

The Ruins of the Gas Chambers: A Forensic Investigation of Crematoriums at Auschwitz 1 and Auschwitz-Birkenau

Daniel Keren, Jamie McCarthy, and Harry W. Mazal

Combining engineering, computer, and photographic techniques with historical sources, this research note discusses the gas chambers attached to crematoriums at Auschwitz 1 and the Auschwitz-Birkenau death camp. Among other things, the authors identify the locations of several of the holes in the roofs through which Zyklon B was introduced: five in Crematorium 1 and three of the four in the badly damaged Crematorium II. The authors began their project before David Irving's libel suit against Penguin Books and Deborah Lipstadt, proceeding simultaneously with, but independently of, the trial. The defense presented the first version of the authors' report during Irving's subsequent application to appeal. Irving's application was rejected by the court.

Introduction

Zyklon B, a solid carrier for the poison gas hydrogen cyanide, was introduced through holes (sometimes called vents) in the roofs into the gas chambers of Crematorium 1 at Auschwitz and Crematoriums II and III in Auschwitz-Birkenau. Holocaust-deniers have focused on the issue of the holes in the roof of Crematorium II, claiming that no apertures can be observed today. The slogan "No Holes? No Holocaust!" is often repeated.¹ Our research was undertaken to establish the facts of the matter and got underway before the slogan resurfaced in 2000 during the libel trial initiated by David John Cawdell Irving against Penguin Books Ltd. and Prof. Deborah Lipstadt.

This study by members and associates of the Holocaust History Project² identifies (among other things) three of the four holes in the roof of Crematorium II and offers a probable location of the remaining hole, currently covered by rubble. We believe that it is the first to add physical confirmation to the testimonial and photographic evidence for the location of the holes. To the best of our knowledge, it presents the first attempt to employ computer vision techniques to analyze the crematorium photographs. We have used the modern numeration for the crematoriums in the Auschwitz camp complex: Crematorium 1 (Auschwitz main camp); Crematoriums II, III, IV, and V (Auschwitz-Birkenau camp).

Part I describes the physical findings and their relation to testimonies and to a ground-level photograph taken during the construction of Crematorium II. Part II covers some additional findings in that gas chamber. Part III discusses some of the aerial photographs in which the gas chamber appears. Part IV addresses the gas chamber in Crematorium I at the main camp, and Part V presents a short overview of material from the realm of computer vision, which will help readers to understand some of the computer renderings in the paper. The analysis of the photographs, combined with the new physical findings and two key testimonies that have gone largely unnoticed, has resulted in some new conclusions about the Zyklon holes in Crematoriums I and II.

The search for the holes is quite a complex task, as both Crematoriums II and III were dismantled in late 1944 and later dynamited by SS sappers in January 1945 before they fled Auschwitz. The structures suffered considerable further deterioration in the following decades (see Figures 1a, b, and c).

Part 1: The Crematorium II Gas Chamber

The Layout

Crematorium II was completed on March 31, 1943,³ and served as one of the major killing installations in Auschwitz-Birkenau until dismantled in late 1944; it was dynamited by the fleeing SS in January 1945. The mass murder by hydrogen cyanide has been reported by survivors and former members of the SS. These testimonies are supported by many documents; neither this literature nor the well-known chemical studies that recovered substantial amounts of cyanic compounds in the chamber's walls are pertinent to the present discussion.⁴

The killing process began by tricking the victims into a semi-subterranean gas chamber camouflaged as a shower room. Once the victims were inside and the door locked, SS-men protected by gas masks poured one or more canisters of Zyklon B (a porous carrier for the lethal gas hydrogen cyanide) into each of four openings in the chamber's roof. Unlike the procedure used in some of the other gas chambers, Zyklon B in Crematoriums II and III was not simply poured onto the floor, but lowered in a removable container into a sturdy wire mesh column. This container, or as we call it below, "inner core," allowed the removal of the Zyklon pellets after the victims had died.⁵ "Wire mesh introduction devices" (*"Drahtnetzeinschiebvorrichtung[en]"*) are listed in the crematorium's inventory.⁶ The removable core was necessary because the chamber had neither doors nor windows leading to the outside, save for one door that led from the hall in which the victims undressed. This mechanism allowed safe retrieval of the pellets, which might still be releasing gas after the victims were dead. Small brick "chimneys" were built over the holes in the roof.

After several minutes, perhaps twenty, the victims were dead and the inner core of the introduction apparatuses holding the partially spent Zyklon B pellets was

pulled out. For fifteen minutes or more a strong ventilation system cleared the air in the chamber, whereupon the door was opened and "Sonderkommando" prisoners transferred the bodies to the furnace room using the corpse-lift installed for that purpose. A solemn testimony to the number of victims is the number of "stokers" mentioned in the SS labor-deployment reports: Crematoriums II and III employed up to 220 each.⁷

The inner measurements of the gas chamber of Crematorium II (and that of Crematorium III) are 30 x 7 meters, with its external brick walls being 0.5 m thick. The roof slab is 8 m wide. The inside height was 2.4 m. The total volume of the chamber was therefore 504 cubic meters. Seven steel-reinforced concrete columns, or pillars, with a cross-section of 0.4 x 0.4 m, supported the roof. These held a central support beam that ran the entire length of the chamber. The beam's cross-section was 0.4 m wide x 0.55 m high. The distance between the centers of the pillars was 3.8 m, while the distance between the centers of the two outermost pillars and the north and south walls was 3.6 m.⁸

The gas chamber's long axis is aligned almost exactly from south to north. We have numbered the seven support columns, as well as the four holes in the roof, in ascending order from south to north. Schematic drawings of the roof and the chamber are presented in Figures 2a and 2b.

To examine photographs from a vantage point to the south of Crematorium II, the windows on the south wall of the main building are useful for locating the gas chamber. We number those ten full-size windows in ascending order from west to east. Window 2 is located directly over the roof of the gas chamber (though in Figure 3, Window 3 appears to overlook it). The same killing process took place in Crematorium III, which, save for some minor differences, was a mirror image of Crematorium II. The gas chamber of Crematorium III, however, is unlikely to yield further information due to the condition of that structure (see Figure 1b).

Previous Knowledge

Three kinds of evidence have long indicated Zyklon B introduction holes in the roof of the gas chamber of Crematorium II, as well as the small brick "chimneys" built over them.

- a) The aforementioned testimonies of survivors and former members of the SS.
- b) The information contained in a photograph, taken by a member of a photography team of the Waffen SS and Police Central Construction Board (Zentralbauleitung der Waffen SS und Polizei), showing three of the Zyklon "chimneys" protruding over the roof (Figures 3 and 4). This photograph was taken in early 1943, shortly before construction was completed. Directly below Window 4 can be seen the brick "chimneys" enclosing the wire mesh introduction devices for Holes 1 (right) and 2 (left). The shape under Window 5 is not an introduction chimney but a portal, discoloration, or another shape on the wall of the crematorium proper. Additionally, a lighter shadow

appears near the middle of the gas chamber, under the east edge of Window 3. This does not correspond to an introduction port either. It may be an object on or near the roof of the gas chamber. It is lower and narrower than "Chimneys" 1 and 2. Also, while "Chimneys" 1 and 2 have at the right of their dark shadows shades of gray that are measurably lighter than the wall behind, the shade of gray to the right of the unidentified form is not clearly distinguishable from the wall. This can be verified by scanning the image and examining the gray levels (i.e., intensities).

The top of the western edge of Chimney 4 can be seen more clearly in Figure 4 just to the left of a locomotive's smokestack. Its lower half is obscured by snow-covered earth, its southern face by the smokestack. Chimney 3 is entirely occluded by the smokestack. David Irving has speculated that the holes are really "drums containing sealant,"⁹ but it is obvious that this cannot be the case: a cylindrical object would produce a gradual light pattern, while the objects above display a sharp change between uniform light and uniform shadow.

We have constructed a three-dimensional computer model of the Crematorium II building and its gas chamber (Figure 5). The dimensions and locations of the features that we modeled have been variously reconstructed from the building's blueprints (e.g., the windows), the surviving ruins (e.g., the location of three of the four holes), or both (the dimensions of the roof). The blueprints are published in Pressac.¹⁰

The "Train Photograph" is consistent with the physical evidence we discovered in the chamber (discussed below). This emerges from a reverse engineering exercise: Is there a camera location from which the given photograph will be identical with the (virtual) photograph of our model? An affirmative answer would lend credibility to the model. This sort of analysis is also applied to the Zyklon holes of Crematorium I (see Part IV, below). Both comparisons demonstrated an excellent match between the wartime photographs and the model our physical findings suggested.

The exact location of the train in the foreground is not known, but by triangulation and by using the principles of projective geometry,¹¹ it can be placed approximately 104.3 m south and 45 m west of the south-west corner of the gas chamber.

The correlation is unmistakable; from the photograph, sizes can be estimated almost to the centimeter. Perhaps this point is best made with an overlay of the photograph by a wireframe showing a skeletal view of the building and gas chamber (Figure 6).

- c) Several aerial photos of the Birkenau complex taken by American and British planes during 1944 (see Figure 7). The clearest of these photographs were taken during an American overflight on August 25. Crematoriums II and III

appear at the edge of precisely one frame, number 3185; in the next, 3186, Crematorium II alone is visible, with Crematorium III having been cut off by the trajectory of the aircraft.

As analyzed by an expert on aerial photo interpretation, Carroll Lucas,¹² these two frames "provided the best quality photography acquired over the site" and therefore are of special interest. Frame 3185 exhibits the better contrast of the two, 3186 being slightly overexposed. The photographic resolution was "on the order of 4-6 feet (1.25-1.85 meters)" Lucas judged. The locations of the four observed "smudges" on the roof correspond very well with the Train Photograph, and with the current physical evidence (described below). The smudges are too large to belong just to the holes themselves. They probably correspond to the tamping down of a trail on the roof by the SS men detailed to introduce the canisters (see Part III).

The photograph shows the smudges alternating slightly, Holes 1 and 3 to the west, 2 and 4 to the east. A Sonderkommando survivor, Henryk Tauber, considered a reliable witness on technical issues, testified that the holes in Crematorium II were on alternating sides. Interestingly, he is "corrected" by Pressac,¹³ who suggested that Tauber confused Crematoriums II and III; the Zyklon holes, however, alternated sides in both crematoriums, although they were considerably farther off center in Crematorium III (exposure 3185 of August 25, not reproduced here). That the holes alternate in Crematorium II is supported by the aerial photograph, the Train Photograph, the physical findings, and Tauber's testimony. This has been overlooked so far by historians and Holocaust-deniers alike, resulting in faulty analyses of the photographs.

* * *

Were the wire mesh Zyklon insertion devices attached to the concrete support pillars? This hypothesis might appear reasonable, but we have found little support for it and strong evidence against it. Mr. Gideon Greif of Yad Vashem, an expert on the Auschwitz-Birkenau Sonderkommando/⁴ contacted at our request two Sonderkommando survivors who worked in Crematoriums II and III. Mr. Shaul Chazan and Mr. Lemke Phlishko both stated that the devices were not attached to the support columns. We are not aware of any other testimony to that effect.

It has been hypothesized that the devices were attached to the sides of central pillars numbers 1, 3, 5, and 7 for reasons of structural support. This would yield a north-south distance of exactly 7.6 m between chimneys, and, if attached to alternating sides of the pillars, an east-west separation of approximately 1 m. The aerial photographs do not support this hypothesis; in particular, the staggered smudges on Crematorium III suggest an east-west spacing of about 2.5 m, and the smudge corresponding to Chimney 4 on Crematorium II is considerably south of where this predicts.

We contend that the introduction structures were supported by four iron bars on each corner and did not require the support of the concrete pillars. The presence of four such bars, as described by the witness Erber,¹⁵ is further evidence that the introduction devices stood on their own and were not attached to the concrete pillars.

It has been further hypothesized that the difficulty of locating the four holes may have reflected their having been filled in before the destruction of the chamber. This does not seem likely for Crematoriums II and III. The original roof consisted of three layers: a thick stone aggregate concrete slab underneath; a thinner, finer, sand-aggregate concrete mixture above; and waterproofing bituminous tar paper in the middle. It is unlikely that the SS would have thought it necessary to duplicate this work, or that they could have done so in four places without leaving a trace. There are considerable areas of the original ceiling visible from under the slab but these show no signs of tampering. In Crematorium I the holes were filled when the structure was converted to a bomb shelter for the SS (date unknown).

The concrete roof is reinforced with crisscrossed steel rods known as rebar in the construction trade. But what is new is that this rebar lattice has provided corroboration of the location of the Zyklon holes: holes planned at the time the concrete was poured would not have had rebar extending through them. As examples, Figure 8a depicts a typical rebar pattern in the roof over the cellar in the crematorium where the victims were ordered to undress, and Figure 8b shows both uncut rebar and rebar that has been cut and bent at the edge of a hole.

One current opening in the roof, near the approximate middle on the west side, does not correspond to any known Zyklon hole (Figure 9). Nothing marks this location on any known contemporary photograph, and a piece of rebar clearly ran across the hole before being cut and bent out of the way. This establishes that it was not a Zyklon hole. It is not known who made this hole, and we have no reason to believe that it was made before the liberation of the camp by the Red Army in January 1945. Clearly it was not made in an attempt to "fake" a Zyklon hole, or else the rebar would not have been left sticking out. This hole can be ignored for our purposes.

Recent Findings

Our research between 1998 and 2000 turned up strong physical evidence of Holes 1, 2, and 4 in the gas chamber roof. This is corroborated by documentary, photographic, and testimonial evidence as described above.

We call attention to the following:

- a) The physical evidence itself. This consists of clear signs of openings; straight cast edges in the concrete of the roof; rebar cut cleanly (i.e., not stretched by the explosion); the absence of rebar in the area within the holes; and the presence of rebar bent inwards at the edges of the holes.

The form of the rebar, most importantly, cannot be explained as a consequence of the explosion that destroyed the roof. Such an explosion would

have bent the rebar outward and upward, as well as thinning it through stretching. The ends of the rebar are hooked around perpendicular rebar to form a square aperture (Figure 16). This indicates creation of those holes when the concrete roof was originally poured in early 1943.

- b) The east-west placement of the three holes found so far follows a clear pattern. Their edges are all 30 centimeters distant from the side of the central beam (making their centers 75 cm from the beam's center). The outer edge of each hole is 300 cm from the corresponding edge of the roof slab. These distances can be measured today to within approximately 1 cm. The probability of such a placement being coincidental is very remote.

We mention that certain Holocaust-deniers, upon seeing a preliminary draft of this paper, argued that dynamite explosions created the holes when the roof tore apart from the concrete support pillars. This is however impossible, for the following reasons:

- The concrete support pillars were not attached directly to the roof, but to the central support beam.
 - While the concrete support pillars are in the center of the roof, the holes are not; as we have observed, a space of 30 cm separates their nearest edge and the central support beam.
 - Not all the holes are found at the same longitudinal (i.e., north-south) locations as the support pillars.
- c) The location of the holes is consistent with the August 25, 1944, aerial photographs.
- d) The location of the holes matches precisely with the Train Photograph (recall Figures 5 and 6).
- e) The alternating arrangement of the holes is consistent with the aforementioned testimony of Tauber and with maintaining structural integrity. Such spacing would also allow a more even dispersion of the cyanide gas.

In the following treatment, all distances are from the center of the objects identified (holes, pillars, central support beam) except where otherwise specified. North-south distances are from the southern end of the roof slab—not the south wall, since the roof shifted considerably when it collapsed after the explosions destroyed the gas chamber (Figures 10a and 10b). **In** general, the most reliable indicator of pre-explosion placement is the eastern edge of the roof, as it is broken almost entirely into large sections, is clearly visible along its length, and has an unmistakable southern corner. The relative distances of some features changed as the holes moved with the roof relative to the pillars.

Hole 1 is the opening in the roof near Pillar 1 (Figure 11a). The pillar remains standing and protrudes through the surface of the roof (Figure 10b), which shifted as it collapsed. While it might appear at first glance that the opening could just as easily have been created by the explosion, careful examination proves

this was not the case. Portions of straight, flat edges and a 90-degree angle survive intact, though most of the concrete around the edge was damaged by the explosion. The center of this hole is 4.1 m from the southern end of the roof slab, and 0.75 m west of the roof's center. We estimate its size at approximately 0.5 m square; this places its eastern edge at 0.3 m west of the west edge of the central support beam.

The roof's lower portion was a thick layer of concrete, over which was laid waterproofing tar paper, and which was finally topped with a thin upper layer of sand-concrete. For the middle layer, brushing tar over the tar paper was necessary to ensure waterproofing. Of the original concrete edge of the hole only a few centimeters of the intact lower layer remain in one corner, but a careful examination of that location reveals two clear drip marks where tar was brushed over the edge (Figure 11b, right). This demonstrates that the hole in the concrete was already there during the waterproofing step, while the roof was still being constructed.

Hole 2 is an opening (Figure 12) that lies in an area of the roof more thoroughly destroyed by the explosion. We suggest that this hole can be identified by several characteristics. These include clean-cut rebar, short but apparently manufactured straight edges of concrete that meet at a 90-degree angle, rebar bent inwards at the edges, and, most notably, the absence of rebar in its open area (Figures 13 and 14). The center is 11.5 m from the southern end of the roof slab and 0.75 m from the central beam. Its size is again estimated at 0.5 x 0.5 m. The eastern edge of the hole is 3 m from the eastern edge of the slab.

Hole 3's projected location is in an area of the roof that is badly damaged and covered with rubble (Figure 15). Preliminary research suggests that the hole itself may have been damaged when the roof collapsed on a portion of its own support structure. This hypothesis, however, requires further investigation. At the time this study was conducted, the researchers did not have permission to conduct the large-scale movement of rubble necessary to identify the third hole, but they are hopeful that permission may be forthcoming.

Hole 4 can be identified by a pattern in the rebar (Figure 16) at the very northern end of what remains of the roof. This was not its very northern end in 1943. To understand the location of this hole, one should observe that the northernmost 4 m of the roof were folded back and under 150 degrees by the explosion and subsequent collapse. That portion of the roof is now lying upside-down beneath the roof slab that originally lay to its south (Figures 17 and 18).

There is no question that part of the roof has folded underneath itself: that it is upside-down emerges from four observations. First, the rebar along the roof's north-south axis is still largely intact at the folds and can be observed running unbroken from the top portion of the roof, 150 degrees around, and through concrete into the bottom portion (i.e., between 3 and 6). Second, when the tar waterproofing was spread atop the concrete slab, it ran over the edge; the drips are visible to this day;

on the edge of this portion of the roof, the tar can still be seen, flowing, as it were, upward. Third, the upper part of "Section 6" (Figures 17 and 15) is the *inner* side of the roof, as seen in the imprint of the formwork. And fourth, the process of elimination: nothing resembling the missing northernmost roof slab (about 4 m in length) can be found anywhere else.

Hole 4 can be identified by the unimpeded square opening set in the rebar in 1943. The surrounding edges were shattered by the explosion and the folding of the roof, leaving only the telltale rebar latticework. Its measurements are 0.5 x 0.5 m. It is possible to measure this hole's distance from the east edge of the roof with great precision: a single unbroken strand of rebar can be traced from that edge, through several pieces of concrete, to the hole itself. That distance is 3 m, with an error margin of approximately 1 cm. Like Hole 2, the center of Hole 4 is located 0.75 m east of the roof's center. Its north-south location is subject to some error due to breaks in the roof slab to its south and an uncertainty concerning the whereabouts of the roof's northern edge (also, now, to the south of the hole). We estimate its location at 25.5 m from the southern edge of the roof slab, with an error margin of perhaps as much as 1 m.

Holocaust-deniers have argued for some time that all holes in the roof of the gas chamber were created after the war. Setting aside the obvious problems with such an argument, the rebar going around, but not through, Hole 4 effectively rebuts this claim. In particular, the reader will observe that at the eastern side of the hole the rebar was bent into loops so as not to pass through the hole-see area of the lower circle on Figure 16. Both ends of one loop remain firmly embedded in a large chunk of concrete to the east of the hole, contradicting any claim of tampering after the war. It is not merely the existence of Hole 4 that is significant, nor its placement precisely where corroborating evidence points. The deliberately looped rebar proves that this hole, as almost certainly the other three, was cast at the time the concrete was poured in January 1943. The homicidal intention of the crematoriums can be placed at no later than this date, a date literally set in stone.

Part II: Additional Findings

The gas chamber in Crematorium II in Birkenau was built following conventional construction methods of the time. Several unusual features, however, were encountered during our research visits. Those not explained previously will be discussed now. We do not touch upon the crematorium proper or on the undressing chamber in this study.

The gas chamber was a fairly simple structure. The floor was cast reinforced concrete with appropriate drainage outlets. The seven support columns are also of reinforced concrete mounted on column footings under the floor slab. The walls are hard-fired conventional brick held together with mortar. The columns are attached to a reinforced concrete beam that spans the entire length of the gas chamber. The roof is cast reinforced concrete with a single layer of damp-proofing and a 2 cm fine

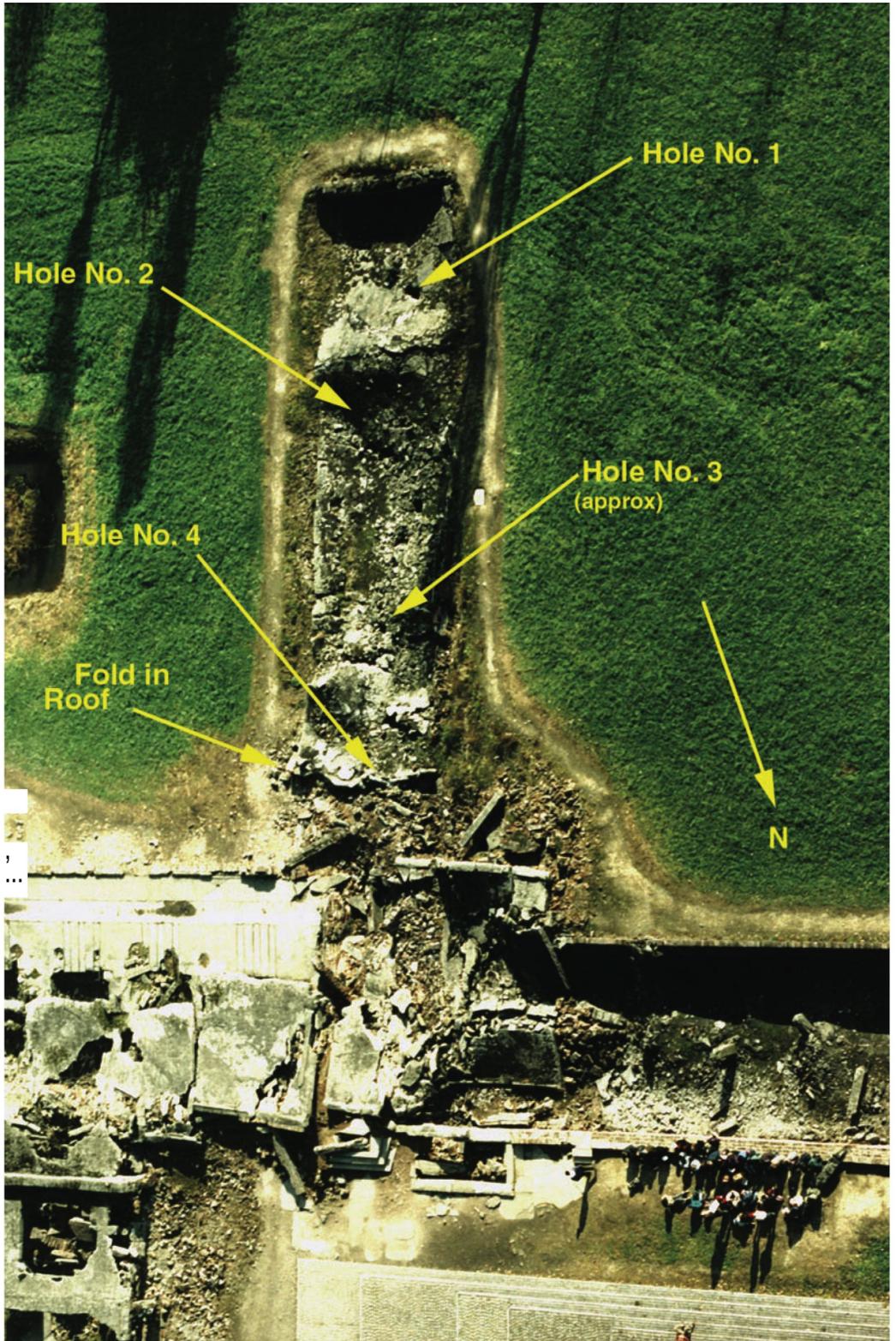


Figure 1a. Aerial photograph of the gas chamber in Crematorium II (courtesy of Wojciech Gorgolewski).

Figure 1b. Ruins of gas chamber in Crematorium II today.

Figure 1c. Ruins of Crematorium II today.