

Snow Report Critique

crumbled easily at the touch.

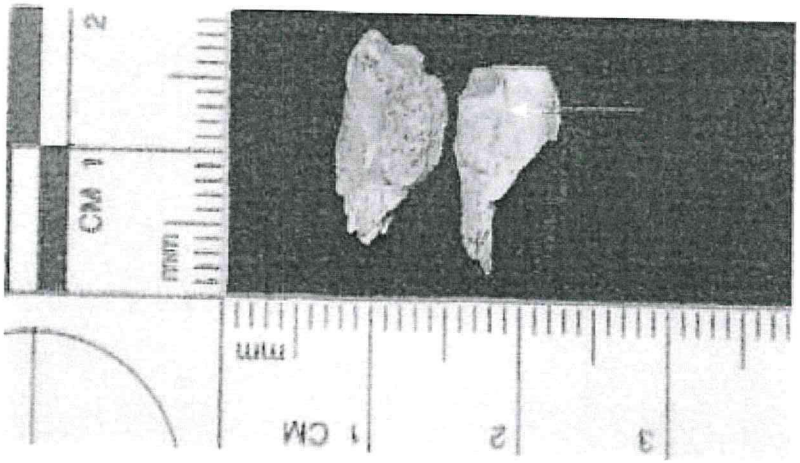


Figure 1. Bone fragments from the Santa Barbara Sheriff's Office Coroner's Bureau showing longitudinal splitting (arrow).

Fragment #1 Broken with Pliers

Fragment #2 Bisected with jigsaw

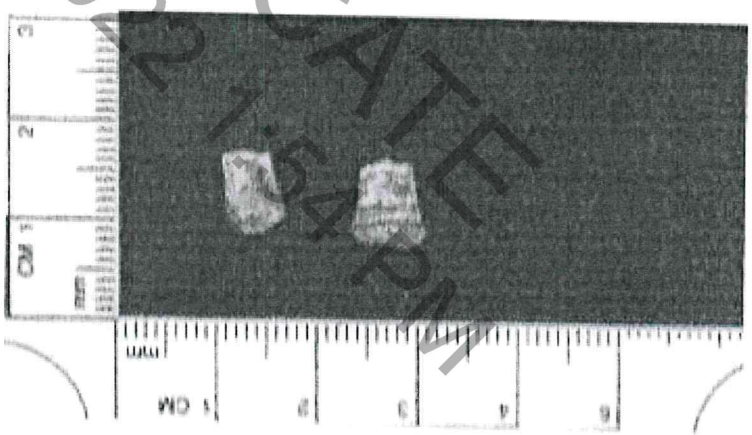
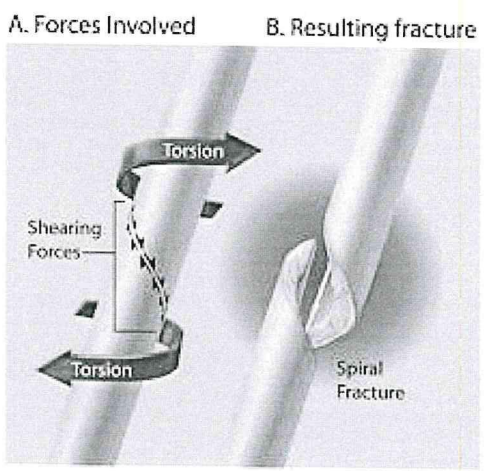
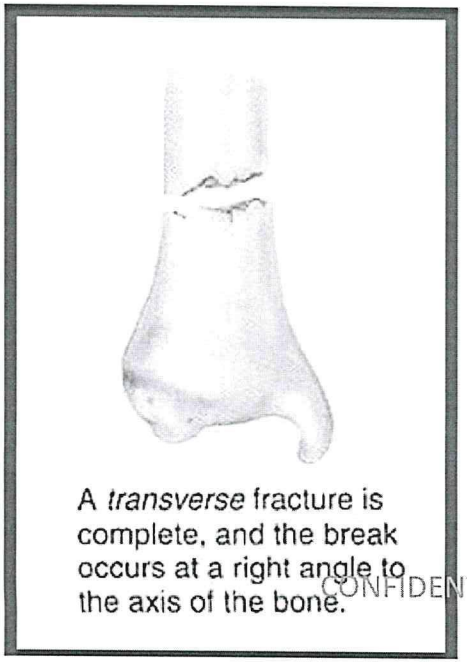


Figure 2. Fragments in plastic ziploc bag from the Santa Barbara Sheriff's Office Coroner's Bureau.

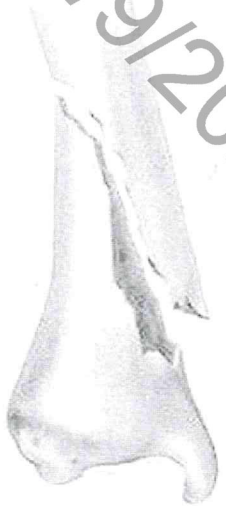
nts in plastic ziploc bag from the Santa E



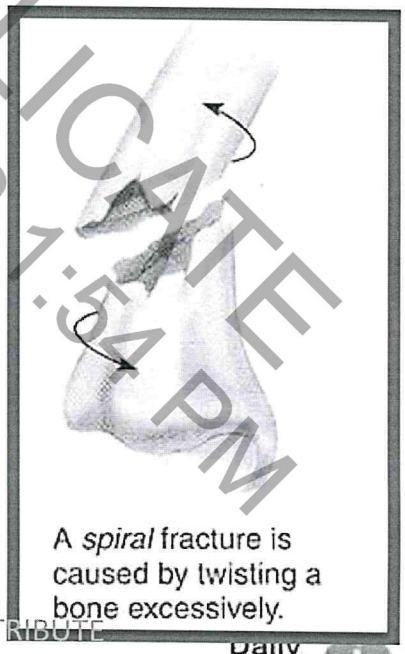
bend in the bone.



A *transverse* fracture is complete, and the break occurs at a right angle to the axis of the bone.



An *oblique* fracture occurs at an angle other than a right angle to the axis of the bone.



A *spiral* fracture is caused by twisting a bone excessively.

Snow Report - critique

Practitioner error refers to human error or mistakes. Practitioner errors may be unintentional and related to negligence or incompetence, such as blunders like transposing numbers when recording data, incorrect instrument use, selection of inappropriate methods, or improper method application. In forensic anthropology, this might include incorrectly transcribing measurements or performing calculations, or selection of a particular age estimation method when another might be more appropriate. Practitioner error may also be intentional, such as fraudulent behavior. Practitioner error is certainly a concern of practitioners and the courts, but it is not really error in the scientific sense, and can be reduced through quality assurance systems, training, proficiency testing, peer review, and adhering to validated protocols and discipline best practices such as those promulgated by Scientific Working Groups like SWGANTH (Christensen et al., 2014; Dror and Charlton, 2006).

BOX 15.1 "ZERO ERROR"

Some forensic practitioners have claimed that the error rate for their technique or method is zero; see US v. Mitchell (1998) for one example. The following testimony was provided by a fingerprint examiner explaining the reasoning behind the zero error rate claim:

> *"And we profess as fingerprint examiners that the rate of error is zero. And the reason we make that bold statement is because we know based on 100 years of research that everybody's fingerprints are unique, and in nature it is never going to repeat itself again."*
>
> (People v. Gomez, 2002)

What this expert fails to understand is that despite the strength of the basis for fingerprint association (that there is a low probability for two identical fingerprint patterns to exist), error and limitations still exist in the comparison methodology. Error depends not only on how rare a particular trait is, but also on how reliable and valid the methods are for determining a match. There is always a non-zero probability of error, and to claim an error rate of zero is inherently unscientific. Reasons behind such misunderstandings of error range from improper training in statistics and the scientific method to concerns that current methods will be exposed as lacking an empirical footing.

Expertise & Approaches

"If scientific, technical or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training or education may testify thereto in the form of an opinion or otherwise, if (1) the testimony is based upon sufficient facts or data, (2) the test is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case."

(Fed. R. Evid. 702, 2000)

Table 15.1 The *Daubert* guidelines

Has the technique been tested using the scientific method?
Has the technique been subjected to peer review, preferably in the form of publication in peer-reviewed literature?
What are the known or potential error rates of the technique?
Are there applicable professional standards for the technique?
Is the technique generally accepted within the relevant scientific community?

Forensic Archaeology & Anthropology: A different Perspective

Overall Context + human remains + artifact analysis + interviews & witness testimony + mapping + flow dynamics + survey work + dog searches + coroner's reports + archival work + test pits + soil samples + biogeochemistry + etc……

<u>Forensic Anthropology & Intuition</u>

We respect intuition as a form of Verstehen*

F.A. framework is Scientific Method:
Facts & Testable Hypothesis

F.A. is not equipped with the tools needed to address questions of supernatural significance

* empathic understanding of human behavior

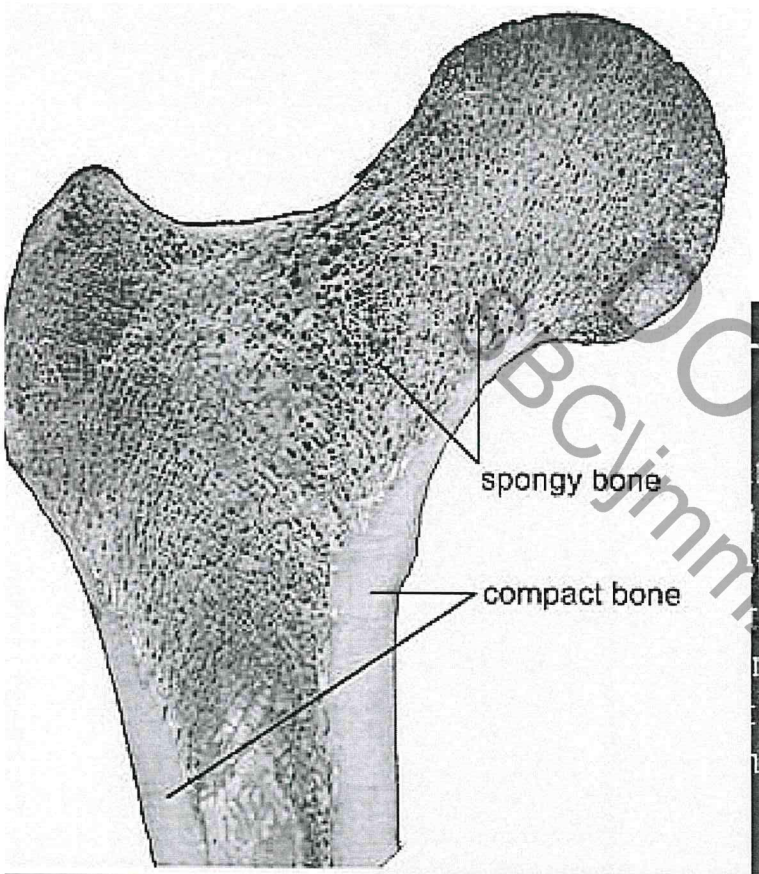
Burden of Proof

Under the **preponderance** standard, the burden of **proof** is met when the party with the burden convinces the fact finder that there is a greater than 50% chance that the claim is true

"Based on a reasonable degree of scientific certainty, there is a preponderance of evidence that the human remains & associated artifacts are consistent with those of Jack Cantin" -- Dr. Kurin

WHAT IS BONE?

COLLAGEN + HYDROXYAPATITE



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BONE MARROW stores fat and makes blood cells

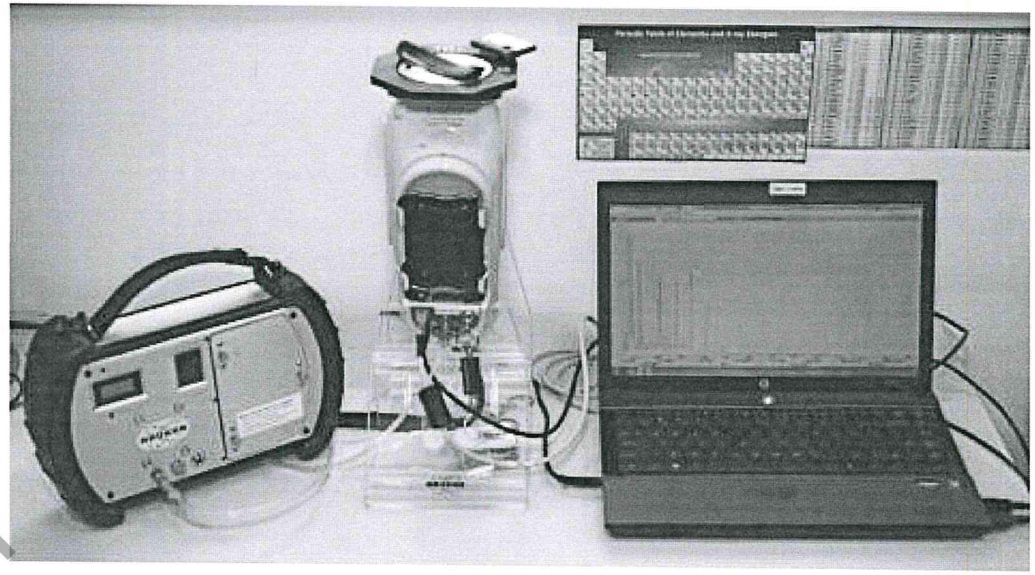
BLOOD VESSEL supplies food and oxygen to bone cells

SPONGY BONE is the strong, lightweight inner layer of bone

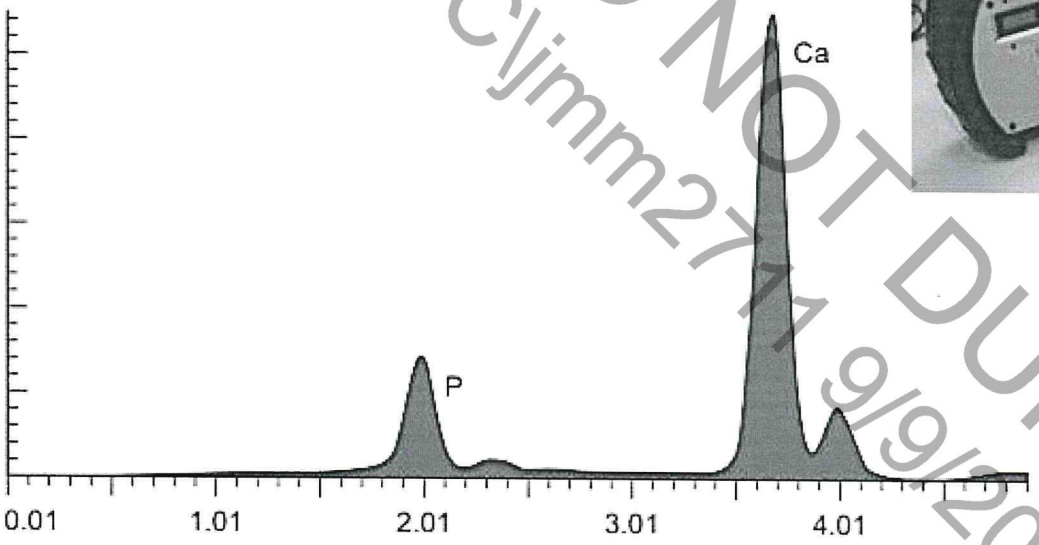
COMPACT BONE is the hard, strong outer layer of bone

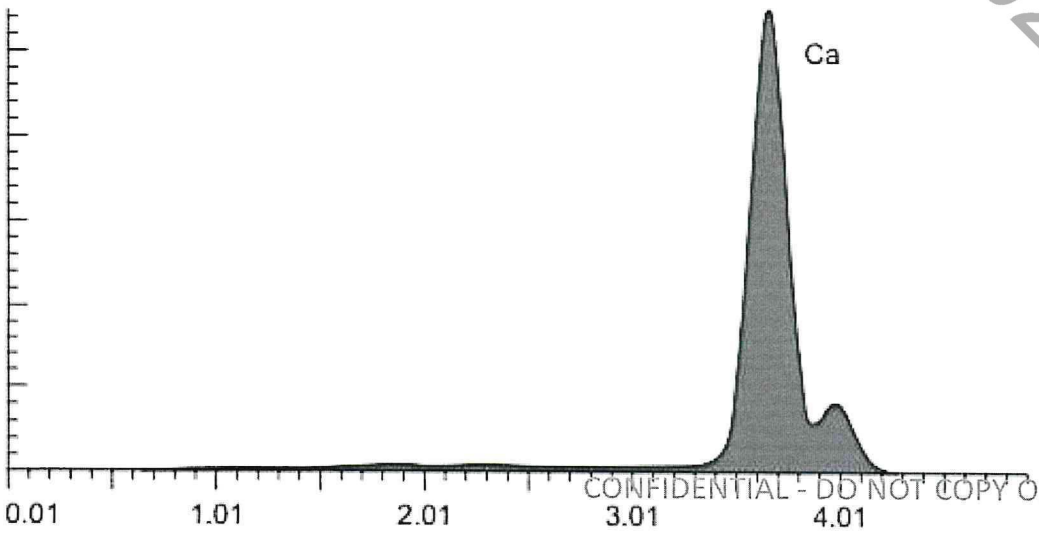
BONE END forms joint with another bone

Is it bone?
YES



PXRF – "REVERSE RECIPE MACHINE"





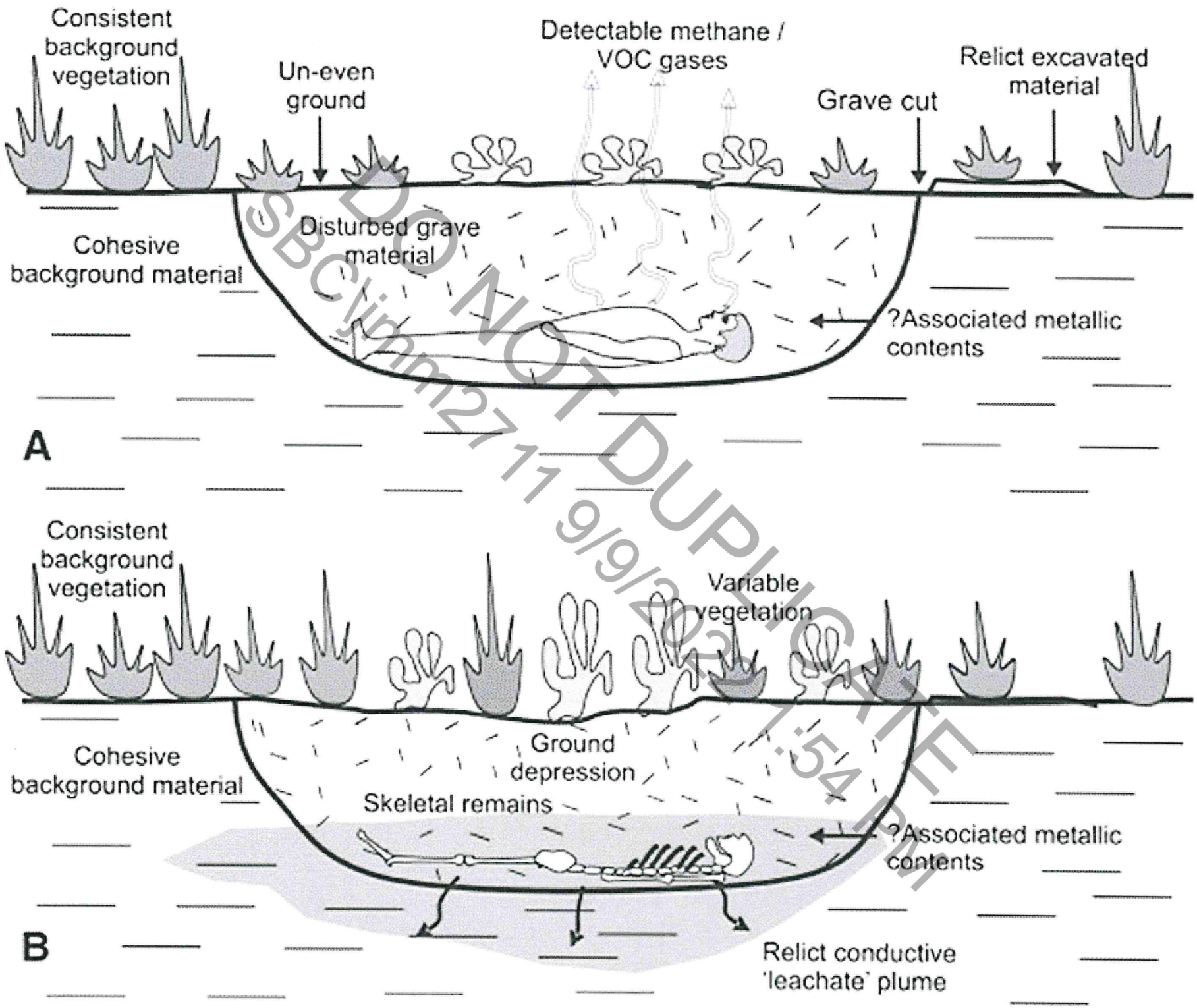
Top = bone

Bottom = seashell

How long have the bones been here?

FORENSIC TAPHONOMY

AT LEAST 2-3 YEARS IN GROUND



Decomposition & Weathering

Table 5.3 Generalized stages of dec

Stage	Features
Fresh	Flies are attracted to open wounds. The sk be present around th
Bloat	Maggots hatch and s missing. Slippage of s appears bloated due pattern and extensive appear from all orifice a decomposition stair may be attracted to c
Active decay	Bloating has subsided desiccation. Beetles r Skin may appear mur holes in desiccated ti remains if the remains scavengers may remo initial decomposition. Birds may remove scalp hair to use in nests.
Advanced decay	The remains may become completely skeletonized with little odor or grease present. Skeleton may shows early signs of sun bleaching or weathering. There may be signs of carnivore scavenging or rodent gnawing. Mice or wasps may utilize the skull as a nest.
Dry/Skeleton	Bone surfaces break down and have an exfoliated appearance. Longitudinal cracks occur, and external cortex may flake away. Bone will appear significantly weathered and will continue to show evidence of fragmentation over time.

(Adapted from Bass, 1997)

Table 5.1 Stages of bone weathering

Stage	Description
0	Bone surface shows no sign of cracking or flaking due to weathering
1	Bone shows cracking, normally parallel to the fiber structure (e.g., longitudinal in long bones), articular surfaces may show mosaic cracking of covering tissue as well as in the bone itself
2	Outermost concentric thin layers of bone show flaking, usually associated with cracks
3	Bone surface is characterized by patches of rough, homogeneously weathered compact bone, resulting in a fibrous structure, all lamellar bone is absent from these patches
4	The bone surface is coarsely fibrous and rough in texture
5	Bone is falling apart in situ

(From Behrensmeyer, 1978)

Decomposition scores

Table 5.5 Scores for decomposition of the head and neck

Score	Description
1	Fresh, no discoloration
2	Pink-white appearance with skin slippage and some hair loss
3	Gray to green discoloration, some flesh relatively fresh
4	Brown discoloration, drying of nose, ears, lips
5	Purging of fluids via orifices, some bloating may be present
6	Brown to black discoloration
7	Caving in of flesh and tissues of eyes and throat
8	Moist tissue with bone exposure over less than one half of the area being scored
9	Dry tissue with bone exposure over less than one half of the area being scored
10	Greasy tissue with bone exposure over more than one half of the area being scored
11	Dry tissue and bone exposure over more than one half of the area being scored
12	Bones largely dry, but retaining some grease
13	Dry bone

(Modified from Megyesi et al., 2005)

Table 5.6 Scores for decomposition of the limbs

Score	Description
1	Fresh, no discoloration
2	Pink-white appearance with skin slippage of hands and/or feet
3	Gray to green discoloration, marbling, some flesh relatively fresh
4	Brown discoloration, drying of fingers, toes, projecting extremities
5	Brown to black discoloration, skin having leathery appearance
6	Moist tissue with bone exposure over less than one half of the area being scored
7	Dry tissue with bone exposure over less than one half of the area being scored
8	Remaining tissue and fluid, bone exposure over one half of the area being scored
9	Bones largely dry, but retaining some grease
10	Dry bone

(Modified from Megyesi et al., 2005)

What is the condition of the bones?

FRAGMENTARY – COLOR – MORPHOLOGY – CAUSE OF DEATH –UNIQUE IDENTIFIERS

Ankle Region – Long Bone

Diaphysis (shaft) – cortical bone

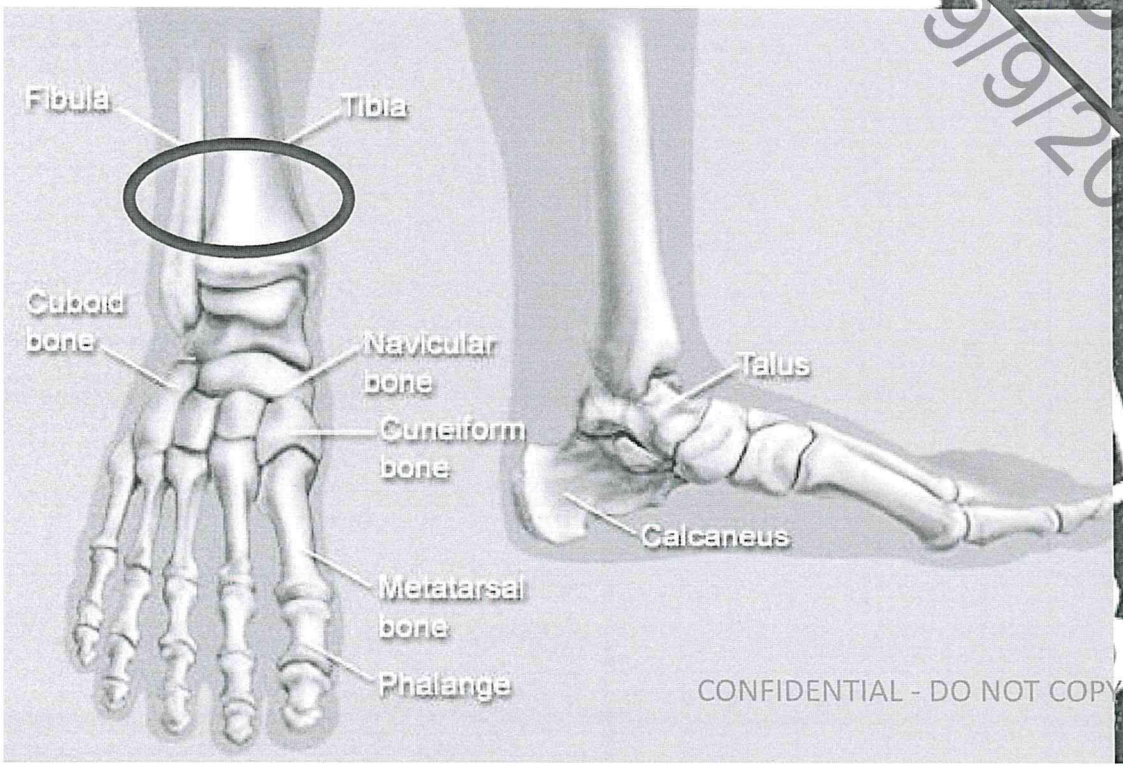
Perimortem Blunt Force Trauma

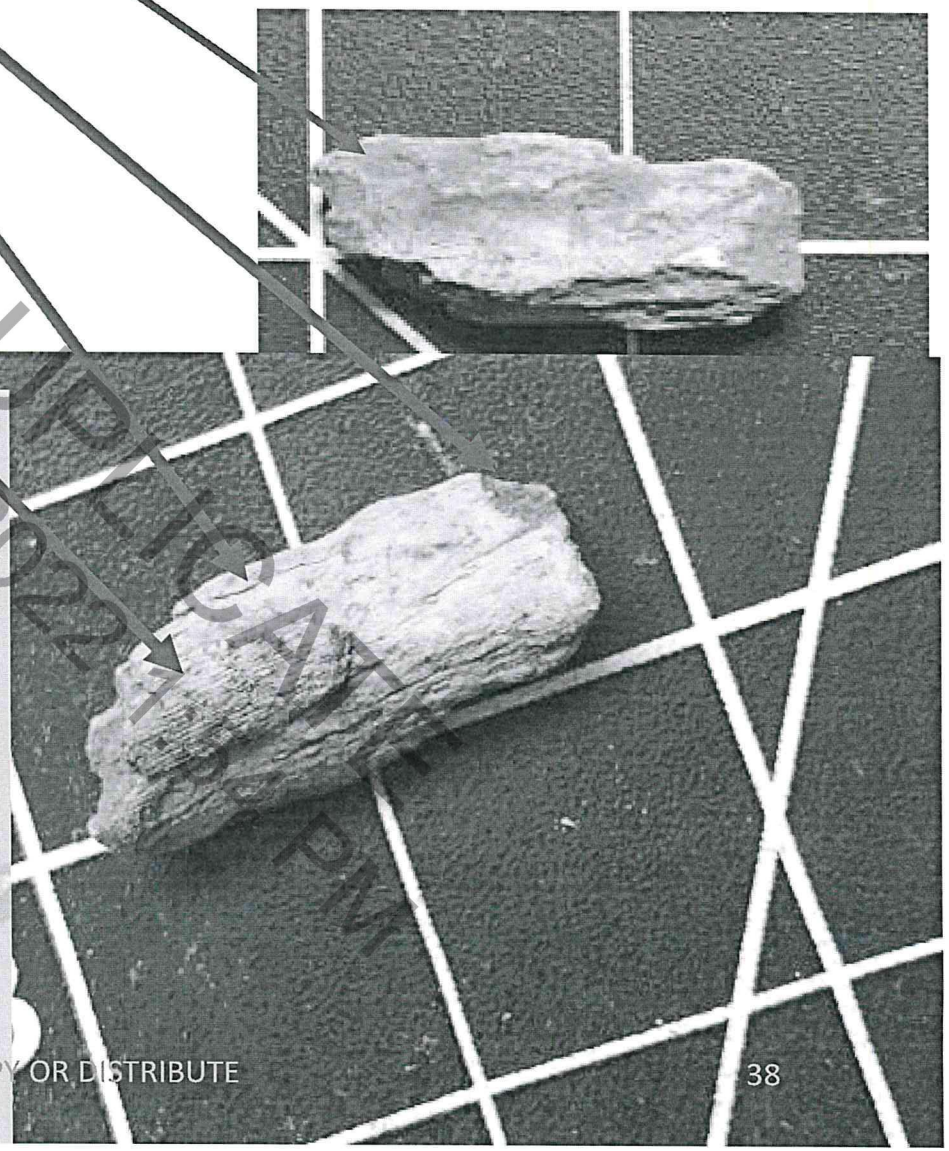
Postmortem thermal cracking

Deposited at least 2-3 years ago

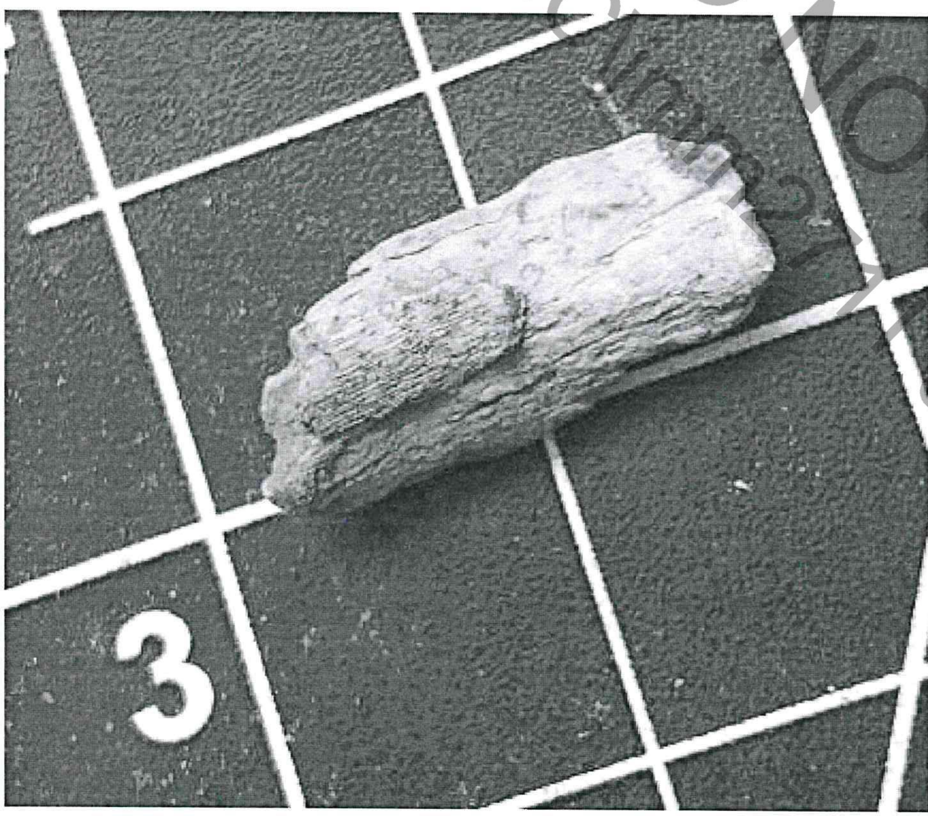
Mild periostitis “shin splints”

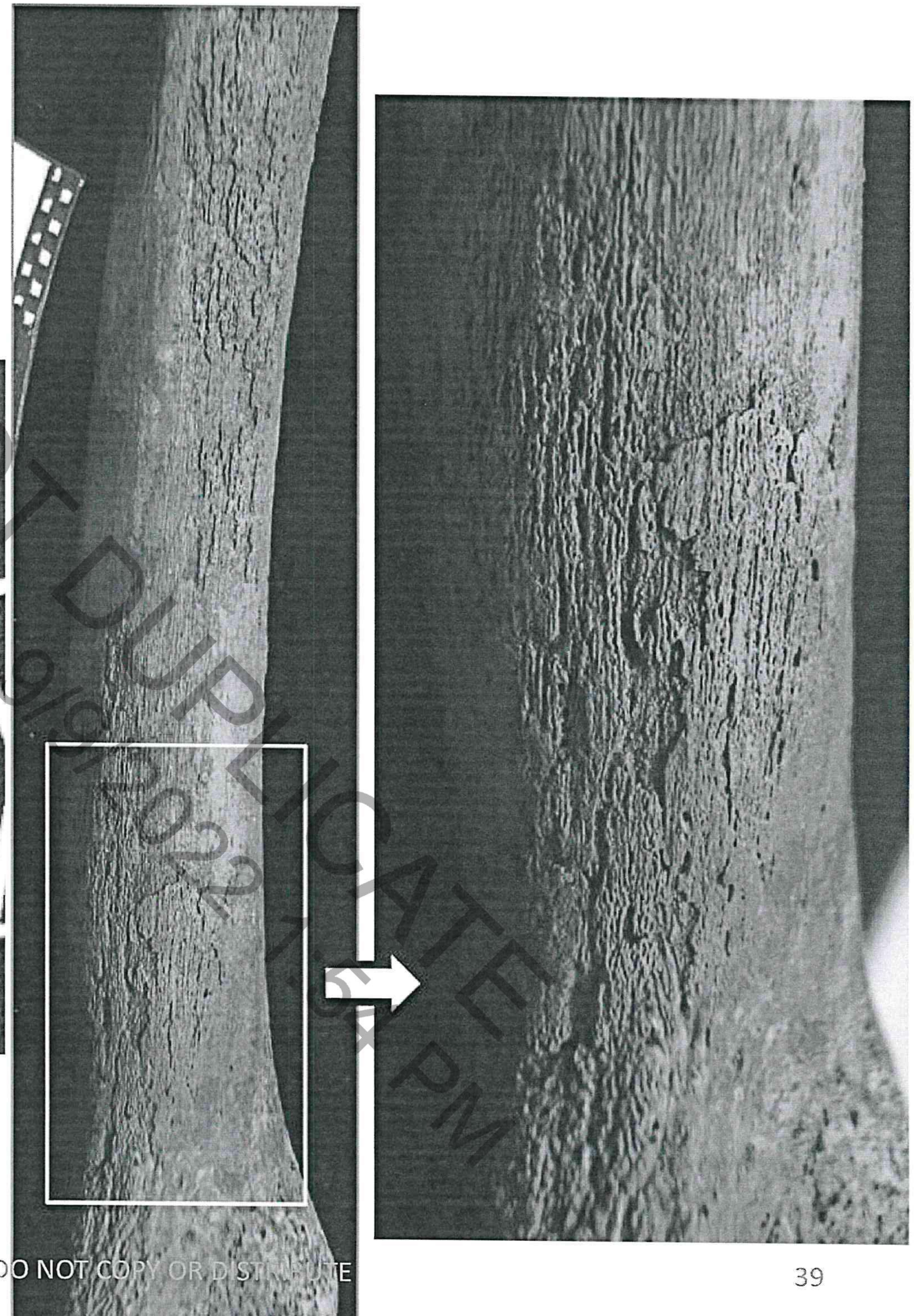
Fragment # 1





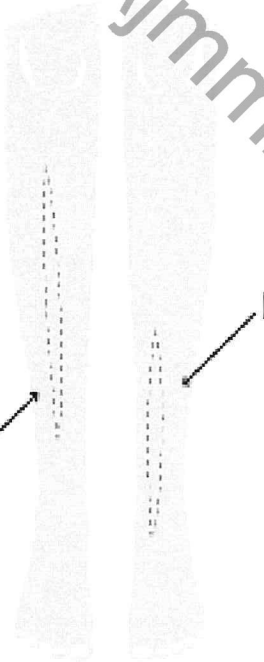
Periostitis



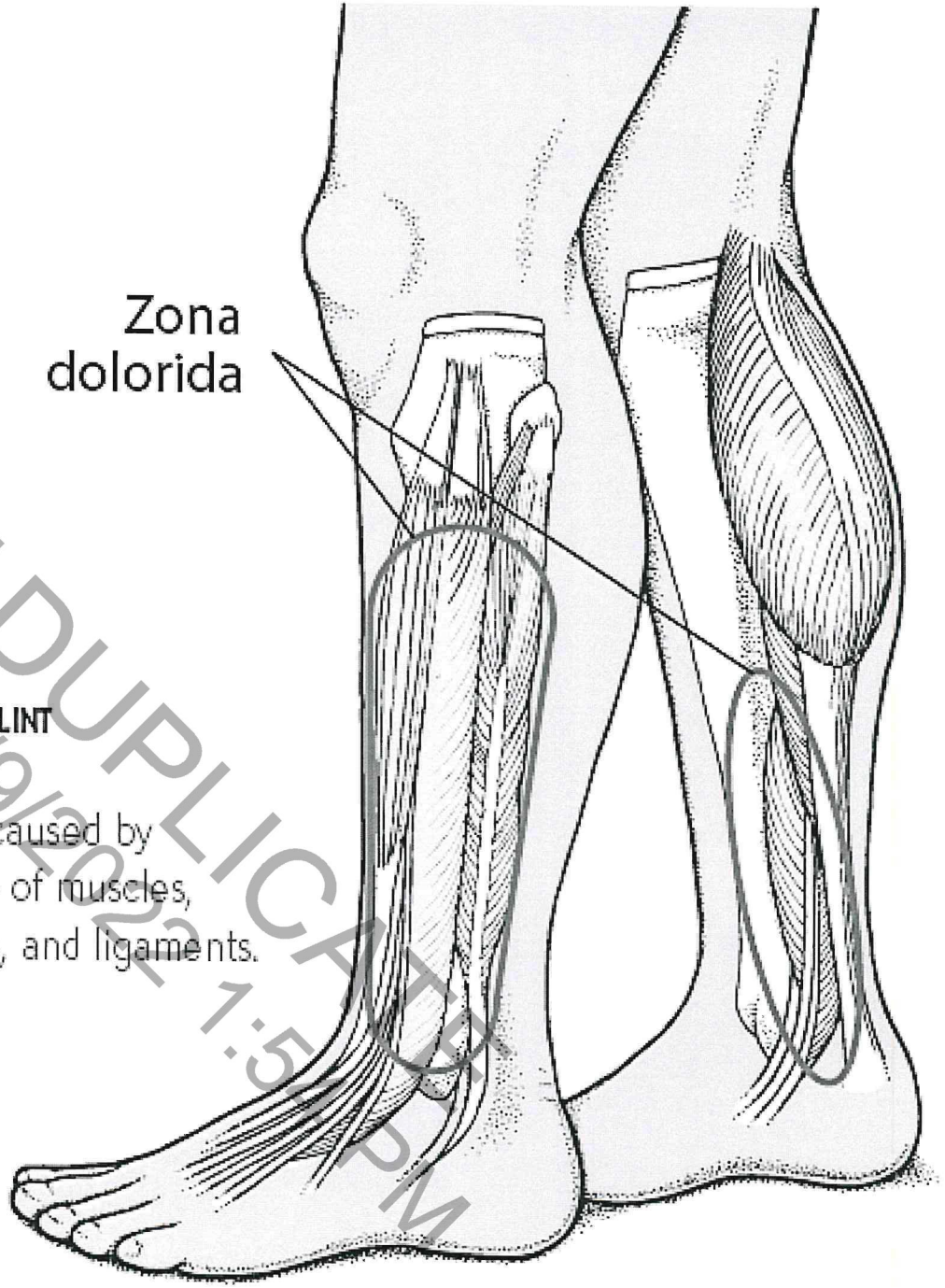


“Shin Splints”

Shin splints, formally named medial tibial stress syndrome, is pain along the shinbone in the lower leg.



Pain is caused by overuse of muscles, tendons, and ligaments.

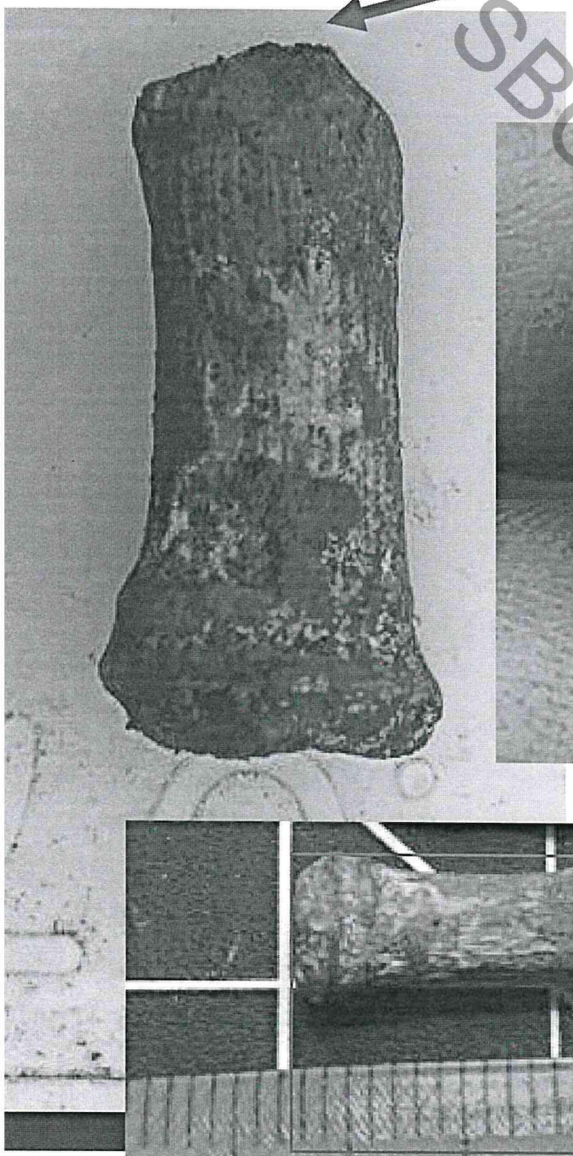


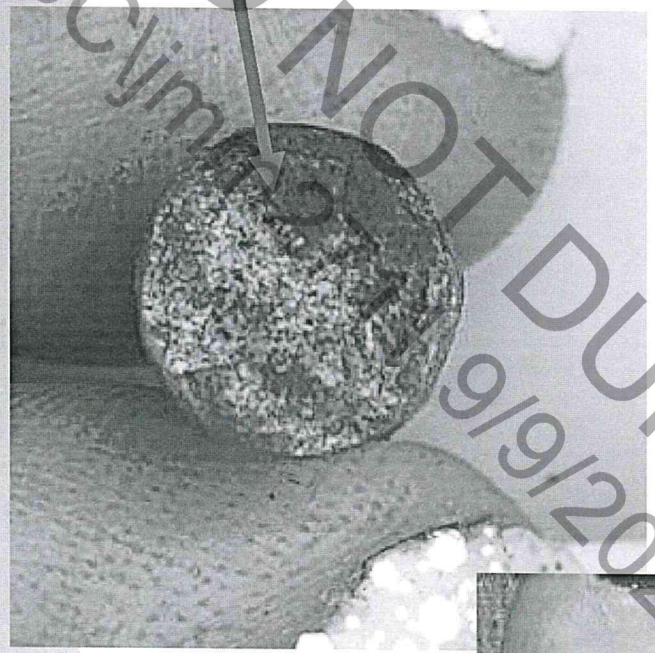
Periostitis tibial anterolateral

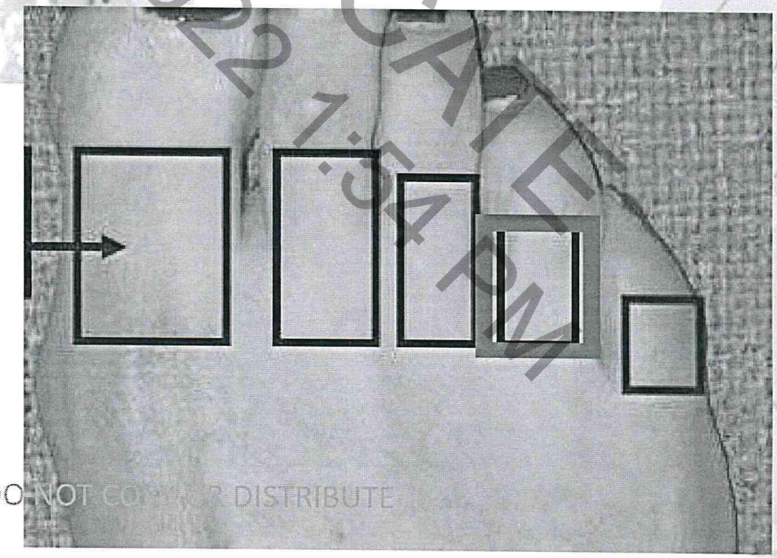
Periostitis tibial posteromedial

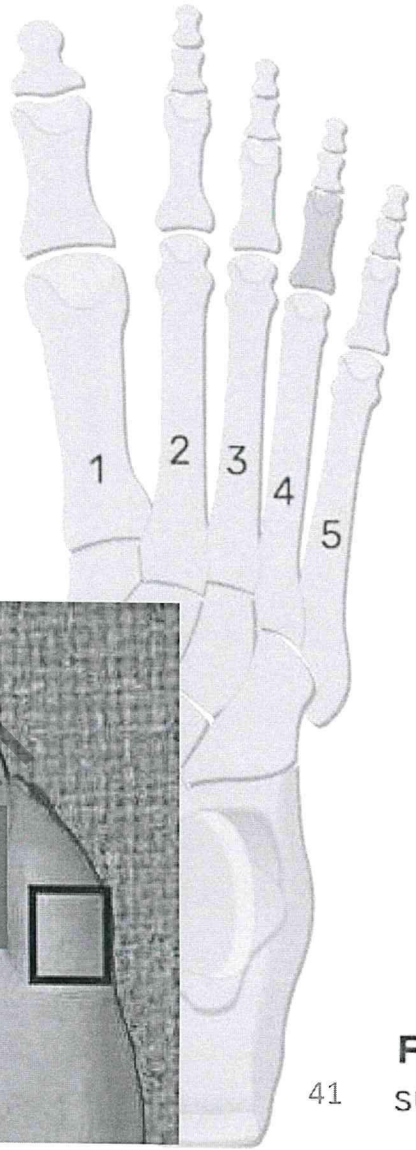
Fragment #2

Toe Bone – 4th Proximal Foot Phalanx
Color is from contaminants in soil
Perimortem blunt force trauma on Distal End
No fused Epiphysis (growth plate) on Pro End

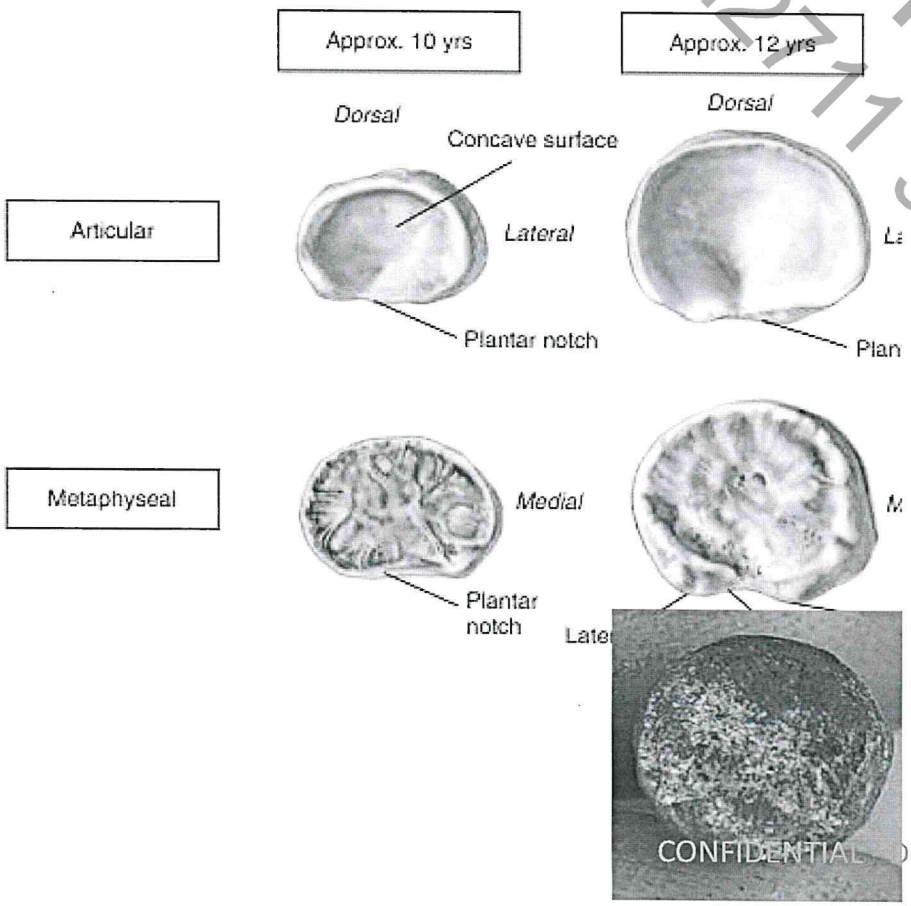


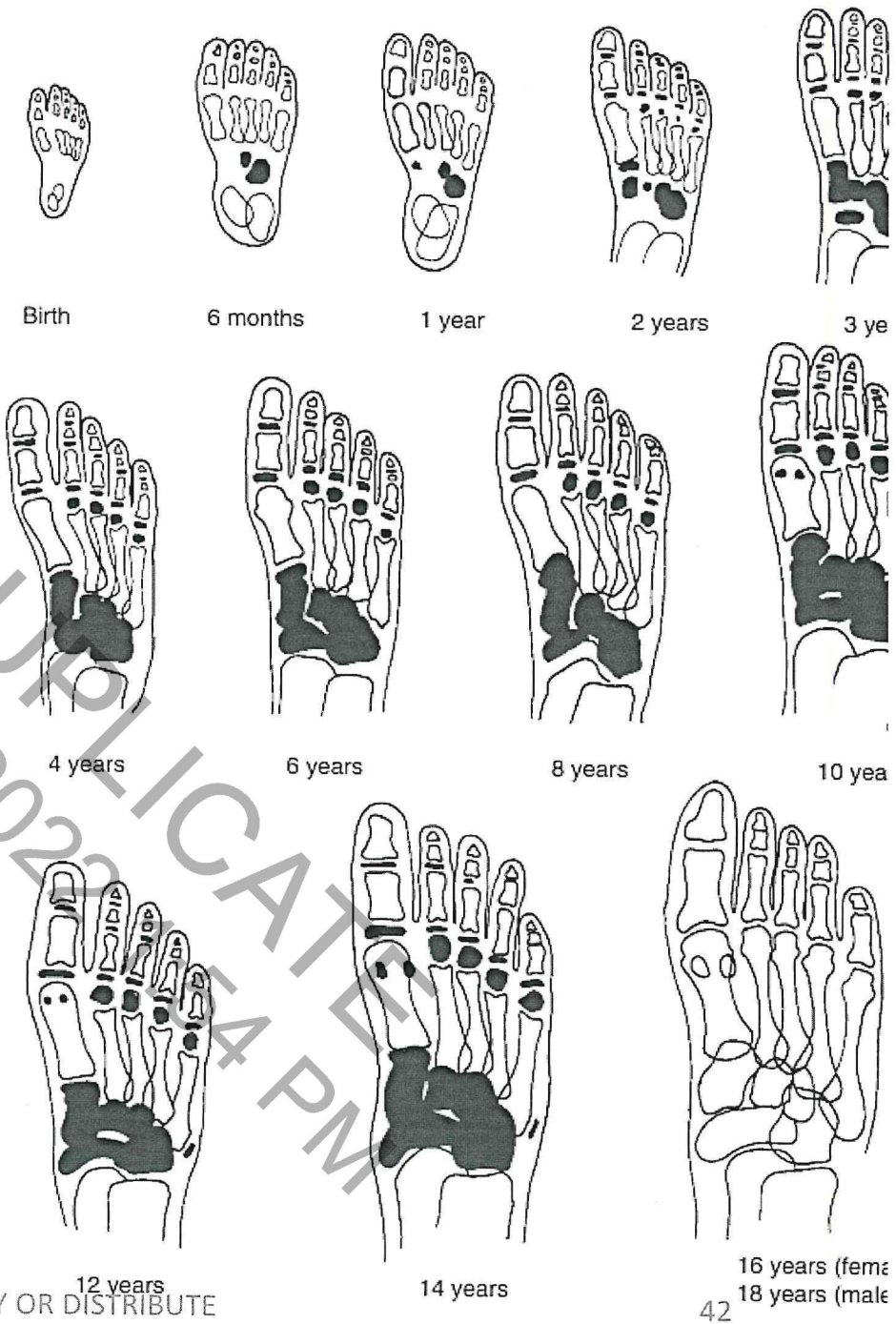






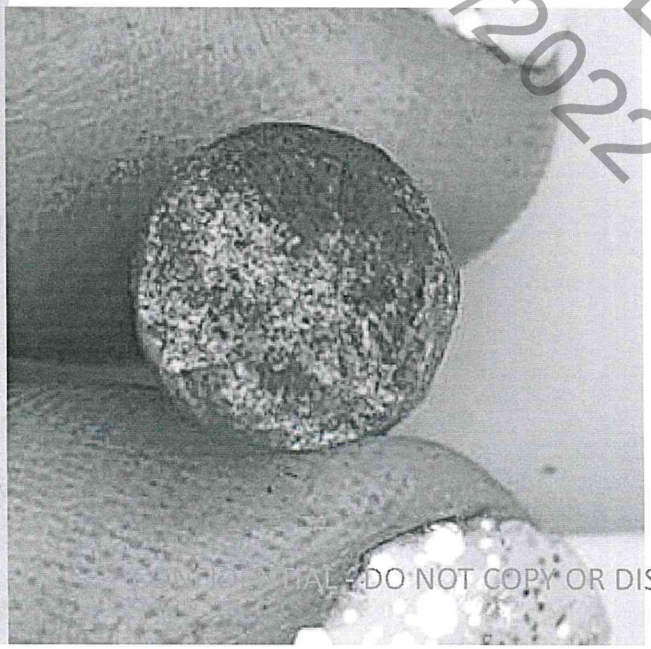
Age Determination Growth Plates (Epiphyses)

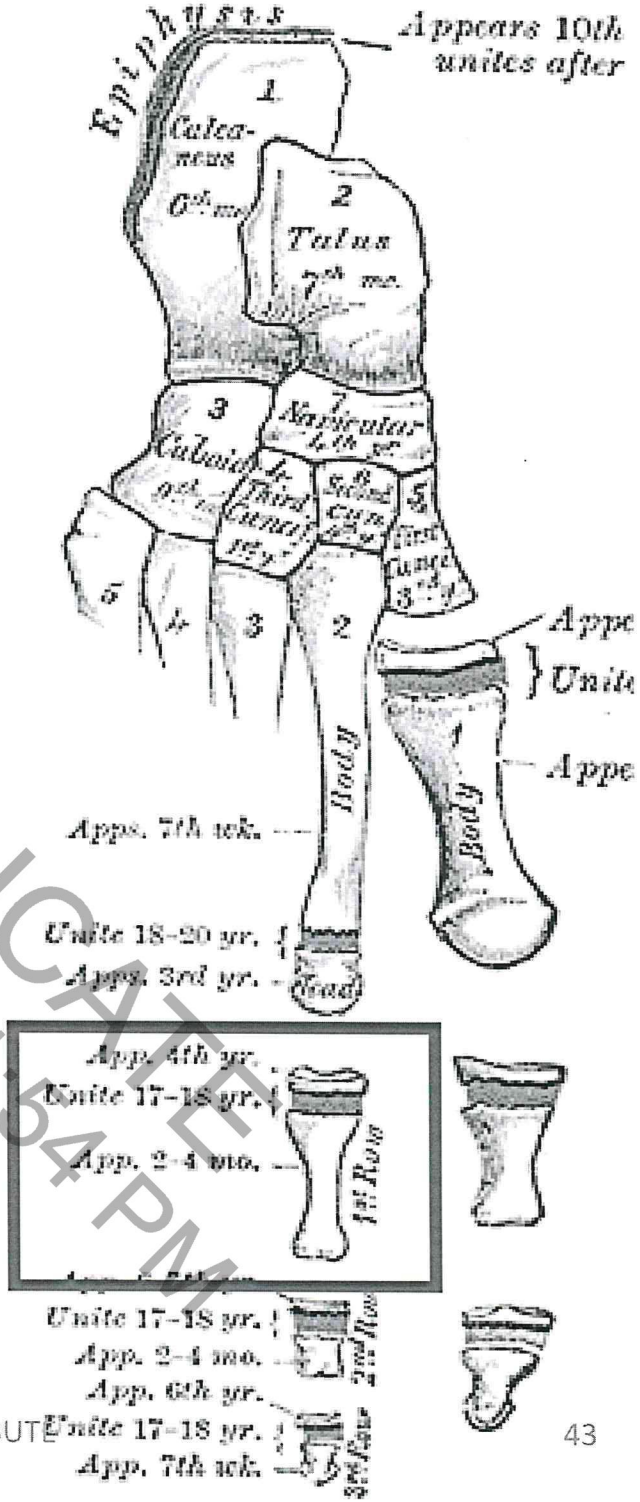




Fragment #2

males: fuses 17-18 yrs





Stature

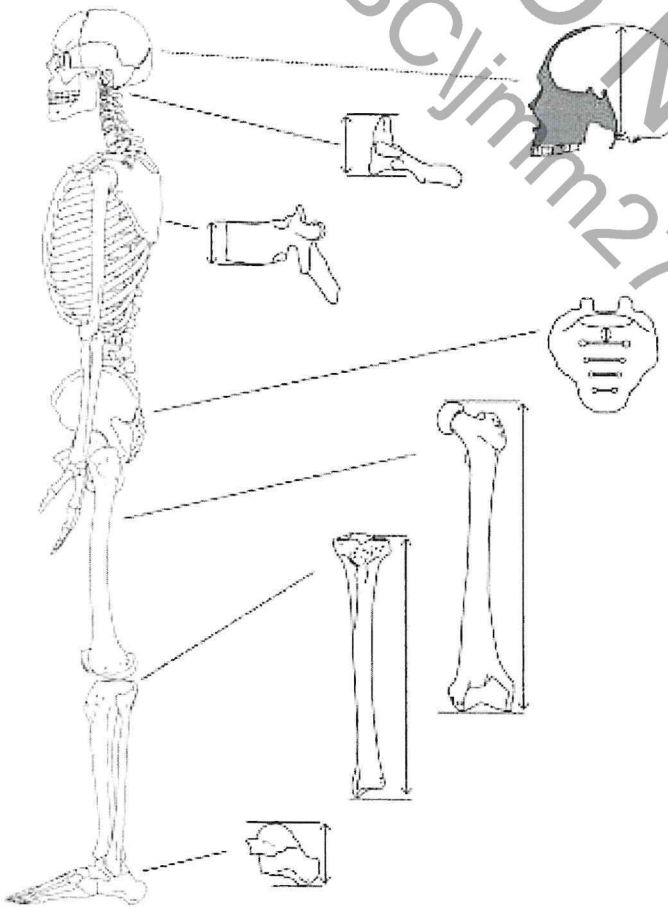


FIGURE 11.1 Measurements used in full skeleton stature estimation methods

(Adapted from

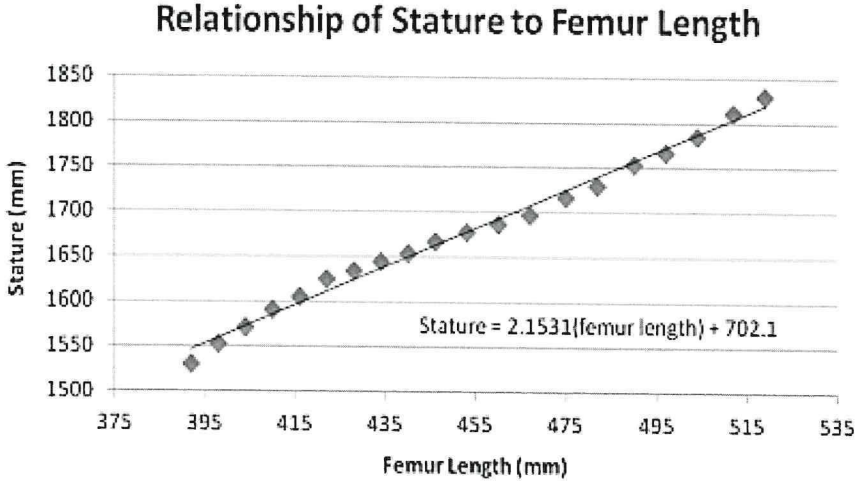


FIGURE 11.3 Example of a regression of femur length on stature in a population of European males and accompanying regression formula

(Data from Hrdlicka, in Krogman, 1962)

Using the formula from Table 11.2 for calculation of stature of European males from the length of the femur:

$$2.38 \text{ (femur length)} + 61.41 \pm 3.27,$$

for a femur length of 500mm (50cm), the calculation would be carried out as follows:

$$(2.38) \times (50\text{cm}) + (61.41) \pm (3.27)$$

$$= 180.41 \pm 3.27\text{cm}$$

$$= 177.14\text{cm to } 183.68\text{cm}$$

$$= 69.74'' \text{ to } 72.31''$$

or about 5'10" to 6'2" tall

FIGURE 11.4 Manual calculation of stature from regression formulae

TABLE 1. Simple linear regression of stature calculated from metatarsal measurements (all measurements in mm)

Metatarsal/group	Formula	No.	*r*	Standard error
First				
Combined data	St = 634 + 16.8 (Met1)	130	.79	65.4
All males	St = 815 + 14.3 (Met1)	70	.72	64.2
All females	St = 783 + 13.9 (Met1)	58	.71	56.1
Euro-American males	St = 768 + 15.2 (Met1)	57	.72	63.2
Euro-American females	St = 656 + 16.3 (Met1)	49	.79	49.6
Afro-American males	St = 556 + 17.6 (Met1)	11	.87	51.0
Afro-American females	St = 796 + 12.8 (Met1)	7	.70	50.8
Second				
Combined data	St = 675 + 13.4 (Met2)	129	.78	65.4
All males	St = 873 + 11.1 (Met2)	69	.66	69.8
All females	St = 791 + 11.5 (Met2)	58	.73	54.8
Euro-American males	St = 868 + 11.3 (Met2)	57	.63	70.1
Euro-American females	St = 712 + 12.8 (Met2)	49	.77	52.0
Afro-American males	St = 605 + 14.0 (Met2)	10	.86	56.8
Afro-American females	St = 783 + 10.9 (Met2)	7	.83	39.9
Third				
Combined data	St = 720 + 13.6 (Met3)	128	.76	67.6
All males	St = 909 + 11.2 (Met3)	69	.66	68.1
All females	St = 836 + 11.6 (Met3)	57	.67	59.7
Euro-American	Afro-American females St = 904 + 9.9 (Met3)		7	.78	44.9
Euro-American					
Afro-American					
Afro-American					
Fourth					
Combined data	St = 715 + 14.0 (Met4)	126	.76	68.5
All males	St = 910 + 11.6 (Met4)	68	.67	68.0
All females	St = 835 + 11.9 (Met4)	56	.67	59.9
Euro-American	St = 863 + 12.3 (Met4)	57	.65	68.5
Euro-American	St = 719 + 13.8 (Met4)	47	.72	57.5
Afro-American	St = 759 + 13.0 (Met4)	9	.88	46.5
Afro-American females	St = 961 + 9.3 (Met4)	7	.76	46.5
Fifth (functional)				
Combined data	St = 782 + 14.7 (Met5F)	128	.69	76.0
All males	St = 989 + 11.8 (Met5F)	68	.59	73.8
All females	St = 953 + 11.3 (Met5F)	58	.61	63.3
Euro-American males	St = 938 + 12.8 (Met5F)	57	.60	72.2
Euro-American females	St = 900 + 12.3 (Met5F)	49	.63	63.3
Afro-American males	St = 761 + 14.7 (Met5F)	9	.72	68.0
Afro-American females	St = 979 + 10.2 (Met5F)	7	.75	47.4
Fifth (total)				
Combined data	St = 768 + 12.8 (Met5)	128	.73	71.2
All males	St = 952 + 10.6 (Met5)	68	.63	70.9
All females	St = 922 + 10.2 (Met5)	58	.61	63.6
Euro-American males	St = 912 + 11.2 (Met5)	57	.63	70.3
Euro-American females	St = 905 + 10.6 (Met5)	49	.60	64.9
Afro-American males	St = 846 + 11.5 (Met5)	9	.76	64.2
Afro-American females	St = 891 + 10.2 (Met5)	7	.78	45.2

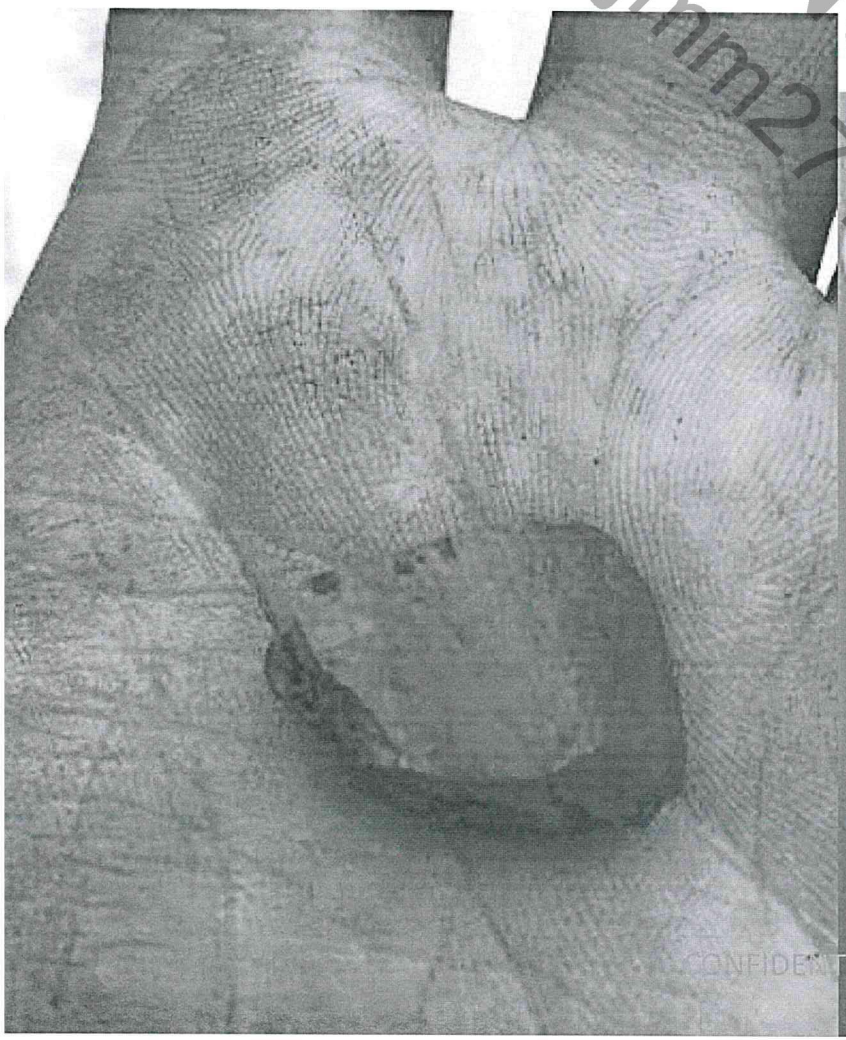
Fragment #4

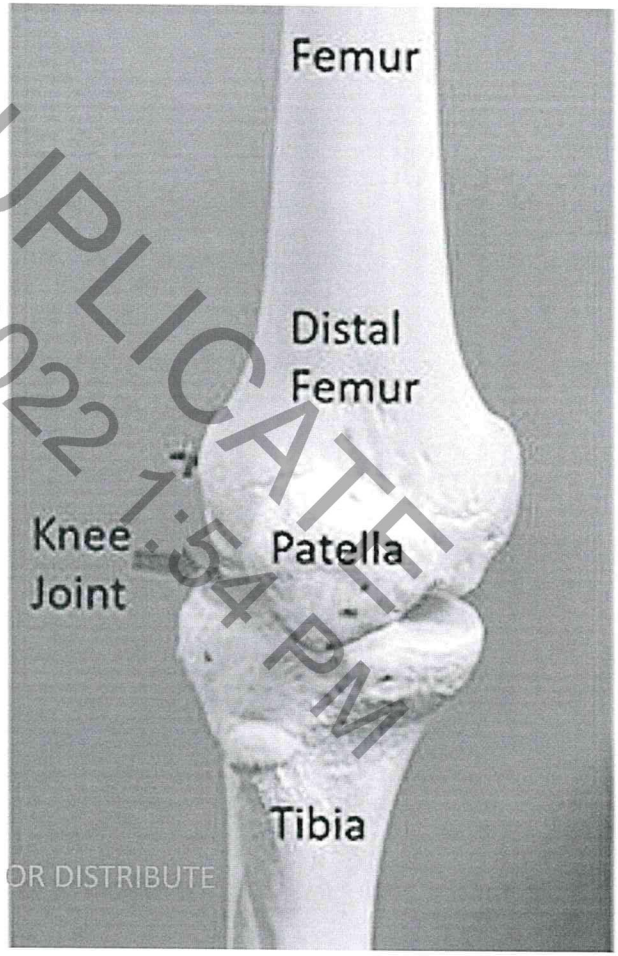
Femoral Shaft

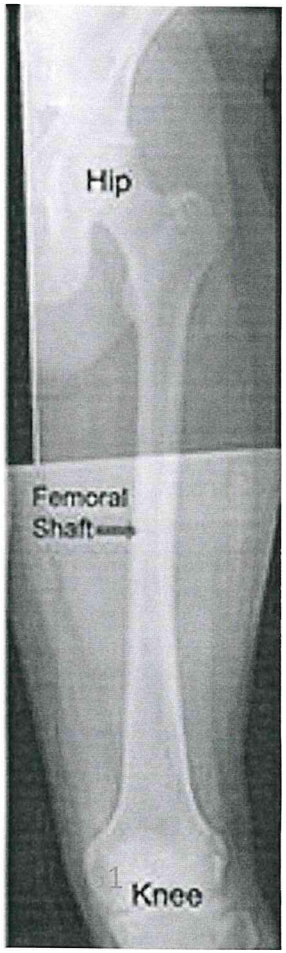
Perimortem Blunt Force Fractures

Perimortem Thermal Damage

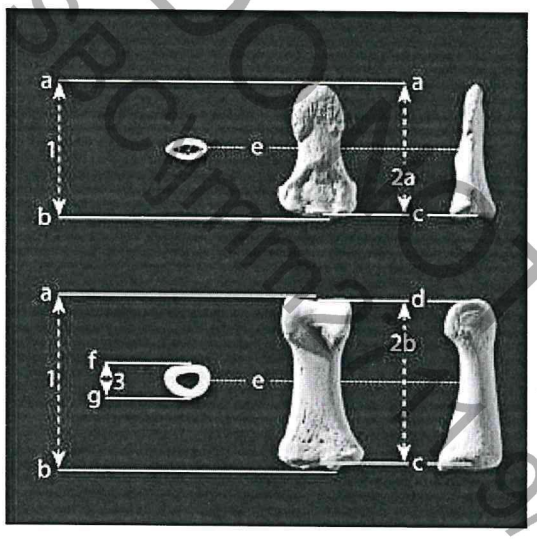
- Color = 900 F
- Electrocution → fracture

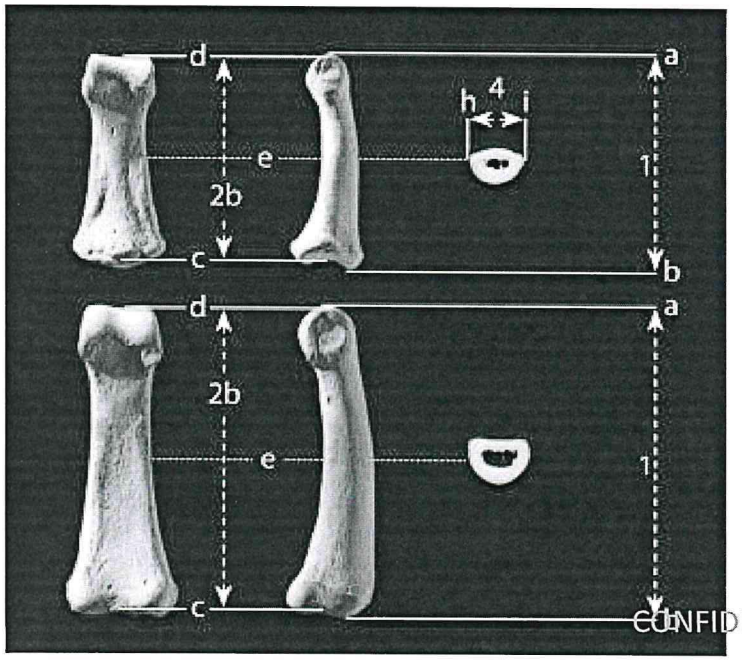


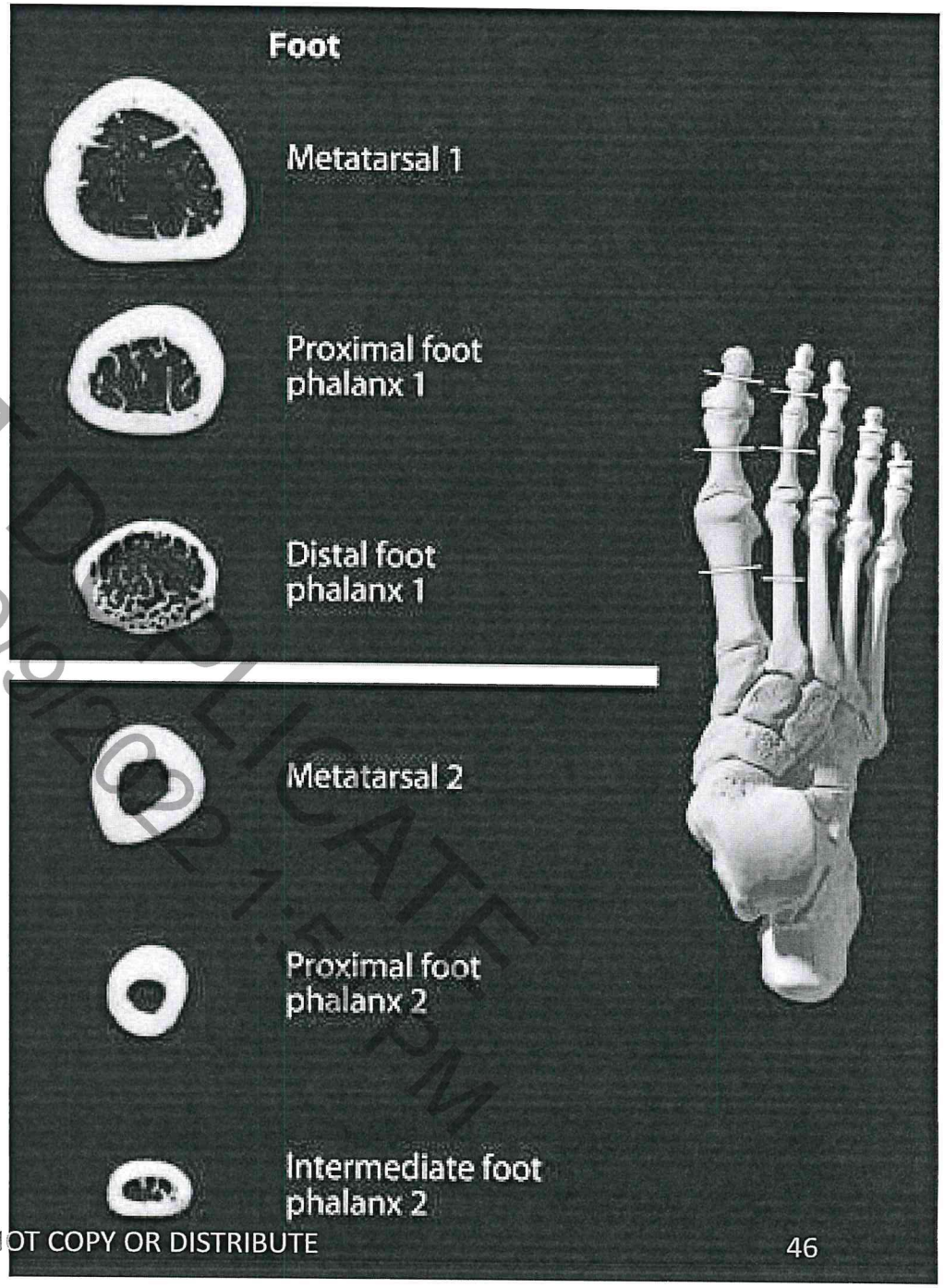




toe bone (more error)
stature: 5’ 9” – 6’ 1”







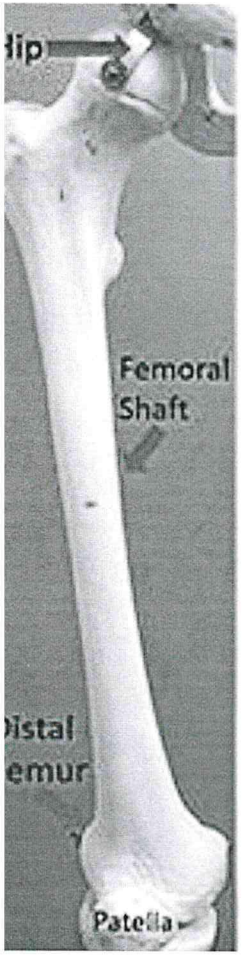
Knee region – metaphysis

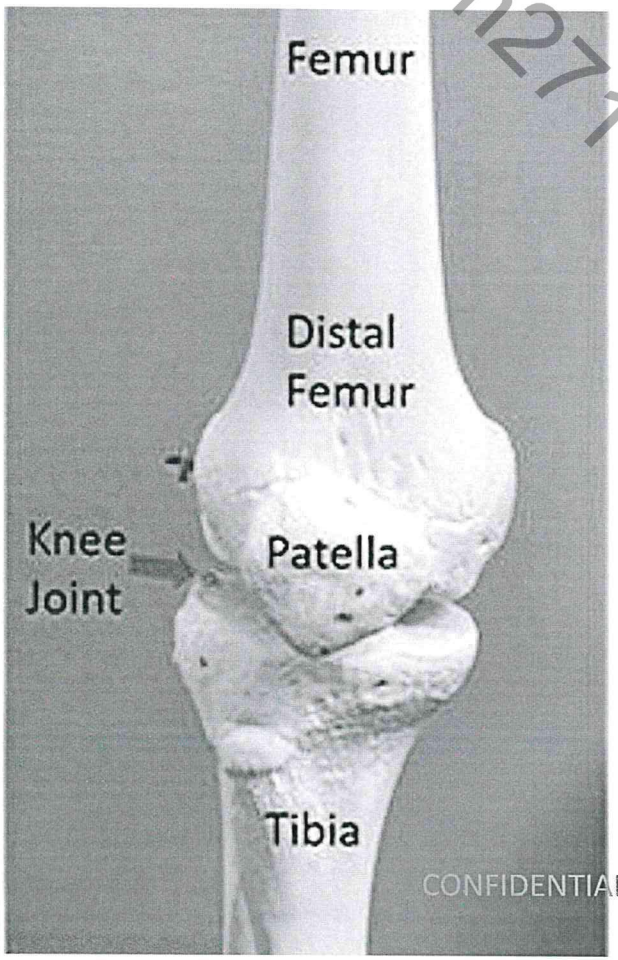
Woven Bone

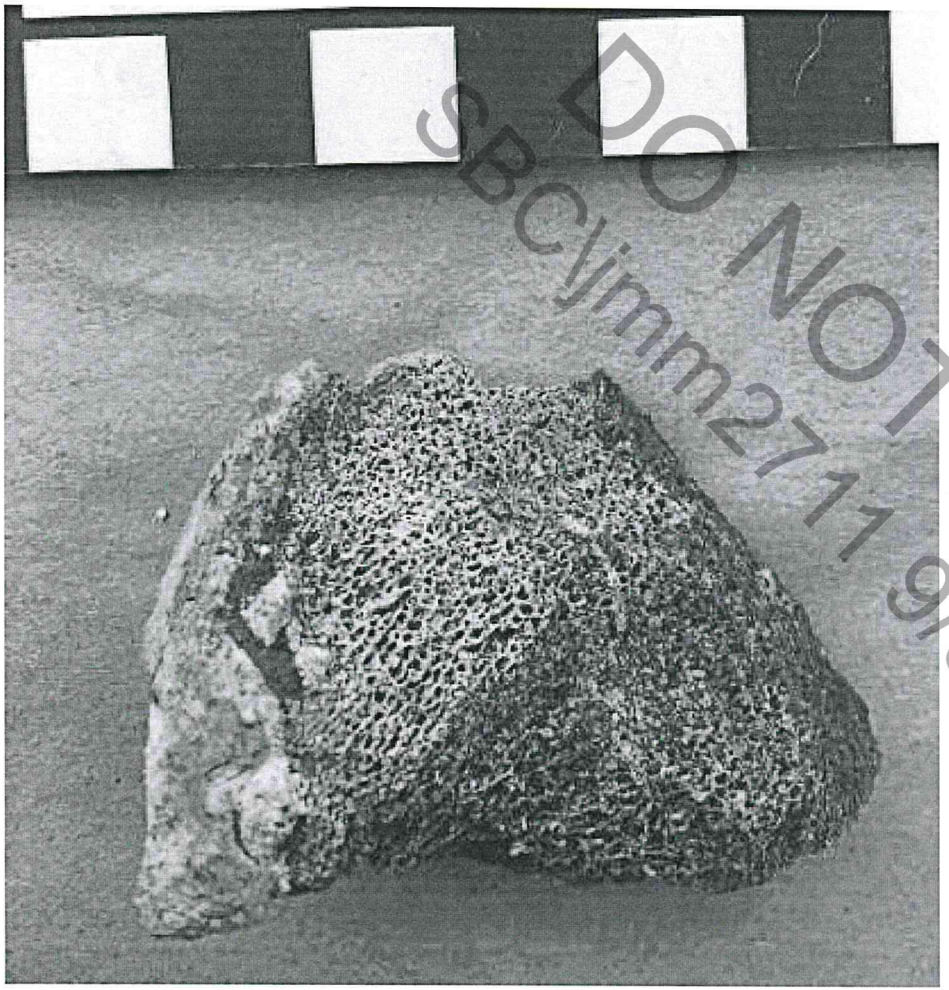
Thermal Damage (color & fracture)

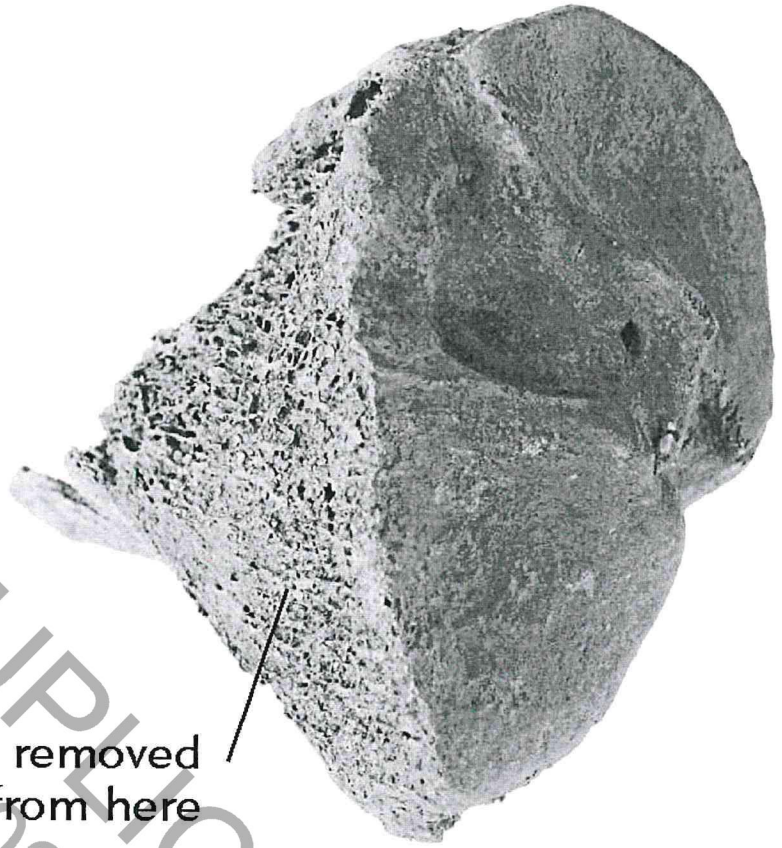
Brittle (acidic soil dissolved organic material)

Fragment #3









e removed
from here

Thorsten Schwark; Anke Heinrich; Andrea Preuße-Prange; Nicole von Wurmb-Schwark (2011). *Reliable genetic identification of burnt human remains. , 5(5), 393–399.* doi:10.1016/j.fsigen.2010.08.008

other tibia for comparison

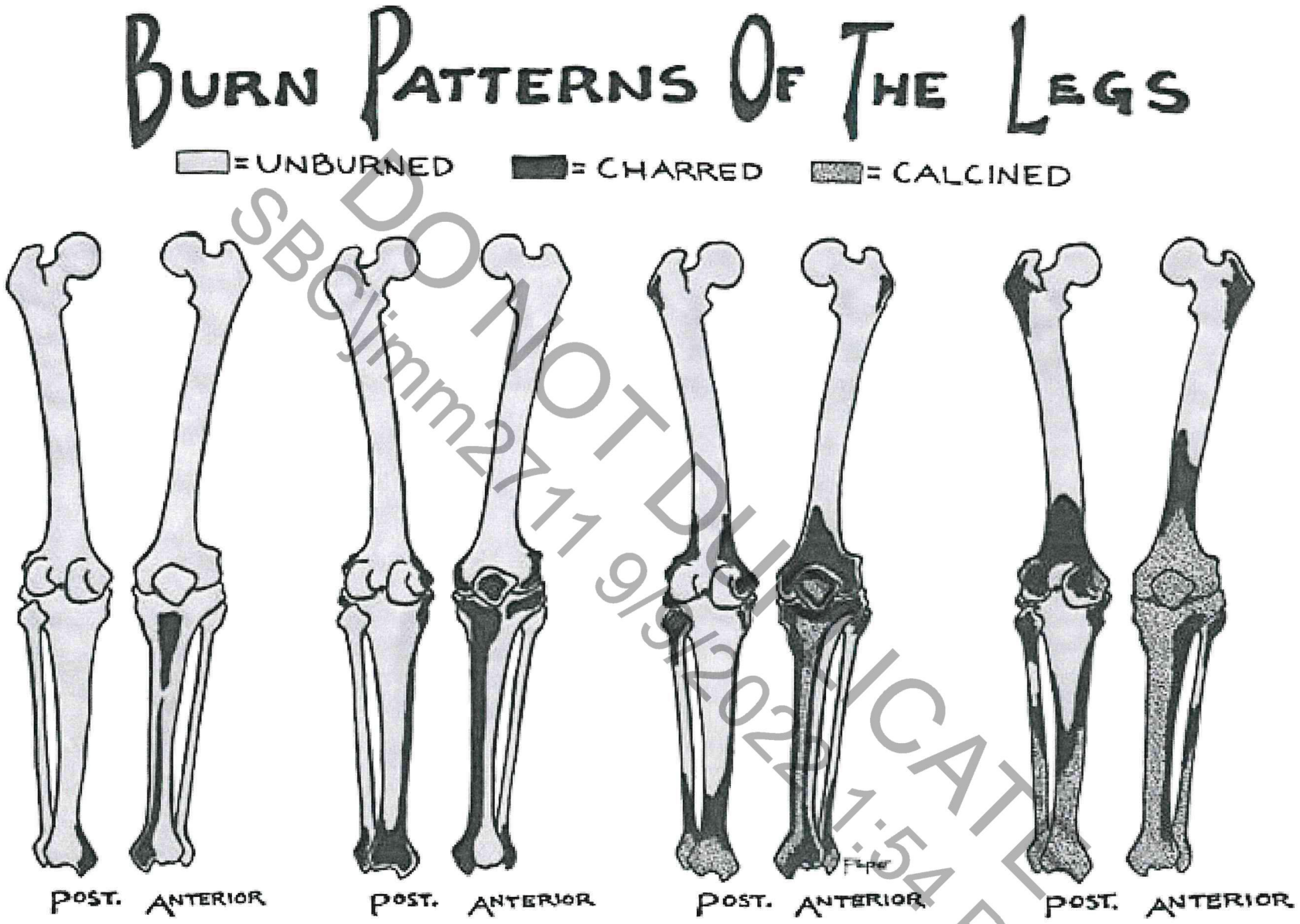
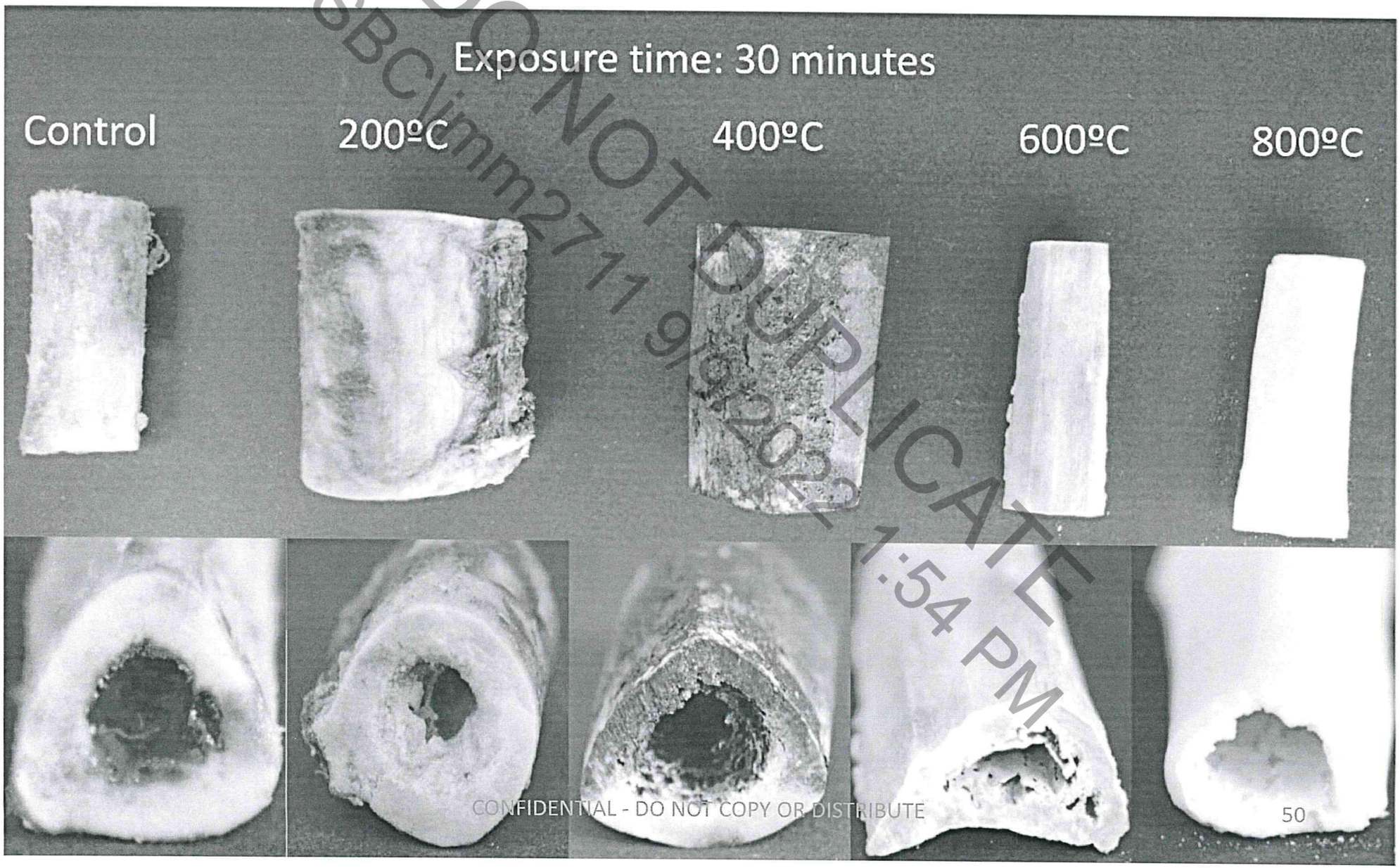


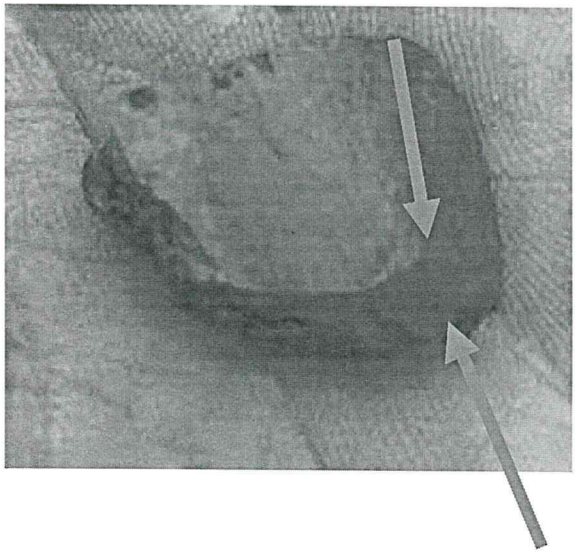
FIGURE 13.24 Burn patterns of the anterior and posterior legs with differential exposure sites of bone in areas of thin soft tissue protection, while other surfaces remain protected by muscle

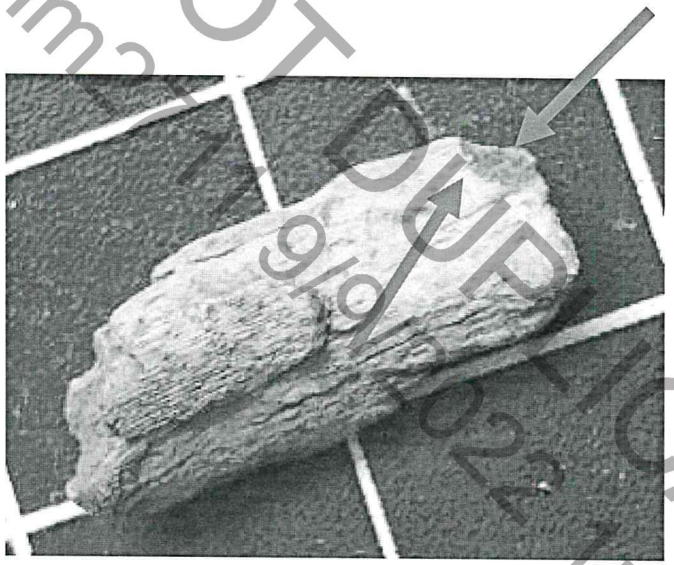
(Image courtesy of Elayne Pope)

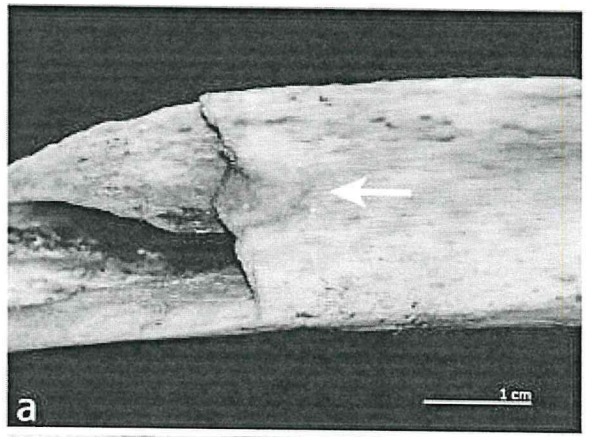
Heat induced color changes

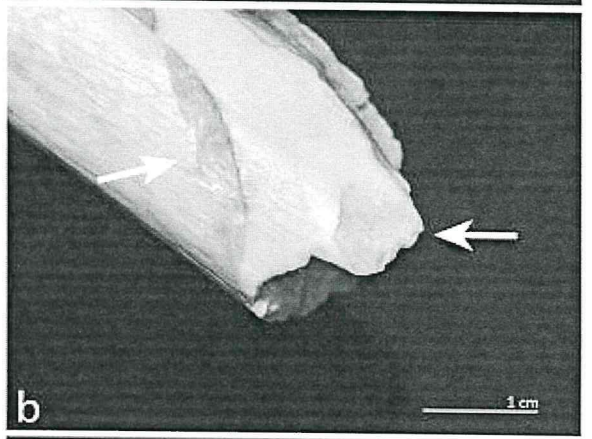


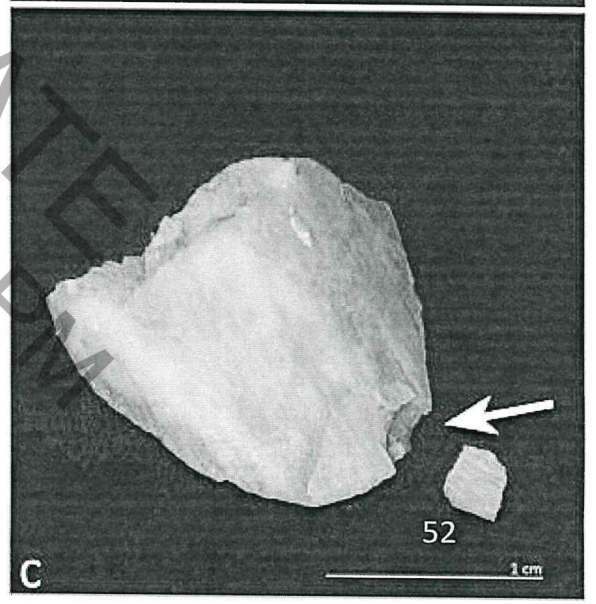
Peri Mortem Trauma
FROM BLUNT FORCE & HEAT











Perimortem Blast Trauma

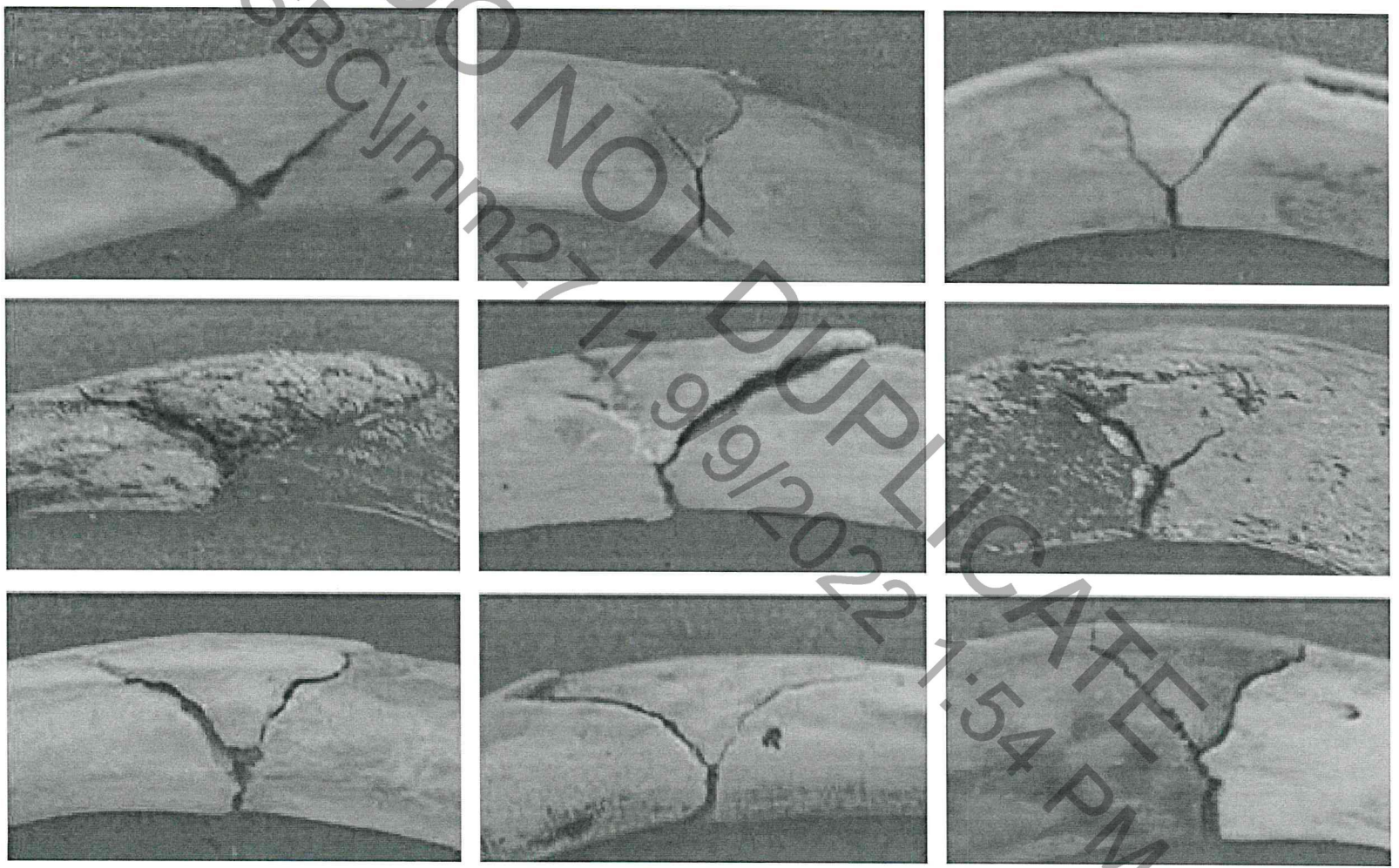
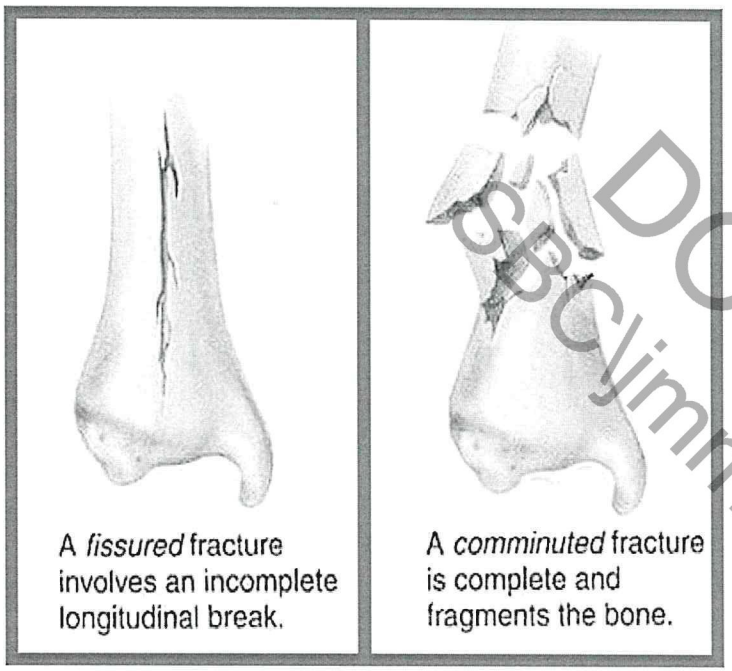


FIGURE 13.29 Butterfly fractures in ribs resulting from blast events

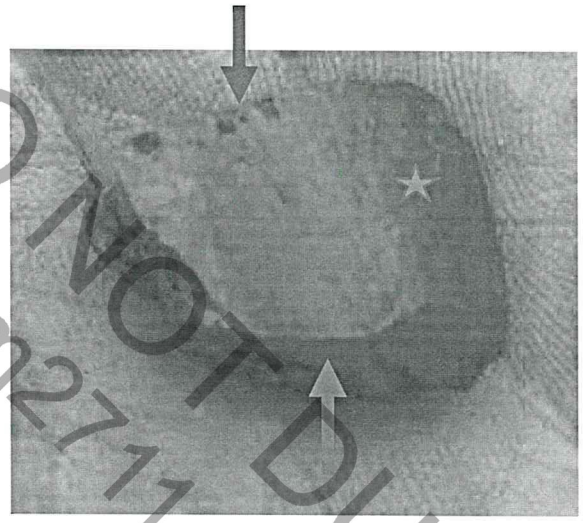
(From Christensen and Smith, 2013)

Heat-induced fractures



A *fissured* fracture involves an incomplete longitudinal break.

A *comminuted* fracture is complete and fragments the bone.



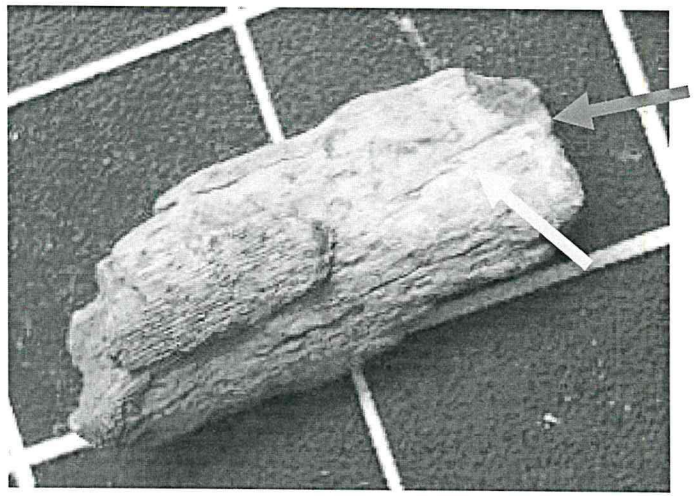


Table 13.2 Heat-induced fractures

Fracture type	Fracture characteristics
Transverse fracture	Fracture occurring transversely in long bone shafts as a function of the bone structure weakening and failing from heat alteration
Curved transverse fracture	Half-moon shaped fractures which occur in long bone shafts as the soft tissues shrink and pull back from the bone; these fractures are indicative of direction of fire progression
Step fracture	Fractures extending transversely from a longitudinal fracture across a long bone shaft
Patina ★	Superficial micro-fractures which often have a mesh or spider-web appearance

Fractures from electrocution

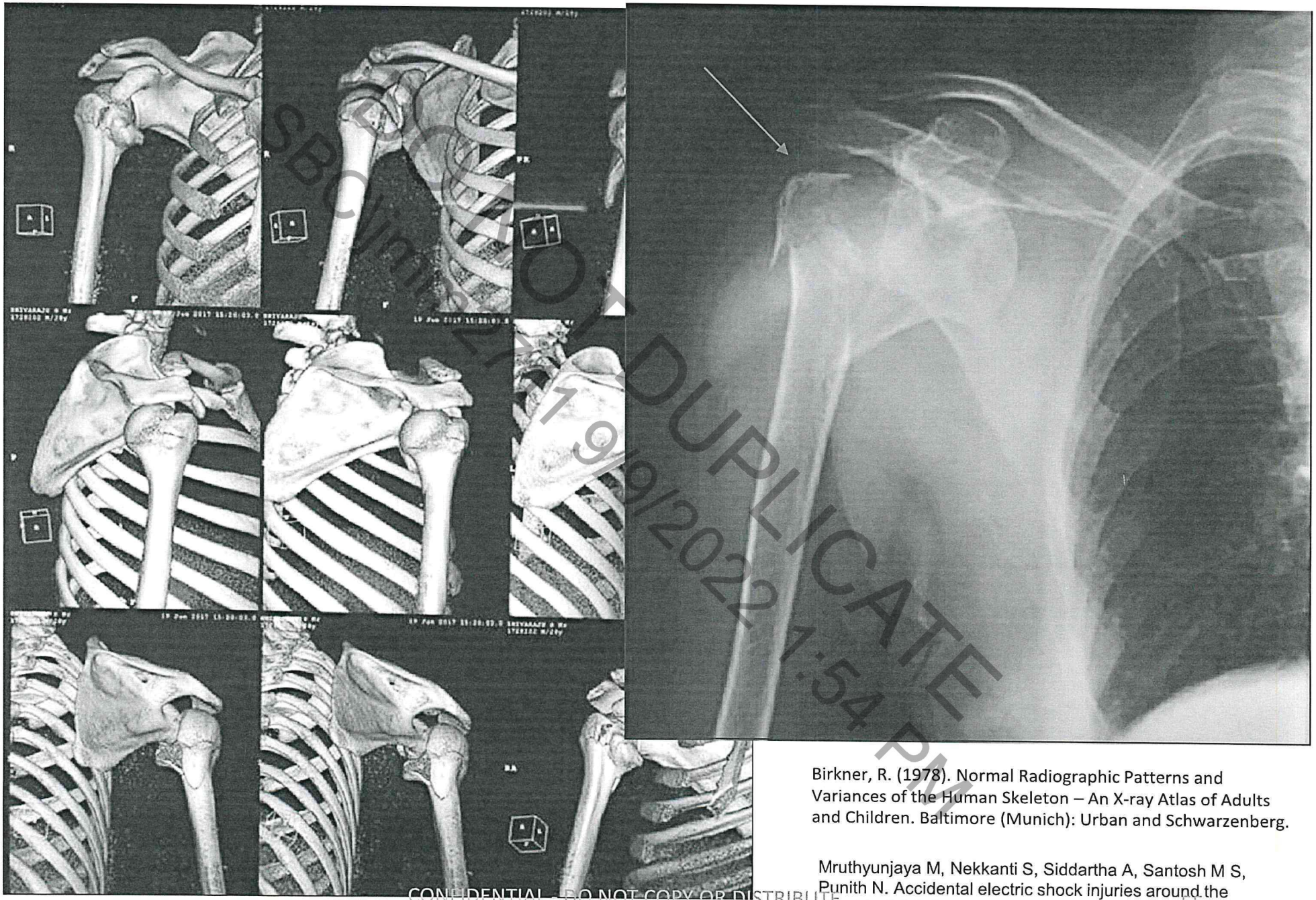


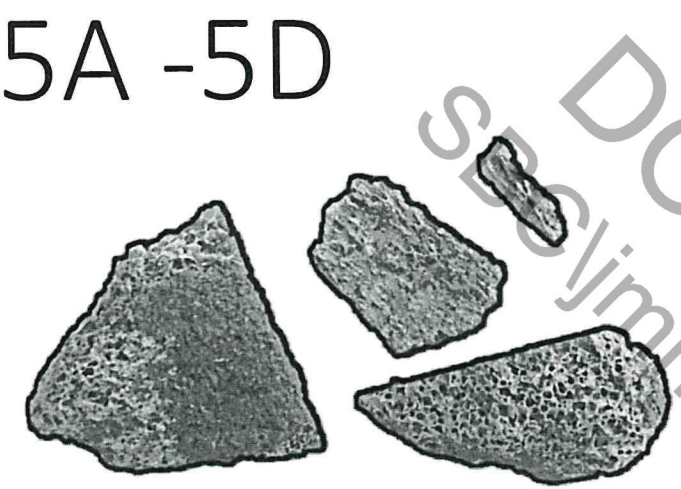
Figure 3c: Preoperative computed tomogrpahy photographs of Case 1

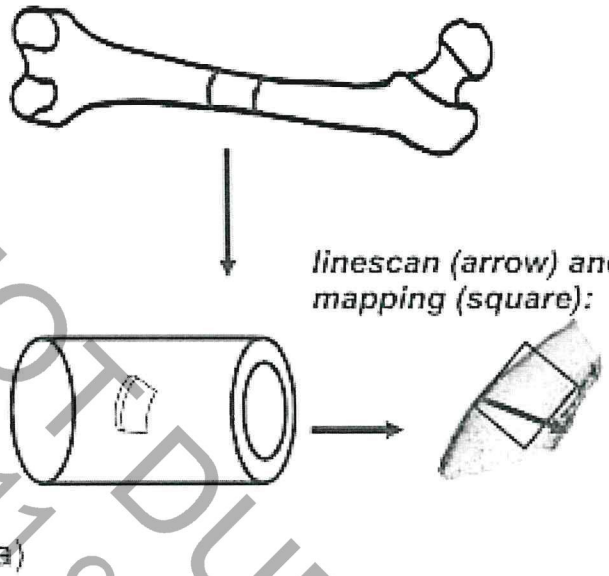
Birkner, R. (1978). Normal Radiographic Patterns and Variances of the Human Skeleton – An X-ray Atlas of Adults and Children. Baltimore (Munich): Urban and Schwarzenberg.

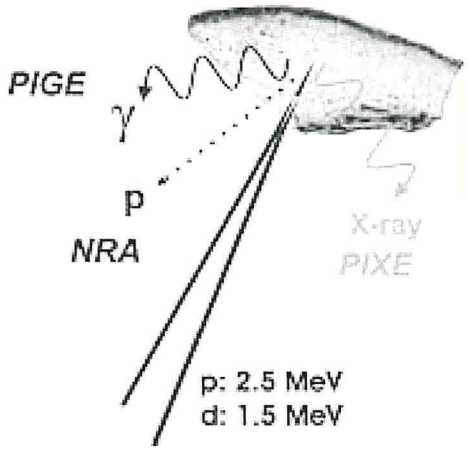
Mruthyunjaya M, Nekkanti S, Siddartha A, Santosh M S, Punith N. Accidental electric shock injuries around the shoulder joint: A case report of two patients. Niger J Orthop Trauma 2018;17:34-9

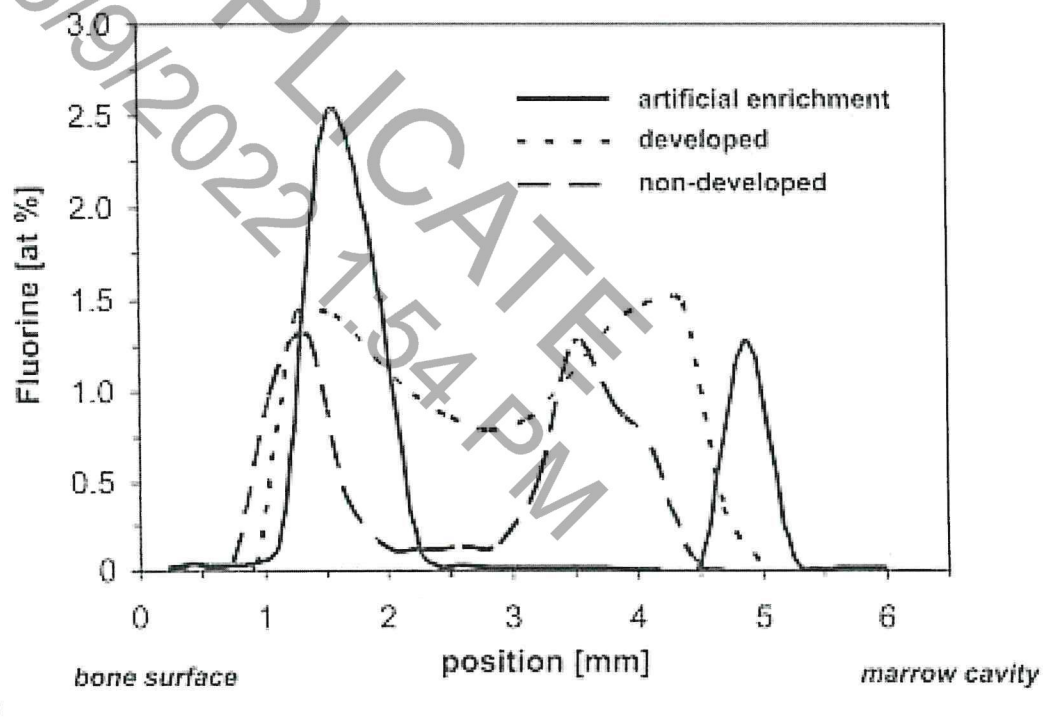
Fragments
5A -5D

Flourine Absorption Dating









Human (C)remains
Legal Rights & Responsibilities

Local law enforcement agencies may occasionally come into contact with cremated human remains, bones or tissue specimens.

Cremated Remains

Pursuant to section 7104 of the Health and Safety Code, the law enforcement agency with the possession of the cremated remains should initiate a found property report and attempt to return the remains to the next of kin or rightful owner by performing a reasonably diligent search for the next of kin or rightful owner.
Only after a reasonably diligent search has been performed and the next of kin or rightful owner is not located, shall the law enforcement agency notify the Medical Examiner-Coroner. The law enforcement agency will contact the Coroner to schedule an appointment whereby the remains and the found property report may be transferred to the custody of the Coroner.

Skeletal Remains / Miscellaneous Bones

Bone appearing human should be reported to the Coroner immediately. If the apparent human bones are still in the place of discovery, the Medical Examiner-Coroner will determine the extent and timing of the response. The Coroner will dispatch an experienced Special Operations Response. team member to make an assessment of the scene and the resources necessary for a successful recovery. In some case the Coroner may determine there is no reason to hold the original place of discovery, therefore the bones may be brought to the Forensic Science Center if prior arrangements have been made with the Coroner Watch Commander. Skeletal or disarticulated remains will not be recovered by the Coroner personnel in open / outside areas during hours of darkness using artificial light. The location should be marked and arrangement made to conduct an organized and thorough response the following morning.

SUMMARY SLIDE

- MAPPING, INTERVIEWS, SURVEY, SEARCHES
- DEBRIS MOUNDS CREATED THRU MOVES NORTH OF H.S. RD.
  - ARTIFACTS IN MOUNDS ARE ALL DISASTER-RELATED
  - ALL TOPSOIL - NO EVIDENCE OF CHUMASH
- ARTIFACTS ASSOC. W/ JACK & CANTIN HOME
  - BOXER BRIEFS, PRIVACY GLASS, BATHROOM TILE, ETC
  - CARPET CAPTURED ARTIFACTS LIKE A NET
- 4 FRAGMENTS OF BONE
  - SNOW'S REPORT IS PROBLEMATIC & SHOULD BE DISCOUNTED
- BONE EVIDENCE:
  - IT IS BONE
  - IT IS HUMAN
  - ALL FROM SAME (LOWER) LIMB (KNEE-SHIN-ANKLE-FOOT)
  - IT WAS DEPOSITED OVER ~3 YRS AGO
  - BONES HAVE BEEN LEECHED OF ORGANIC COLLAGEN & CONTAMINATED BY WASTE
  - BONE COLORING & CRACKING INDICATE PERI-MORTEM THERMAL SHOCK
  - BONE FRACTURES INDICATE HI-IMPACT PERI-MORTEM BLUNT FORCE POLY-TRAUMA
  - CAUSE OF DEATH: BODY WAS PULVERIZED & ELECTROCUTED
- UNIQUE IDENTIFIERS FOR PRESUMPTIVE ANALYSIS
  - FRAGMENT 1: SHIN SPLINTS – ATHLETIC (RUNNING, MNTN BIKES, SOCCER) (CHUMASH ARE SEA PPL)
  - FRAGMENT 2: NO GROWTH PLATE = 16-19 YEAR OLD; STATURE: 5' 9" – 6' 1" (CHUMASH ARE SHORT)
- MEETS BURDEN OF PROOF – PREPONDERANCE OF EVIDENCE STANDARD (50.01%)

Where we Are & Next Steps

- Individual Profile consistent w/ Jack – Preponderance of Evidence

- DNA → risks & diminishing rewards

- Excavate all Margolis mounds
- Excavate area around Augies
- Excavate Wyant

More about DNA

BOX 14.5 NUCLEAR AND MITOCHONDRIAL DNA COMPARISONS IN IDENTIFICATION

Nuclear DNA (nDNA) and mitochondrial DNA (mtDNA) are both used in forensic examinations for identification, each having advantages and disadvantages based primarily on the frequency of each type of DNA in the general population (and therefore its evidentiary value in identification), and copy numbers within the body's cells (which affects the ability to obtain a DNA profile from a sample).

nDNA is inherited from each parent and is considered to be unique to each individual (except for identical twins). In nDNA analysis, however, the entire genome is not examined. Most of the human genome is exactly the same in all individuals, with only a fraction of a percent of nDNA varying from person to person. Forensic scientists examine only these variable regions. Typically around 13 regions or **loci** that are highly variable are examined, and there is a very small chance that two people will have the same nDNA profile for all of these regions. mtDNA, on the other hand, is inherited only from the mother, and an individual therefore shares the same mtDNA with all maternal relatives. A particular mtDNA profile is therefore much more common in the general population than a nDNA profile. While not unique, mtDNA analysis can be very useful in missing persons investigations.

In order to perform a forensic DNA analysis, DNA must be extracted from the sample and amplified. There is only one full copy of nDNA in each cell, located within the nucleus, while mtDNA is located within the mitochondria of cells, and there may be thousands of mitochondria in each cell. An individual therefore has many, many more copies of mtDNA than nDNA. It is much easier to obtain a full mtDNA profile from smaller samples, and even from degraded or deteriorated samples including very old bones and teeth.