

TITLE A REEVALUATION OF THE HEAD WOUNDS IN
THE ASSASSINATION OF PRESIDENT JOHN F.
KENNEDY: EVIDENCE OF A SECOND GUNSHOT

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ABSTRACT

The purpose of this paper is to reevaluate the evidence in regard to the wounds sustained to the President's head during his assassination. The author provides an analysis of the head motion and skull fragments based on a previous independent optical study of the photographic record of the assassination, the postmortem radiographs, and the photographic and radiographic records related to the skull fragments recovered from the assassination. This data establishes that a second shot, fired from the front, struck the President's head a fraction of a second after a bullet from the rear.

In 1975 the ITEK corporation performed a photographic analysis of the Zapruder film. Their study dealt with the double motion of the President's head and the particulate matter ejected from it. ITEK concluded a single shot from behind based on the forward movement of four major particles on initial frames of the film. This is challenged by the documentary record of five skull fragments having been recovered. This study photographically identifies a fifth large skull fragment being ejected backwards from the rear of the head on later frames not evaluated on the ITEK study. An anatomic evaluation of a portion of suture contained in the large fragment, which dictates it must be sagittal, is used to confirm the rear origin as seen on the film. Both documentary and radiographic evidence is provided showing that this fragment bore a portion of an exit hole and establishes the presence of a second exit wound in the President's head. This second bullet, which originated from the front of the motorcade a fraction of a second after another bullet from behind, was the cause of the delayed backward component of the head motion and establishes conspiracy in his assassination

While watching the parade in which President Kennedy rode, Abraham Zapruder's home movie captured the assassination on film. His Bell and Howell camera ran at 18.3 frames per second, registering the tragic events every .054 seconds. This gruesome photographic record shows that upon a bullet's impact, the head was forced just two inches forward and exploded. Then a few frames later it violently reversed direction and slammed him against the car's back seat.

This double motion of the President's head has been the source of some controversy as to the probable cause or causes. Many eyewitnesses to the assassination reported hearing two nearly simultaneous shots at the time the head was seen to explode. Therefore, much of the debate has centered on whether one bullet could be responsible for this double movement or if two bullets might have struck sequentially, first from the rear and then a fraction of a second later from the front.

Although a discrepancy exists between the original autopsy team (1) and subsequent reviews of the autopsy materials (2,3) as to precisely where a bullet entered the rear of the skull, to date no findings have been described to support a second bullet striking the head as the cause of the backward motion. Because both the prosecutors and subsequent reviewers of the autopsy materials agree that only one shot struck the head, several causes for this backward thrust have been postulated. The experimental studies of Lattimer and Alvarez, predicated on one gunshot wound to the head, found that it is possible to cause objects to move backwards from a single shot entering from behind (4,5).

In 1975 ITEK corporation, a renowned optical analysis firm, did a detailed study of Zapruder's film. This analysis addressed both the head motion and the particulate matter

ejected from it. ITEK's search for skull fragments stopped at frame 316 after having visualized all the particles that were displaced by the initial head burst. Compelling evidence will be provided from an anatomical analysis of all the skull fragments recovered from the assassination, the postmortem skull radiographs and an evaluation of later frames of the Zapruder film that leads to the revolutionary conclusion that two sequential gunshot wounds struck President Kennedy in the head.

THE ZAPRUDER FILM AND ITEK STUDY

Using a first generation copy of Zapruder's film, ITEK outlined the President's head and shoulder as well as the major particles. They then measured the position and sizes of the particles, beginning on the initial impact of the bullet at the 312th frame of the film. These outlines were then traced and digitized. Their study of the particulate matter involved spectral filtering to define the size and shape of the particles, as well as spatial filtering to sharpen the blurred edges.

This enhanced version of the film allowed ITEK to quantify the motion and conclude that two separate impulses acted upon the President's head (6). The initial impulse, or forward acceleration, occurred at Zapruder frames 312-313, while the second acceleration, was initiated at frames 315-316. This second acceleration was not only greater in magnitude but backward. In each case the head lead the motion. This continued until frame 323 when the President's backward momentum caused his body to bounce forward off the rear seat cushion.

ITEK's analysis of the particulate ejecta found four major particles which held together during flight and an omnidirectional spray of fine particulate matter near the head on the two frames immediately following impact. Two of the major particles arose from the

front of the head and flew forward, up and out of the limousine. ITEK concluded that these were skull fragments due to their cohesiveness during flight and calculated their speed at approximately 87 m.p.h. (Figure 1). This is supported by documentary evidence of two skull fragments recovered from the scene (7).

Two additional smaller cohesive particles, first identified on frame 314, were directed down into the limousine (Figure 2). These particles traveled an order of magnitude slower than the other two previously identified major particles. While ITEK did not offer a specific conclusion as to the nature of these two particles, three skull fragments were recovered from the interior of the limousine.

THE RECOVERED SKULL FRAGMENTS

In total, five fragments of skull were recovered in and around the President's open topped car. Of these, two were found outside the limousine. The first found was retrieved from the street minutes after the assassination and mentioned in the Warren Commission testimony of Dallas County Deputy Sheriff Seymour Weitzman (8). The second was not discovered until the following day when pre-med student Billy Harper found it in the grass near the south curb of Elm Street. This was forwarded to the FBI laboratory for analysis (Figure 3). Receipts were issued by the Secret Service upon their final disposition at the White House (7).

The three other fragments were found in the rear of the Presidential limousine on the evening of the assassination. These were sent to the autopsy pathologists who were still conducting the postmortem. At the hospital, three radiographic exposures of these fragments were taken in the x-ray department. Both the skull fragments and the radiographs were examined by the autopsy team. Of particular significance was the

largest of these three fragments which measured 10 X 6.5 cm. The autopsy report notes that in one corner external beveling was visible to the naked eye and that several metallic particles were detected radiographically at the same point (1)(Figure 4). These characteristics convinced the original autopsy team, as well as others (2,3), that this contains a portion of an exit wound. The roentgenograms disclose that one of the edges extending from the exit hole is 8 cm in length and has a portion of a cranial suture.

THE POSTMORTEM RADIOGRAPHS

In the initial stages of the autopsy, radiographs of the President's body were taken. Three exposures of the skull were made; an attempted AP and both right and left lateral views. Technically, the right frontal area is overexposed and as a result quite dark. The House Select Committee on Assassinations (1977-78) created optically enhanced versions of the AP and right lateral views (Figures 5,6). These reveal a confluent area of bone loss extending from the margin of the frontal exit hole, located 5.5 cm to the right and just anterior to the coronal suture, rearwards to near the posterior border of the right parietal bone. At the posterior margin of bone loss a 6.5 mm in diameter metallic fragment is present located some 10 cm above the external occipital protuberance (EOP). Fractures radiate from this impact focus inferiorly and laterally into the surrounding bone. Bone loss extends somewhat across the midline into portions of the left parietal bone.

Note is made of a transverse fracture of the right occipital bone located 3 cm above the EOP. This fracture, which has not been described in previous government reviews of these films, appears to interrupt the propagation of other fractures radiating out from the higher impact focus. No metallic particles are seen in the immediate vicinity of the transverse fracture.

DISCUSSION

ITEK arrived at the conclusion that a single bullet struck from behind because the four major particles they identified were all ejected forward. This conclusion is in error. A total of 5 fragments of bone were recovered whereas ITEK only identified four. More importantly, they failed to search later frames for evidence of this fifth skull fragment and where it might have originated.

The documentary record supports ITEK's identification of four major particles arising from the front of the head on frames immediately after the head explosion. The Harper and Weitzman fragments recovered outside the limousine are well documented. The two other smaller particles ITEK saw were directed down into the limousine. The radiographs of the three skull fragments found in the vehicle disclose that two were actually smaller than the Harper fragment. While correctly locating four out of the five skull fragments, the third fragment found in the limousine went unaccounted for in the ITEK study. This was a crucial error because this was not only the largest fragment but it also bore a portion of an exit wound in one corner.

ITEK evaluated frames 313-316 of the Zapruder film which only show fragments arising from the midparietal region anteriorly. This is established by the anatomic localization of the Harper fragment on the film. ITEK concluded that the two upward particles seen on frame 313 are skull fragments consistent with the documentary record. The Harper fragment demonstrates vascular foramina on its inner surface and can be localized in the midparietal bone (9). On frame 313 it is the more posterior of the two and is traveling on the steepest trajectory arising from its origin in the midparietal bone

(Figure 7). The Weitzman fragment, on the lower trajectory, had to arise forward of the Harper fragment in the more anterior parietal region. This landed in the street and was documented as being recovered within minutes of the assassination. Significantly, ITEK did not identify any other large particulate matter on these early frames and concluded its search on frame 316 having not identified the fifth and largest fragment.

This deficiency in number of fragments recovered can also be extended in to the visual record as well. ITEK did not identify any particulate matter emerging from the top rear of the head. Frames prior to 316 show that no skull fragments emerged from behind the Harper fragment. Postmortem photographs and radiographs demonstrate bone missing in this area near the crown of the head. ITEK failed to search frames after 316 for any skull fragments arising from the rear of the head which would account for the full extent of bone loss.

As the President's backward motion is reversed against the rear seat cushion, subsequent frames show an object which continues its backward motion out the head. This is seen on the trunk of the limousine and is white, cohesive, and retains its triangular shape. It has a distinctive right angle corner joined by a semielliptical convex third side(Figure 8).

Eyewitness accounts of this being skull are corroborated by the photographic and radiographic record. On comparison the object in both the film and on the radiographs has the same dimensions, shape and orientation(Figure 9). They are one and the same and represent the fifth piece of skull unaccounted for in the ITEK study. A sequence of frames shows it sliding smoothly across the rear of the limousine. These events were seen by Jacqueline Kennedy who retrieved it from the trunk. It was left in the rear of limousine to be later found and brought to the autopsy. It has been the consensus of the

autopsy team and subsequent reviews that this carried a portion of an exit wound in one corner. Identification of this fragment accounts for all five skull fragments which were recovered from the assassination and delineates the full extent of the damage in the rear of the skull as documented on the Zapruder film and postmortem radiographs. This establishes the presence of a second exit wound in the rear of the President's head.

The Zapruder film's photographic documentation of the large fragment arising from the rear of the head is validated by anatomic considerations inherent in the cranial suture it contains along one edge. A rearward origin of the fragment would predict that this is a portion of the sagittal suture. Given the pattern of bone loss, the only suture that could be incorporated into the large fragment is either coronal or sagittal. The edge of the large fragment containing the cranial suture and a portion of the exit hole is 8 cm in length. The frontal exit hole is approximately 5.5 cm to the right of midline and just anterior to the coronal suture. If the large fragment actually contained coronal suture this would project the 8 cm edge some 2.5 cm across the midline when related to the frontal exit hole. The absence of the bregma on the radiographs indicates that this fragment could not have originated from this forward position. By extending across the midline, it would have to include the sagittal suture terminating into the coronal. The fragment does not show two sutures forming the bregma but only one suture. The absence of this anatomic landmark dictates that this can not be coronal suture. The large fragment must bear sagittal suture and have originated from the right posterior parietal region just as the Zapruder film shows. ITEK's observations of the Harper and Weitzman fragments arising from just behind the coronal suture on frames 313-314, negates the possibility that this single large fragment of bone could have originated from this same area. Later

frames conclusively demonstrate the expulsion of the largest fragment from the rear of the head and its subsequent retrieval into the rear of the limousine where it was later discovered.

When the large fragment is correctly oriented along the sagittal suture, its corner bearing several metallic fragments coincides with the same location as another radiographically documented metallic fragment present at the edge of the intact right posterior parietal bone (Figures 5,9). The 6.5 mm metal fragment, as well as those in the corner of the large bone fragment, marks the point where a bullet struck the upper rear of the skull from inside out and forces the conclusion of a second exit wound. Both the postmortem skull radiographs and those of the largest skull fragment agree as to where this second bullet struck the skull to cause the backward motion. ITEK quantified this delayed, backward acceleration as being greater in magnitude and opposite in direction to the original forward acceleration at 313. A second sequential impact originating from the front would provide the large amount of force necessary, at the appropriate time, to cause the greater, delayed backward acceleration initiated on frames 315-316.

Having identified a second exit wound in the top rear of the head, attention was turned to the radiographs to search for any possible evidence of a separate entry hole that may have gone overlooked. A transverse fracture of the right occipital bone located just slightly above the EOP is described here for the first time which appears to manifest Puppe's phenomenon (10). This lower fracture is cited as evidence of an initial bullet's entry. An entry hole at this level is supported from several sources including the autopsy protocol (1), the sworn testimony of the prosecutors, their contemporaneous autopsy notes as well as Warren Commission illustrations (11). The autopsy report specifically states

that fractures radiated from the hole of entry located slightly above the EOP(1). This lower transverse fracture was created by the entry of a jacketed bullet similar to a 6.5 mm Mannlicher-Carcano round. The absence of metallic particles near this fracture is consistent with an entry created by jacketed ammunition. This bullet subsequently perforated just anterior to the right coronal suture. The impact focus higher in the rear, manifested by radiating fractures which are interrupted by this preexisting lower one, must be attributed to a second bullet which fragmented. The backward head motion and the presence of external beveling provide compelling evidence to indicate that this bullet originated from the front of the motorcade.

ALTERNATIVE EXPLANATIONS EXPLORED

Alternative explanations are possible for any given set of observations. Any theories based upon the entry of a single bullet would have to explain the presence of metal fragments and external beveling at the higher impact focus. Two theoretical explanations were considered and both were rejected for failing to account for all that is known.

One explanation which was postulated was the entry of a jacketed bullet creating the lower fracture which ricocheted off the frontal bone and fragmented in the process. It could be further proposed that the metallic particles might have reflected acutely backward causing extensive fractures with some remaining in the right posterior parietal bone. An internal ricochet, striking from inside, could then be responsible for the external beveling and metallic particles at the higher impact site. Internal ricochets may occur in as little as 10% of the cases and probably even less with the high velocity jacketed ammunition which was used in the assassination. The acute angle of reflection required in this case would be less likely as well. Internal ricochets are more commonly

associated with lead bullets rather than jacketed ammunition which is less likely to fragment and has a greater chance of perforating (12). The probability of an internal ricochet occurring in conjunction with bullet perforation is unknown. Moreover, bullet perforation in this case is proven. Two large fragments, weighing a total of 65.6 grains out of the original 161 grain bullet, were recovered from the limousine. Putting aside the consideration of the delay, the fact that the backward thrust was greater than the forward one eliminates a ricochet as a viable explanation for the head snap as some energy is always lost in reflecting off a surface.

Another possible explanation that was considered was the presence of an atypical entry wound at the higher impact focus in the rear of the head. External beveling at an entry site is not impossible and can be seen in a keyholed entry as described by Dixon (13). It can be theorized that a jacketed bullet struck and fragmented at a point 10 cm above the EOP and created an atypical entry wound with keyholing. This could explain the external beveling and lead in the corner of the largest fragment which is known to have arisen from here. In their Warren Commission testimony, the autopsy pathologists had the question of keyholing addressed to them and they gave a description of the entry wound incompatible with such an entry (11). This scenario also requires a jacketed bullet to uncharacteristically fragment extensively on impact.

A criticism central to any single gunshot theory is that none offer an adequate explanation for the delay in the expulsion of the largest fragment. Either a ricochet or an atypical entry wound would have immediately created fractures at the higher impact site. If these fractures were initially present when the temporary pressure cavity occurred, one would have expected that the isolated fragment of skull would have been ejected in the

initial explosion as the others were. While a reverse jet effect has been postulated as a cause, the studies of Lattimer and Alvarez demonstrate that had it actually played any part in the head motion, it should have manifested itself on the Zapruder film immediately. Frames 313 and 314 do not show any significant backward acceleration or the ejection of any skull fragments from the rear which means that there was no jet effect (Figure 10). The second delayed acceleration can be attributed to nothing else but a separate force. Such a force, different in magnitude and opposite in direction, can only be attributed to a second shot which eyewitness accounts have recorded.

SUMMARY

This diagnostician is compelled to conclude that the President was killed by two nearly simultaneous shots to the head, different in both origin and character. This is evident on the Zapruder film which shows two separate accelerations of the head in opposite directions and a two-step process of bone loss. This is further supported by a pattern of intersecting skull fractures and the manner of fragmentation of each bullet on the postmortem skull radiographs.

The evidence is most consistent with the first entry of a 6.5 mm jacketed bullet similar to, if not the same, ammunition known to have been fired at the rear of the President's motorcade. The second shot, fired a fraction of a second later, struck from the front. This bullet fragmented on impact, embedding metal particles in both the top rear of the head and the corner of the skull fragment it dislodged from this impact site.

Reluctantly, this clinician must find that the murder of President Kennedy was not the act of one man, as history has reported, but the result of a scientifically proven conspiracy.

Acknowledgments

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LEGENDS

Figure 1. ITEK's digitized outline of two large particles on frame 313 (Figure 3.3.16).

Figure 2. Compilation of all four particles ITEK identified (Figure 3.3.15).

Figure 3. FBI photograph of Harper fragment determined to have originated in midparietal bone.

Figure 4. Radiograph of three skull fragments recovered from rear of limousine.

Figure 5,6 Attempted AP and Right lateral postmortem skull radiographs. Arrowheads point to 6.5 mm metallic fragment. Arrows point to transverse fracture of right occipital bone slightly above EOP which appears to manifest Puppe's phenomenon.

Figure 7. Frame 313 of the Zapruder film. Harper and Weitzman fragments are identified. In the top rear of the head, the scalp remains in place and no particulate matter is seen arising from under this scalp.

Figure 8. Frame 328 of the Zapruder film. Largest limousine fragment (LLF) seen on trunk from where it was later recovered.

Figure 9. Enlarged radiograph of LLF showing its characteristics. The absence of the bregma indicates this is sagittal suture and thus directs the exit point to the top rear of the head.

Figure 10. Frame 314 of the Zapruder film shows intact scalp covering the top rear of the head. Had damage initially existed at the higher impact focus the underlying large fragment should have been expelled.

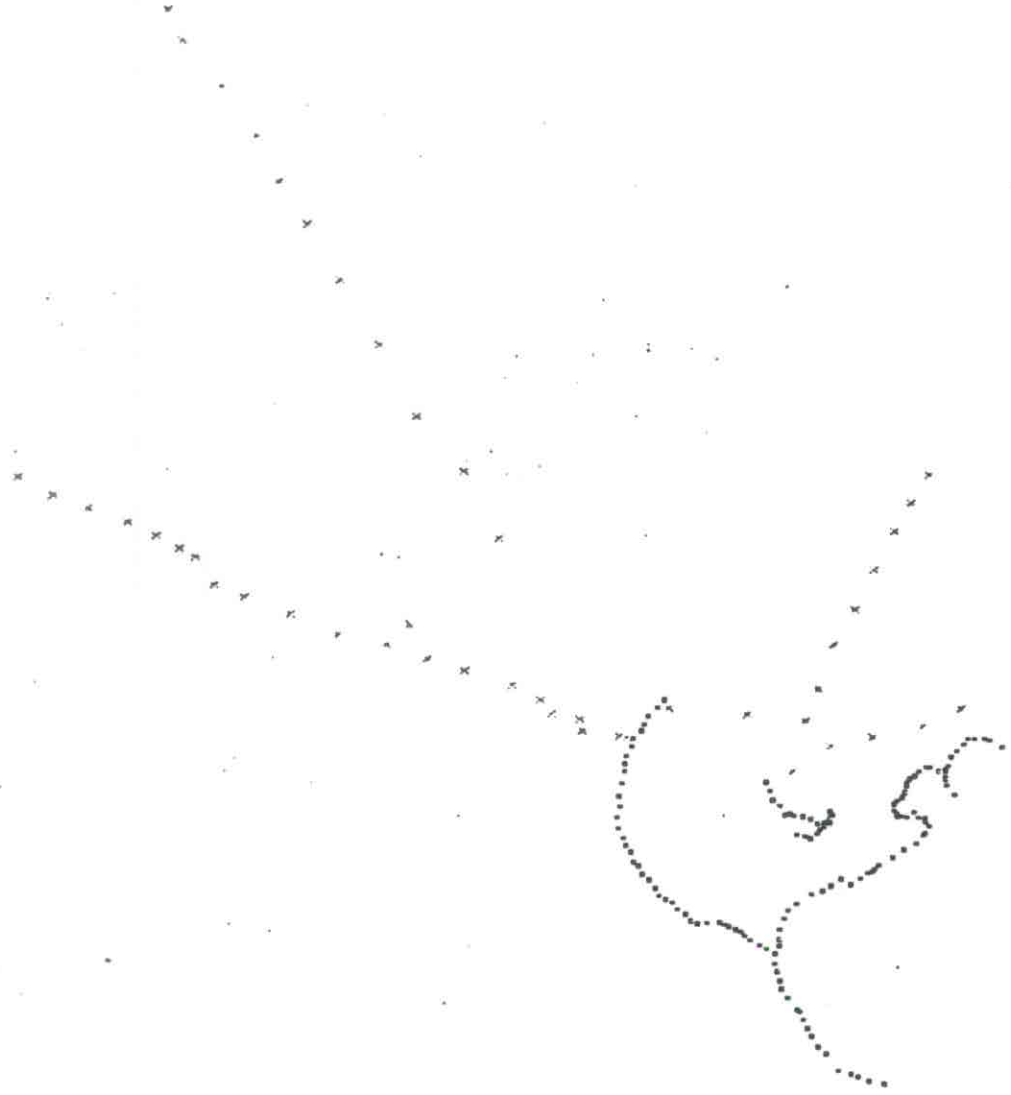
Figure 3.3.16

PRESIDENT KENNEDY FRAME 313
SHOWING EJECTED PARTICLES



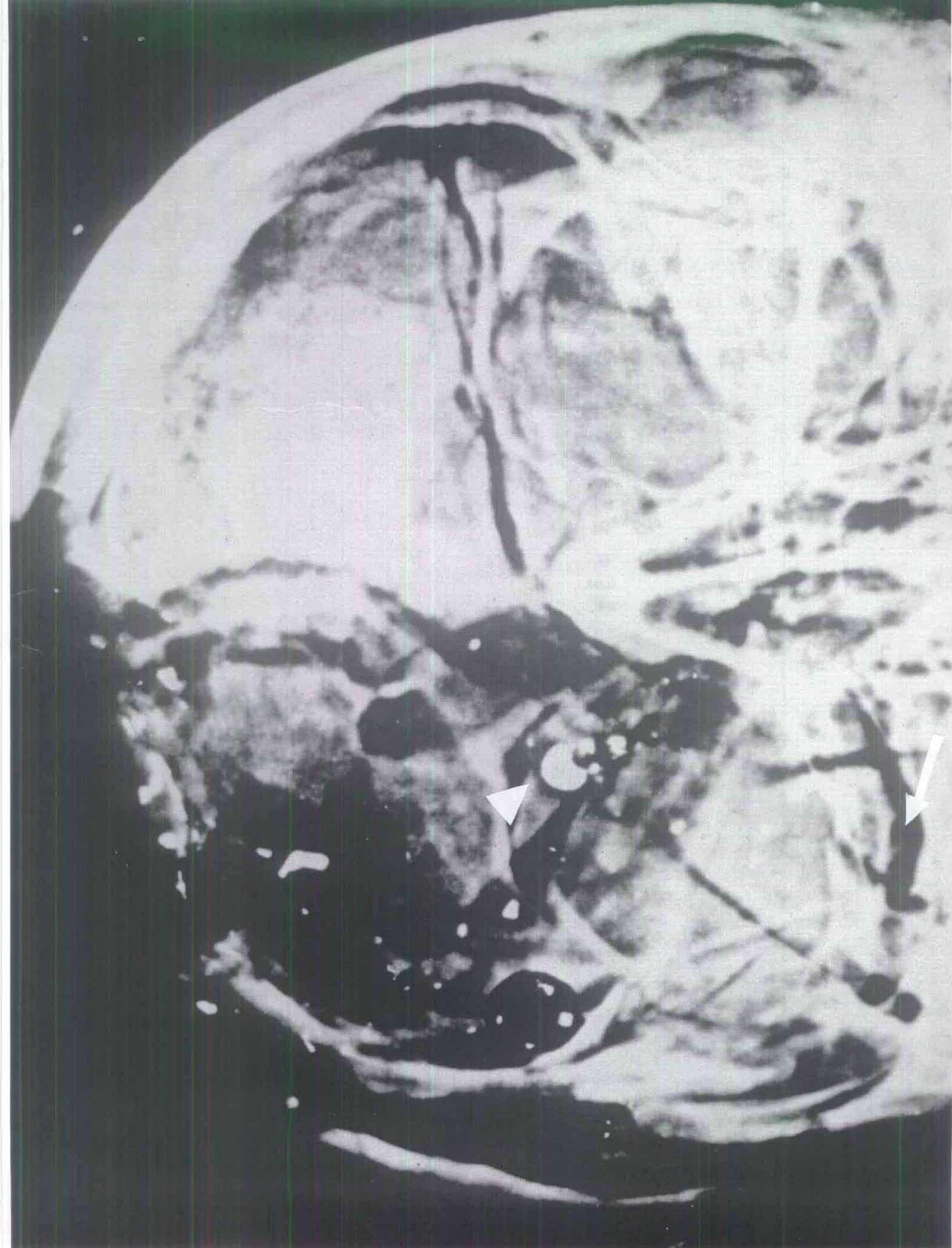
Figure 3.3.15

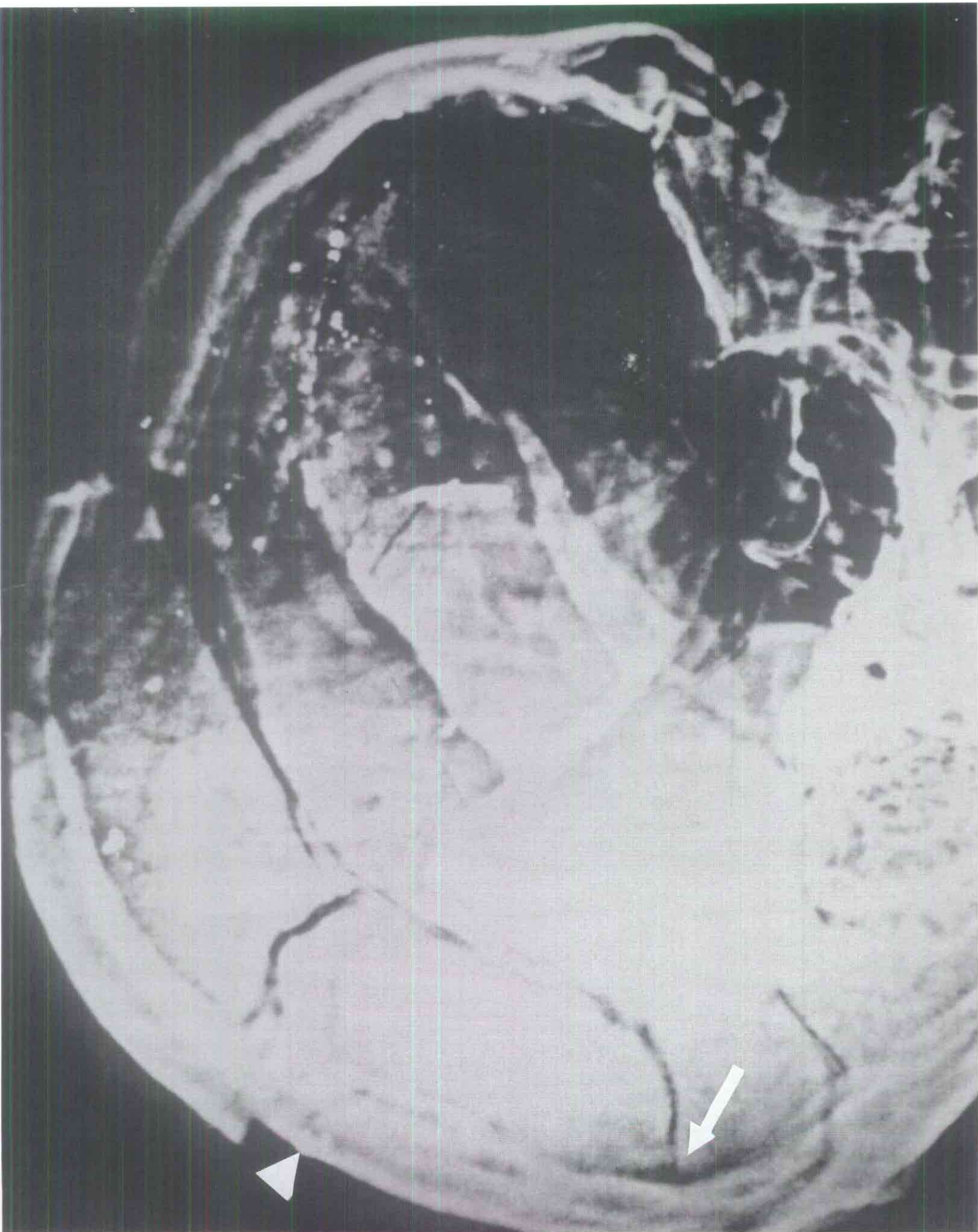
PRESIDENT KENNEDY, FRAME 313
TRAJECTORIES OF EJECTED PARTICULATE
MATTER FOUND ON FRAMES 313 & 314







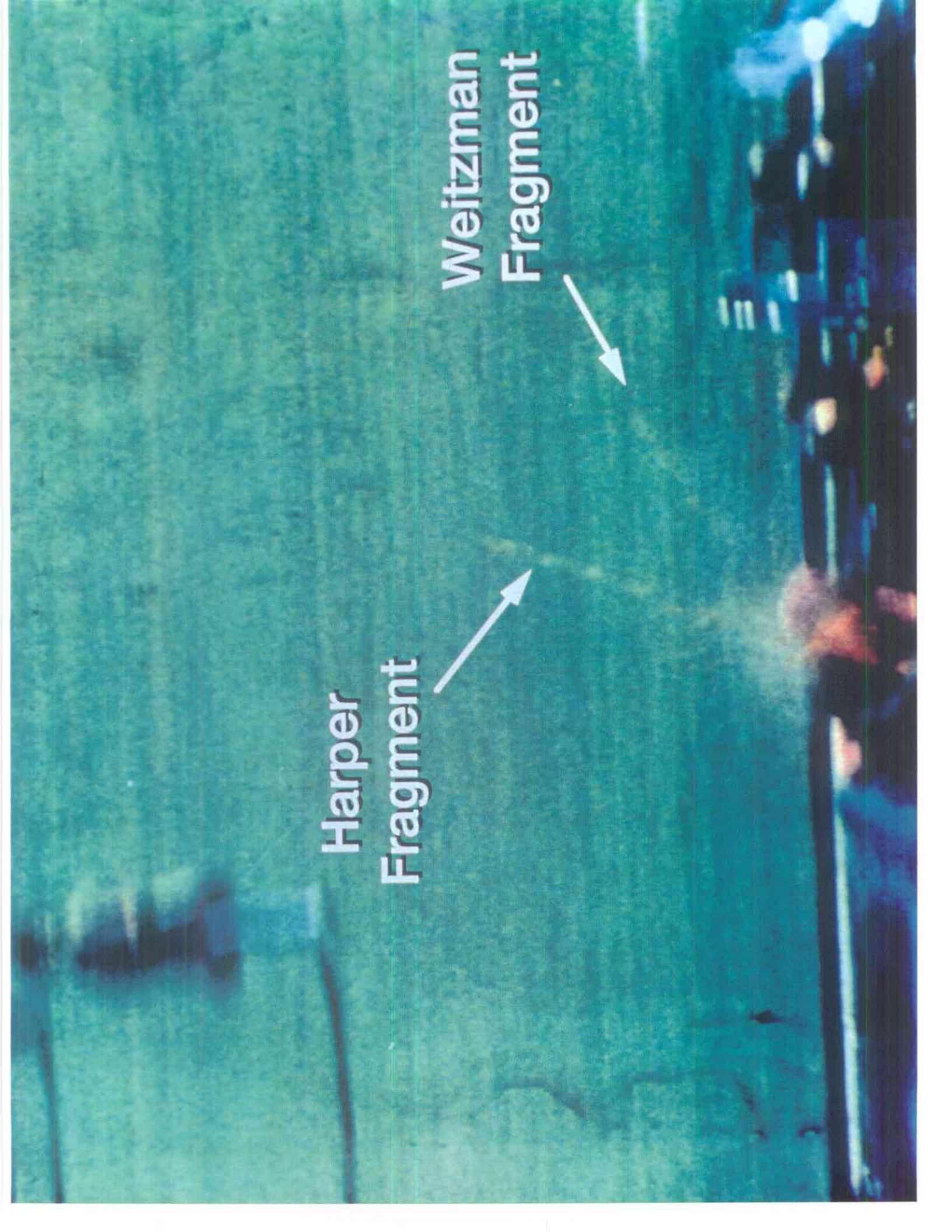




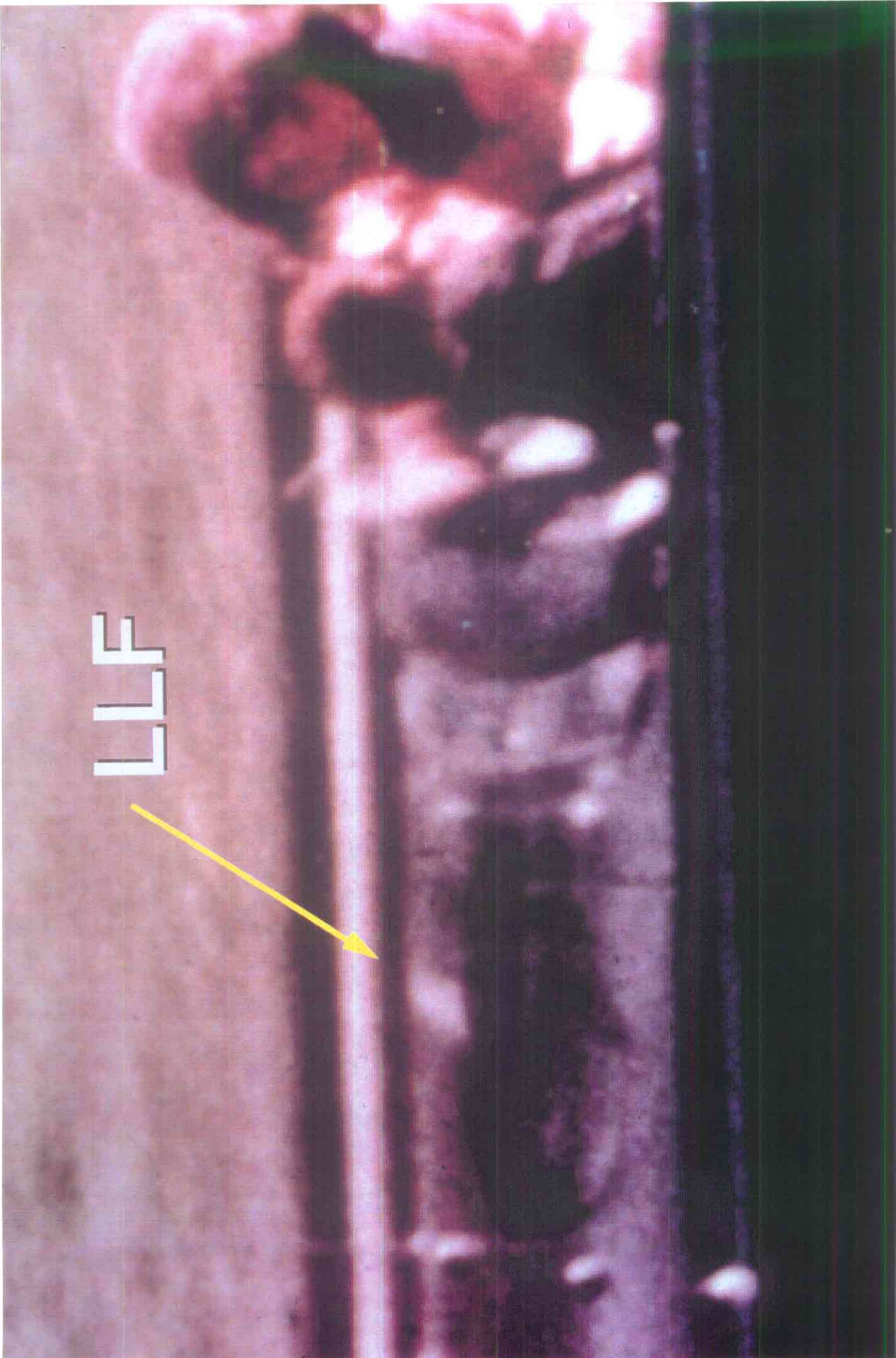
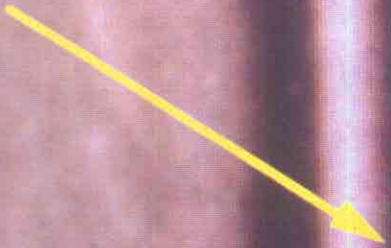
**Harper
Fragment**



**Weitzman
Fragment**



LLF



LLF

SUTURE



METALLIC PARTICLES /
EXTERNAL BEVELING

