

# FRESCOES FROM AYIA IRINI, KEOS. PART I<sup>1</sup>

(PLATES 54–58)

ARCHAEOLOGICAL excavation carried on by the University of Cincinnati under the direction of John L. Caskey<sup>2</sup> has revealed that the rocky peninsula of Ayia Irini on Keos in the Cyclades was inhabited with few, if any, interruptions from the Early Bronze Age through the early phases of the Late Bronze Age. The settlement developed into a thriving commercial town which traded with communities on the Greek mainland, on other Cycladic islands, and on the island of Crete. Massive fortification walls were in use by the beginning of the Middle Bronze Age and, as the town continued to expand, a second circuit was constructed enlarging the enclosed area in the later Middle Bronze Age. The height of the town's prosperity appears to have occurred in the succeeding phase at the beginning of the Late Bronze Age. The settlement was badly damaged, probably by earthquakes, at the end of this phase (Late Minoan I B/Late Helladic II) and again at the end of Late Helladic III A 1.

The stratified destruction debris contains concrete evidence of the changing cultural and economic influences in the Aegean world of the Late Bronze Age. In the earlier debris (L.M. I B/L.H. II) large amounts of pottery imported both from Minoan Crete and from the Helladic mainland are found; the imported pottery in the later destruction debris (L.H. III A) is almost entirely of mainland production.

The debris from the L.M. I B/L.H. II destruction, which consists of earth, large building stones, broken pottery, and objects fallen from the upper storeys into the basement rooms, also contains numerous fragments of painted plaster. Small pieces are all that remain of the once brightly frescoed upper walls which decorated many of the early Late Bronze Age buildings at Ayia Irini. And as the imported

<sup>1</sup> The encouragement and criticism of John L. Caskey and Evelyn B. Harrison, who suggested this study, has been invaluable. In addition to them, I would like to thank Mabel Lang and Edith Porada for their critical comments when this material was presented as a doctoral dissertation to Columbia University in 1970, and Agnes Sakellariou, Maria Shaw and Emily Vermeule for their suggestions and comments when visiting the site. I am particularly grateful to Mark A. S. Cameron who generously shared his unique knowledge of the Cretan frescoes, and was the first to point out the details which identified our Blue Birds as belonging to the same species represented in the House of the Frescoes at Knossos.

<sup>2</sup> Excavation of the site by the University of Cincinnati began in 1960. Preliminary reports by J. L. Caskey have appeared in *Hesperia*, XXXI, 1962, pp. 263-283; XXXIII, 1964, pp. 314-335; XXXV, 1966, pp. 363-376; XL, 1971, pp. 359-396 (hereafter *Investigations, Part I*); XLI, 1972, pp. 357-401 (*Investigations, Part II*). A complete bibliography of the site appears in *Investigations, Part I*, p. 359, note 1, where articles from other journals are also listed. For further information on the fortifications, main period of occupation and the destruction of the site see *Investigations, Part I*, pp. 363-368.

pottery from this period shows that the islanders were in close contact with Cretan civilization, so the frescoes show a dependence on Cretan models for most of their designs. Non-Cretan design elements and artistic preferences, some suggestive of mainland art, others local or Cycladic in origin, can, however, be seen in the paintings.

Painted plaster fragments were found in most of the excavated areas of the site.<sup>3</sup> Many of these were small pieces decorated in one color which probably came from single-colored walls, usually red. A few were from painted designs too fragmentary to be identified.<sup>4</sup> The best preserved and most complicated frescoes were found in rooms of House A, House B, House J, and Area M (*Investigations, Part I*, figs. 2, 3).

The fragments were separated from the earth and debris during excavation, and reassembled on open trays in the workrooms. There was no lime incrustation and most of the fragments were in a good state of preservation. The excessive salinity of the soil, however, was very destructive to the painted surfaces of fragments found near or below present sea level. Although some pieces completely withstood the corroding effect of the salt water and the slick surface of the fresco remained intact, other pieces were crumbling already as they were excavated. In general, it proved more successful to allow all the fragments to dry thoroughly before cleaning, in the hope that the paint would consolidate with the plaster; the best preserved pieces, however, could be safely lifted directly from the damp earth. Where the salt had already destroyed part of the painted surface while the fragments lay in the soil, after drying more of the paint flaked off or became powdery. To counteract further destruction most of the fragments were washed with distilled water and later some were impregnated with a mixture of Paraloid B 72, acetone and amyl acetate<sup>5</sup> to prevent the paint particles from being dislodged by salt crystals rising to the surface as the plaster dried.

The cleaned fragments were laid out on large tables and all joining fragments glued together with an acetone-soluble glue, UHU. Only fragments found in the same room or adjacent rooms joined, a fact which suggests that the frescoes were still on the walls when the destruction took place, that none had been previously discarded.

<sup>3</sup> A complete description of all the fresco material will appear in the final publication of the site.

<sup>4</sup> An exception exists in the small fragments found in place on Wall G of Room V in the Temple which could be identified as belonging to a sponge-pattern of white on black similar to the more colorful pattern found in Room 39 in House A. See *Investigations, Part I*, p. 386.

<sup>5</sup> In 1965 the fragments excavated in 1960-64 were cleaned by flaking off the dry earth and then gently washing the surface with water (after experiments with methanol, alcohol, or carbon tetrachloride proved less successful). Distilled water was first used in 1970. In 1967 many fragments were impregnated with an acrylic resin (10% Elvacite 2044 dissolved in xylene) but some retained a shiny surface. In 1970 Stella Bouzaki removed the acrylic resin, recleaned the fragments, and applied the Paraloid mixture. We are extremely grateful to her for her skillful and painstaking preservation of the fresco material.

A laboratory analysis undertaken by the Conservation Center of the Institute of Fine Arts at New York University has established that the paintings at Ayia Irini were painted on lime plaster using earth pigments made from red and yellow ochers, carbon black and Egyptian blue.<sup>6</sup> They were executed in *buon fresco* except in the few instances where the addition of a secondary color, when the wall was no longer wet enough for adequate penetration, resulted in *secco fresco*. (This was almost certainly unintentional since most of the secondary colors are also in the *buon fresco* technique.) The type of plaster, the composition of the pigments and the painting techniques correspond to what we know of contemporary Cretan frescoes and those preserved from later periods on the mainland.<sup>7</sup> The chemical composition and technical procedures were identical in all the samples taken from the different rooms at Ayia Irini. There is no indication of any redecoration of the walls, except possibly in the Temple.

The most interesting comparative material will be discussed along with each group of frescoes and any chronological conclusions which can be drawn from these comparisons will be presented. From such comparisons and a preliminary study of the pottery and architecture of Ayia Irini it appears that the frescoes were probably executed no earlier than the beginning of the late Bronze Age, and probably in the L.M. I B/L.H. II phase in which they were destroyed.<sup>8</sup>

## I. FAUNA

### 1. THE BLUE BIRD FRESCO

The Blue Bird fresco was found in Rooms 31 and 30 of House A.<sup>9</sup> This building survives as a large complex in which are basement storage rooms, staircases and corridors. Rooms 31 and 30 were adjacent storerooms; large storage vessels were

<sup>6</sup> This analysis was undertaken by Professor Lawrence J. Majewski, Director of the Conservation Center, Institute of Fine Arts, New York University, with the aid of his students, Laurence Hoffman and Marjorie Reich; see Appendix.

<sup>7</sup> For general discussions see L. Majewski, "The Conservation of Wall Paintings in Archaeological Excavations," *Colt Archaeological Institute, Monograph Series*, 3, London, 1966, pp. 24-36, and P. Duell and R. J. Gettens, "A Review of the Problem of Aegean Wall Painting," *Technical Studies in the Field of the Fine Arts*, X, 1942, pp. 179-223.

For analyses of specific paintings see W. J. Young, Appendix, pp. 229-230 in M. Lang, *The Palace of Nestor at Pylos in Western Messenia*, II, *The Frescoes*, Princeton, 1969; N. Heaton, "On the Nature and Method of Execution of Specimens of Painted Plaster from the Palace of Tiryns," pp. 211-216 in G. Rodenwaldt, *Die Fresken des Palästes (Tiryns)*, II, Deutsches Archäologisches Institut in Athens), Athens, 1912; N. Heaton, "The Mural Paintings of Knossos," *Journ. Roy. Soc. Arch.*, LVIII, 1910, pp. 206-212.

<sup>8</sup> Chronological conclusions must remain tentative until the study of the pottery, architecture and finds from the site has been completed.

<sup>9</sup> Caskey, *Investigations, Part I*, figs. 2, 3. Additional fragments of this fresco were discovered in 1972 during the removal of the large storage vessels in Room 31.

found in place around the walls of Room 31. A staircase led up to the rooms of the ground floor. The deposit in Room 31, where the greatest number of fresco fragments was found, consisted of earth, fallen stones, fragments of fine pottery, stone vessels and painted plaster, all of which fell from above. The pottery is of the L.M. I B/L.H. II styles.

The fresco portrays many blue birds, resembling the modern rock dove (*Columba livia*<sup>10</sup>) standing on an irregular sandy ground. There is no attempt to suggest a

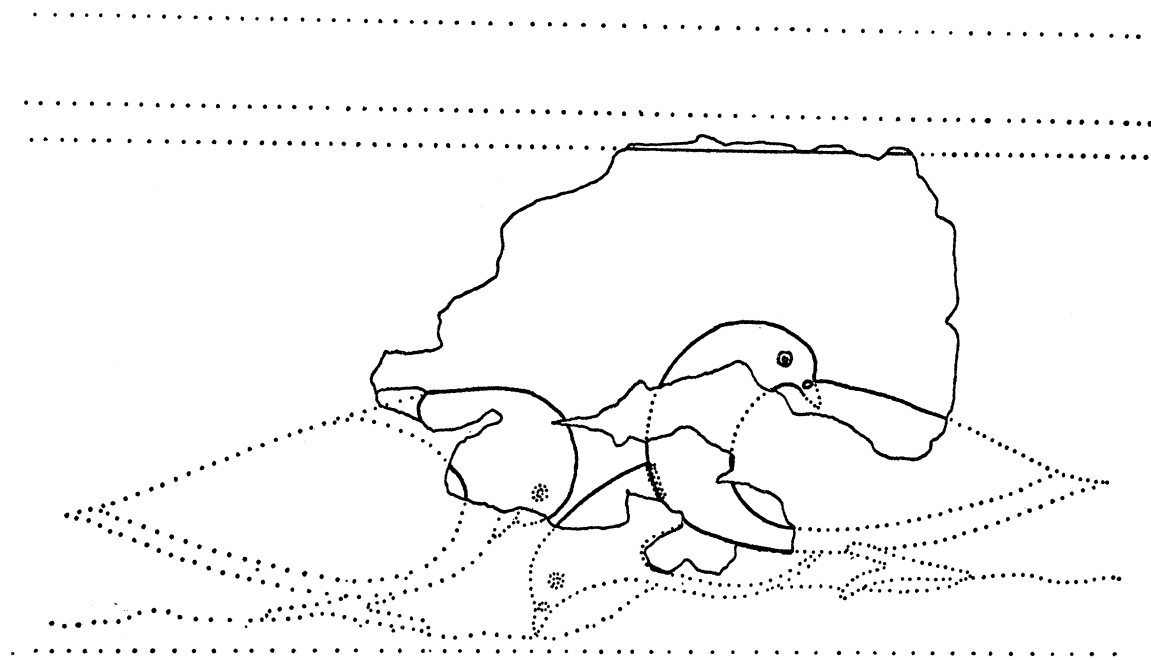


FIG. 1. Reconstruction of the Blue Bird frieze, central portion, F. 183.

naturalistic setting with plants or rocks; the background is an empty yellow ocher field. The birds are bright blue with light blue wings. Their round eyes are formed by two rings, the outer red, the inner yellow ocher. There is a roughly triangular white spot at the base of each beak, but no beaks are completely preserved. The shape of the short triangular beak can be seen just in front of the head of bird C on Fragment No. 9. The paint, probably bright blue, has disappeared, but the wet plaster held an impression of the original painting. This mark and other impressions of

<sup>10</sup> R. T. Peterson, *et al.*, *A Field Guide to the Birds of Britain and Europe*, London, 1966, p. 178. James Tate, Department of Ornithology, Cornell University, kindly pointed out to me that the "white spot" which represents the cere positively identifies the birds as columbidae, and that red feet, a red eye-ring surrounding a yellow-orange iris, and a lighter underbelly (represented in our birds by a white stripe) suggest a probable ancestor of the modern *Columba livia*, now common in Greece and the Aegean.

eye-rings retained in the plaster are further evidence that these painters worked in a *buon fresco* technique, applying their pigments to a wet plaster wall. On several other heads an irregular blob of blue projects in front of the white spot at the base of the beak (Fragments Nos. 10, 11, 12, 13); these blue areas may represent careless renderings of the beaks. Red dots, usually in double rows, decorated the birds' necks and breasts. Their legs and feet are red with as many as three toes on each foot. Some birds have an added white stripe along the belly (Fragments Nos. 6, 7). The birds are in various standing poses. One has its head tucked into its breast, another looks back over its wing, a third bends down to peck at the ground. It is almost certain that there were several flying birds as well (see below).

The upper border of the design consists of a broad blue band and a narrow white one separated from each other and from the yellow ocher background by impressed string marks. There is no separate border at the bottom; the red sandy ground continues to the bottom of the frieze.

#### CATALOGUE

The lime plaster is white and fairly coarse with occasional tiny pebbles imbedded in it. The surface is smooth but not slick and polished. The undersurface of the fragments is uneven and retains impressions of vegetable matter and tiny sticks imbedded in the layer underlying the plaster. This underlying layer could well be one of mud plaster reinforced by vegetable matter, applied over a mud-brick or stone wall. The fragments range in thickness from 0.015 m. to 0.005 m.; the average thickness is 0.01 m.

The painted surface tends to be chalky, but in general the paint adheres well to the plaster. The colors are yellow ocher, red, bright blue, light blue and a paste-like added white. In places the original surface is left unpainted to provide a white area. Usually the blues are painted over the yellow ocher background but for large areas the blues are applied directly to the unpainted surface of the plaster. Microscopic examination in the laboratory revealed that the blue color itself consists of two layers of pigment, a thin layer of Egyptian blue (calcium copper silicate) over a layer of black or gray (see Appendix). Depending on the thickness of the upper layer of blue over the gray underpainting the resulting color varies from bright blue to dull blue gray. This variation accounts for the apparent shading of the blue in the upper border, from gray at the upper edge to blue at the lower edge. Presumably the reason for this underlying layer was to conserve the blue paint which was specially prepared from copper and was an expensive pigment. The red and yellow ocher details and the added white are painted over the blue. The sandy ground is indicated by a stippling of red dots over the unpainted plaster. On one fragment a preliminary sketch line in pale yellow ocher indicates the undulating ground line which is the upper boundary of the red stippled area. This line was not followed in the final

painting; the stippled area crosses it. Otherwise, there are no signs of preliminary sketching.

1. (F. 161) Pl. 54, b; three pieces joined;  $0.082 \times 0.094$ , th. 0.008-0.016 m.; paint flaked off at upper right and lower left; surface restored in plaster of Paris. Surface of plaster curves forward 0.002 m. along the upper horizontal edge; impressed string marks along either edge of the band. Top border abutting a beam: broad band (0.043 m.) of blue, darker along the upper edge, and narrow band (0.015 m.) of white. Below: top of light blue wing, yellow ocher background.

2. (F. 164); five pieces joined;  $0.124 \times 0.092$ , th. 0.013-0.02 m.; surface worn near the top; impressed string marks separate the bands. Top border: part of blue band, white band, yellow ocher background below.

3. (F. 285) Pl. 54, b; single piece;  $0.044 \times 0.055$ , th. 0.012 m.; impressed string marks separate the bands. Top border: edge of blue band, white band, top of blue head, yellow ocher background.

4. (F. 283) Pl. 54, c; single piece;  $0.044 \times 0.056$ , th. 0.01 m.; paint flaked off at top; filled with plaster of Paris. Plaster surface curves forward *ca.* 0.002 m. along the lower horizontal edge. Bottom border abutting a beam: blue belly and red foot of bird, facing left, standing on stippled red ground, yellow ocher background.

5. (F. 284); two pieces joined;  $0.042 \times 0.031$ , th. 0.01 m.; plaster surface curves forward *ca.* 0.001 m. along the lower horizontal edge. Bottom border abutting a beam: stippled red ground, yellow ocher background.

6. (F. 162) Pl. 54, c; three pieces joined;  $0.069 \times 0.071$ , th. 0.011-0.019 m.; paint and added white flaked off at right edge, joints filled with plaster of Paris. Blue belly with white stripe, and red foot of bird which faces left, standing on stippled red ground. Yellow ocher background.

7. (F. 274) Pl. 56, a; two pieces joined;  $0.029 \times 0.032$ , th. 0.011 m.; paint flaked off at upper left, white stripe partly flaked off. Blue belly with white stripe underneath, over the yellow ocher background.

8. (F. 163) Pl. 54, c; three pieces joined;  $0.104 \times 0.075$ , th. 0.009-0.012 m. Light blue wing, blue belly and red foot of bird which faces left, standing on stippled red ground, yellow ocher background.

9. (F. 183) Fig. 1, Pl. 54, a; seventeen pieces joined;  $0.243 \times 0.174$ , th. 0.013 m.; joints and missing areas filled in with plaster of Paris. Impressed string marks at top of panel. Bird at left (A) bending head down into breast feathers; bird in center (B) bending its neck down towards the ground; bird at right (C) turning head back over its wing. A: blue breast, head, neck and part of folded light blue wing with double rows of red dots along the back of the neck and breast, indentation of eye-rings on head. B: back of blue neck, part of light blue folded wing and upper line of blue belly, overlapped by C. C: blue head, neck and breast, part of blue belly and folded light blue wing, double row of red dots along outer edge of breast, part of yellow ocher eye-ring, white spot at base of beak and indentation of beak on top of folded wing. Red dots along breast of C mark the overlap with B. Yellow ocher background, part of white band at top.

10. (F. 176 + 184) Pl. 55, a; two pieces joined;  $0.085 \times 0.072$ , th. 0.015 m.; surface damaged at upper left and center right, joints filled with plaster of Paris. Bird, facing left, head bent slightly down. Blue head, neck and light blue folded wing, white spot at base of beak, indentations of eye-rings, red spots on breast, yellow ocher background.

11. (F. 167) Pl. 55, a; two pieces joined;  $0.027 \times 0.028$ , th. 0.009 m.; surface flaked off at right, part of eye-rings flaked off. Blue head facing left, tucked back into folded light blue wing; red and yellow ocher eye-rings, white spot at base of beak (pose similar to that in C in Fragment No. 9).

12. (F. 168) Pl. 55, b; seven pieces joined;  $0.086 \times 0.044$ , th. 0.009-0.012 m.; joints filled with plaster of Paris; eye-rings, dots on breast almost lost. Blue head, neck and light blue wing

of bird, facing left, possibly flying. Traces of inner yellow ocher eye-ring, red dots on breast, white spot at base of beak, white background with narrow blue streaks slanting slightly upwards from left to right.

13. (F. 169) Pl. 55, c; single piece;  $0.032 \times 0.029$ , th. 0.016 m.; paint flaked off around edges and from eye-rings. Blue head, facing left, white spot at base of beak and indentations of eye-rings, yellow ocher background.

14. (F. 170) single piece;  $0.038 \times 0.038$ , th. 0.006-0.008 m.; surface damaged at top, only yellow ocher eye-ring preserved. Blue head, possibly facing left, trace of eye-ring.

15. (F. 171) Pl. 55, c; four pieces joined;  $0.074 \times 0.045$ , th. 0.006 m.; paint flaked off eye-rings. Blue head, probably facing right, red eye-ring, yellow ocher background.

16. (F. 172) single piece;  $0.038 \times 0.037$ , th. 0.012 m.; surface flaked off at lower edge, gouged at upper. Blue head, probably facing right, trace of white spot at base of beak and red and yellow ocher eye-rings.

17. (F. 173) two pieces joined;  $0.029 \times 0.019$ , th. 0.013 m.; paint flaked off at edge. Part of blue head, red and yellow ocher eye-rings.

18. (F. 174) single piece;  $0.028 \times 0.015$ , th. 0.017 m.; paint flaked off at edges. Part of blue head and red and yellow ocher eye-rings.

19. (F. 175) Pl. 55, c; single piece;  $0.019 \times 0.015$ , th. 0.009 m. Part of blue head, yellow ocher eye-ring, yellow ocher background.

20. (F. 182) Pl. 55, a; two pieces joined;  $0.034 \times 0.022$ , th. 0.008 m.; part of red eye-ring flaked off. Blue head, facing left, red and yellow ocher eye-rings, white spot at base of beak and trace of blue beak, yellow ocher background.

21. (F. 272) Pl. 56, a; two pieces joined;  $0.047 \times 0.026$ , th. 0.011 m.; paint flaked off at upper right. Blue head? Blue area with white spot over yellow ocher background below. (If head, it is badly drawn; possibly it represents a belly with a white spot underneath.)

22. (F. 273) Pl. 55, c; three pieces joined;  $0.033 \times 0.028$ , th. 0.009 m.; black stain on surface. Blue head? White spot at base of beak?

23. (F. 177) Pl. 55, d; two pieces joined;  $0.043 \times 0.048$ , th. 0.003-0.01 m.; paint flaked off in places. Blue breast with two intersecting double rows of red dots (perhaps representing two overlapping birds) and light blue wing.

24. (F. 181) Pl. 55, d; two pieces joined;  $0.045 \times 0.074$ , th. 0.008-0.012 m.; surface very hard and mottled, paint flaked off at upper and left edge, white (probably light blue, discolored) at top. Blue breast of bird, facing left, with double row of red dots, yellow ocher background below. Light blue area at bottom, right (wing?).

25. (F. 275) Pl. 55, d; three pieces joined;  $0.073 \times 0.047$ , th. 0.009-0.011 m.; paint flaked off at upper right edge. Blue breast, part of belly and light blue wing of bird facing right, stippled red ground below, yellow ocher background. Red dots along inner edge of breast beside wing, along outer edge of breast and sprinkled across it.

26. (F. 276) Pl. 56, a; two pieces joined;  $0.046 \times 0.057$ , th. 0.007-0.012 m.; surface mottled in places, paint flaked off at top. Blue breast and light blue wing of bird, facing right, trace of red dots along outer edge of breast. Blue area to right, probably another bird, yellow ocher background at upper right.

27. (F. 180) Pl. 55, b; three pieces joined;  $0.054 \times 0.061$ , th. 0.013 m.; surface damaged in places, joints filled with plaster of Paris. Wing?: blue area with three parallel light blue stripes, widely spaced (outstretched wing or possibly tail?), light blue wing above.

28. (F. 277) Pl. 56, a; three pieces joined;  $0.045 \times 0.028$ , th. 0.008-0.013 m.; paint flaked off at joints. Outstretched wing?: blue area with parallel light blue lines across it, white or light blue area at bottom (cf. Fragment No. 27).

29. (F. 178) Pl. 56, a; three pieces joined;  $0.037 \times 0.077$ , th. 0.01 m.; paint flaked off in places. Blue tail or neck extending to left, light blue open (?) wing at right, part of another light blue wing above, yellow ocher background.

30. (F. 179) Pl. 55, b; two pieces joined;  $0.044 \times 0.056$ , th. 0.009 m.; joint filled with plaster of Paris. Top of light blue wing at bottom, round light blue trailing feather and pointed white trailing feather above to left, slanting downwards from left to right, yellow ochre background.

At least seventeen different birds are represented in the preserved fragments. There are sixteen heads, at least eight facing the left and four the right, and thirteen, possibly fifteen, pairs of feet standing on the sandy ground. The bird on Fragment No. 12 is probably flying, certainly raising his wings high above his head behind him. On Fragment No. 3, the head of a bird is touching the white band of the upper border. This seems an impossible stretch for a bird if its feet remain on the sandy ground below and suggests that this head also belonged to a flying bird. The two trailing feathers on Fragments No. 30 are more likely to belong to a flying bird than to a standing one,<sup>11</sup> and several other fragments probably represent portions of outstretched, flying wings.

The height of the upper border, which clearly ran beside a horizontal beam, ranges between 0.047 m. and 0.05 m. The area of sandy ground beneath the feet of the birds ranges in height between 0.02 m. and 0.045 m. No section preserves the entire height of the central portion of the frieze.

A minimum height of 0.22 m. can be estimated, however, by adding the preserved height of Fragment No. 9 (which shows one bird overlapping another incomplete one), enough to complete the lower bird in Fragment No. 9, and the height of Fragment No. 4 which shows a pair of red feet ( $0.175 + ca. 0.02 + 0.025$  m.). This gives a minimum height of *ca.* 0.28 m. for the entire height of the frieze and a maximum of *ca.* 0.31 m.<sup>12</sup>

The upper border is preserved, in fragments, to a length of at least 1.55 m., possibly as much as 1.82 m., and the lower border, also in fragments, to at least 0.52 m. Fragment No. 9 preserves parts of three birds within 0.24 m. Although no fragment preserves an entire bird, enough is known about the component parts to restore with certainty all but the tails. The length of a restored bird would be 0.20-0.22 m. (depending on the length of the tail). A minimum length of *ca.* 0.44 m. is necessary to contain the three birds on Fragment No. 9. If such close overlapping as this is common, a minimum length of *ca.* 2.48 m. is necessary for the seventeen known birds. If such overlapping is unusual and the average number of birds within

<sup>11</sup> I am grateful to Mark Cameron for pointing this out to me.

<sup>12</sup> Recorded heights for other friezes include: Knossos, Caravanserai 0.28 m. (Sir Arthur Evans, *The Palace of Minos at Knossos*, hereafter *P. of M.*, II, London, 1927, p. 109); House of the Frescoes, Blue Birds 0.6 m. (*ibid.*, p. 454), crocuses 1.0 m. and others 0.8 m. (*ibid.*, p. 459); myrtles 0.45 m. (M. A. S. Cameron, "Notes on some new Joins and Additions to well known Frescoes from Knossos," *Europa*, ed. W. C. Brice, Berlin, 1967, p. 65). From Pylos: Bluebird frieze 0.164 m. (M. Lang, *Pylos*, II, p. 151); others 0.62-0.66 m. (*ibid.*, p. 225). From Phylakopi, flying fish 0.23 m. (T. Atkinson, R. C. Bosanquet, *et al.*, *Excavations at Phylakopi in Melos*, London, 1904, p. 70).



0.44 m. is more likely to be two than three, a minimum length of *ca.* 3.74 m. must be postulated for the frieze.

The frieze must have been set between two horizontal members, either ceiling and beam, two beams, or beam and lower dado. Most probably, since no fragments of a lower dado were found in the room, it ran above a door lintel, between two beams, or just below the ceiling with a beam for the lower border.<sup>13</sup> The lower basement walls of Room 31 are *ca.* 3.65 m., *ca.* 4.60 m., *ca.* 3.15 m. and *ca.* 3.60 m. in length (plus an opening of *ca.* 1.00 m.). The Blue Bird frieze would fit nicely along either of the long walls of an upper storey room.

Our Blue Birds seem to represent the same species as those which appear in the fresco from Room E in the House of the Frescoes at Knossos (Late Minoan I A).<sup>14</sup> The Cretan birds closely resemble the modern rock dove in their general shape, the white spot at the base of the beak, the red dots indicating iridescence on the breast and neck, and the black-tipped feathers of the tail. Our birds are painted in a formula very similar to that used in Crete. The Knossian birds, however, have black beaks, and (probably) black feet, while ours seem to have had blue beaks and red feet. No traces of black paint occur on any of our fragments.

The most striking difference between our Blue Bird fresco and the Knossian 'Blue Bird' fresco is that our birds are depicted against an empty background; the only indication of a natural setting is suggested by the sandy ground on which they stand. The birds from the House of the Frescoes, on the contrary, are only part of a splendid garden scene of monkeys and birds, running stream and lush vegetation, all carefully painted in great detail. This fresco is the most complicated representation of a natural scene preserved, but others in this tradition are common. The scene from Room 14 at Hagia Triada with a leaping deer and a cat hunting a pheasant (Late Minoan I B)<sup>15</sup> and the newly-discovered "Springtime Scene" with flying swallows from Thera (Late Minoan I A)<sup>16</sup> are good examples.

The partridge and hoopoe from the Caravanserai at Knossos (Late Minoan I A),<sup>17</sup> however, seem to belong to another tradition or style of painting. The landscape is represented by an abstract convention of multi-colored curving bands above and below the birds, probably suggesting a cave opening on a rocky hillside, and the plants are few and stiffly formal in appearance in comparison to those of the garden scene from the House of the Frescoes. The Caravanserai birds are painted with a

<sup>13</sup> A position above a lintel or just below the ceiling has also been assigned to the Caravanserai frieze (*P. of M.*, II, pp. 109, 460, fig. 49) and the Bluebird frieze from Pylos (*Pylos*, II, p. 18).

<sup>14</sup> For the Blue Birds from the House of the Frescoes at Knossos see *P. of M.*, II, pp. 454-457, pl. XI; M. A. S. Cameron, "Unpublished Painting from the 'House of the Frescoes' at Knossos," *B.S.A.*, LXIII, 1968, pp. 1-31, particularly p. 8.

<sup>15</sup> W. S. Smith, *Interconnections in the Ancient Near East*, New Haven, 1965, fig. 110.

<sup>16</sup> S. Marinatos, *Σύντομος Ὀδηγὸς Προσωρινῆς Ἑκθέσεως Ἀρχαιοτήτων Ἀθήρας*, Athens, 1971, pp. 14-15.

<sup>17</sup> *P. of M.*, II, pp. 110, 113, frontispiece.

meticulous attention to detail, but the landscape elements have been deliberately conventionalized and subordinated to them.<sup>18</sup> The frieze is long and narrow, and the birds are of great size in relation to the total height of the fresco. The repetitive, symmetrically organized poses of the standing partridges create a formal rhythm which contrasts markedly with the freer atmosphere in the House of the Frescoes composition. Our fresco seems to belong to the same tradition as the Caravanserai frieze. The birds are of paramount importance, the landscape minimal, and the composition long and narrow.

Other friezes depict birds of various species, but none are similar to our Blue Birds. The birds from Katsaba in Crete (Middle Minoan III B or late Minoan I A) have fat bodies, long pointed tails and feathered crowns.<sup>19</sup> A brown bird with a red head and a white wing appears on a fragment from Phylakopi (dated to the Second City by Bosanquet and called "Early Mycenaean").<sup>20</sup> The only other birds which resemble ours are those of the Bluebird frieze from the Palace of Nestor at Pylos (Late Helladic III B).<sup>21</sup> They are blue with red beaks, round white eyes, black legs and red feet. The outstretched wings consist of blue-green and white feathers, outlined in black and decorated along the edges with black dots. They may represent the end of a development and be ultimately derived from the same prototype as ours but this is not certain.

An entirely empty background similar to that of our frieze is unknown in Cretan frescoes; the closest parallels occur on later mainland scenes, such as that of the Ramp House frescoes from Mycenae (Late Helladic III A).<sup>22</sup> Empty backgrounds do occur at Pylos (Late Helladic III B) but there the colors change periodically and are separated by wavy transitional vertical bands.<sup>23</sup>

Our Blue Bird frieze appears to be a local Cycladic adaptation of well-known Cretan frescoes, employing the same colors and techniques of painting, but simplifying the design and eliminating the background setting. A Late Minoan I B date for our fresco is reasonable, since the Cretan frescoes from which ours appears to be derived are securely dated in Late Minoan I A.

## 2. THE DOLPHIN FRESCO

The Dolphin fresco was found in Room VII of House J, Area J.<sup>24</sup> This house is directly behind the fortification wall at the western side of the site, north of House F.

<sup>18</sup> *P. of M.*, II, p. 114 notes this and discusses possible interpretations.

<sup>19</sup> S. Alexiou, "Ἀνασκαφὴ Κατσαμπᾶ Κρήτης," *Praktika*, 1955, pp. 314, 318, fig. 2; W. S. Smith, *Interconnections*, p. 79. Alexiou does not identify the birds but Smith states that two types are represented, one resembling the Caravanserai hoopoe and the other the Hagia Triada pheasant.

<sup>20</sup> *Phylakopi*, p. 77, fig. 65.

<sup>21</sup> *Pylos*, II, pp. 151-152, pl. J (9 F nws).

<sup>22</sup> W. Lamb, "Frescoes from the Walls," *B.S.A.*, XXV, 1921-23, p. 255.

<sup>23</sup> *Pylos*, II, p. 13, pl. B.

<sup>24</sup> Caskey, *Investigations, Part I*, figs. 2, 3.

The plaster fragments were found on a floor with pottery of the Late Minoan I B/ Late Helladic II period.

The design consists of a school of dolphins swimming to the right; parts of at least six, possibly nine, are preserved. The dolphins are painted light shades of blue, yellow ocher and pink; each one has at least one horizontal stripe of a contrasting color along its side. This colored stripe may represent a degeneration of the wavy line which often appears along the side of dolphins in Aegean art of the Late Bronze Age.<sup>25</sup> The three best preserved are swimming horizontally, parallel to each other. A fourth behind is leaping upwards. The two vertical fins of the central dolphin are preserved one above and one below the widest part of the body. The tails are shown in an upright position, a convention common in two-dimensional representations of dolphins in the Bronze Age.<sup>26</sup> No heads are preserved. The

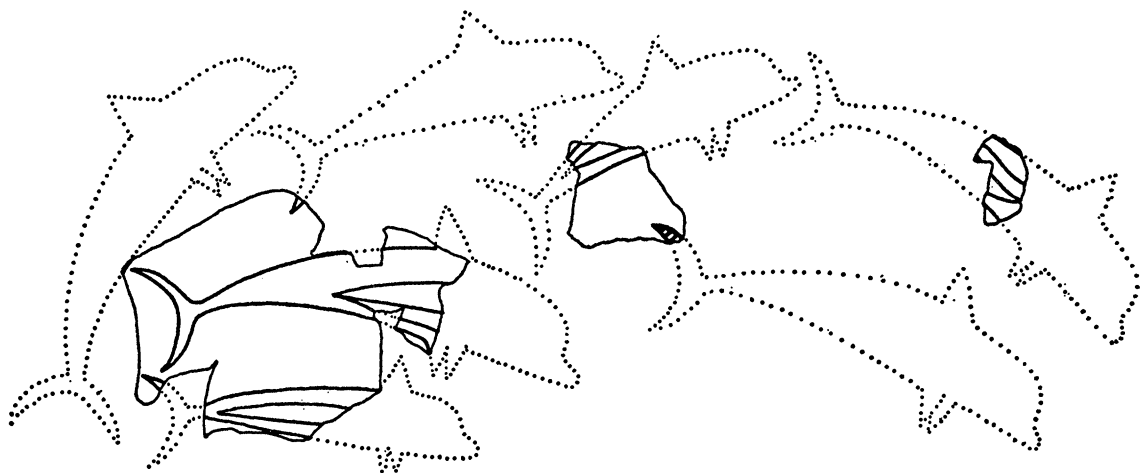


FIG. 2. Possible Reconstruction of the Dolphin fresco, F. 157, 157A, 157B.

estimated length of the dolphins varies from *ca.* 0.12 m. to 0.16 m. On none of the fragments is there any indication of bubbles, sea spray, or underwater rocks and sponges; the background is empty.

#### CATALOGUE

The plaster is white, neither very homogeneous nor fine in quality. The fragments are uniform in thickness; their undersurfaces are very even with no traces of attachment to an irregular surface of mud plaster or stones. Probably the layer

<sup>25</sup> For example on the side of the dolphins in the fresco from the Queen's Megaron at Knossos (*P. of M.*, I, London, 1921, fig. 394) and on the dolphins on the inlaid dagger from Prosymna (S. Marinatos and M. Hirmer, *Crete and Mycenae*, New York, 1960, pl. XXXVIII, bottom).

<sup>26</sup> Contemporary three-dimensional representations of the dolphin indicate the tail in a natural manner, e.g. the small terracotta dolphin (K4.443) found at Ayia Irini (*Hesperia*, XXXI, 1962, pl. 101, e).

of plaster on which the fresco was painted was laid onto an already plastered surface. The average thickness of the fragments is 0.006 m. The surface of the plaster is smooth and the paint, although thin and almost transparent in places, is well bonded with the plaster. The background is the unpainted white plaster. The colors are light blue, light yellow ocher, pink and black.

1. (F. 157) Fig. 2, Pl. 56, b; nine pieces joined;<sup>27</sup>  $0.161 \times 0.112$ , th. 0.006 m.; partially restored in plaster of Paris, the surface stained by black spots. Parts of four dolphins. In the center a yellow dolphin with a light blue stripe along its side, traces of pink above and below the blue, two yellow vertical fins, one on the back, one on the belly, and a yellow tail. Above: the tip of a yellow and blue tail. At upper left: the lower edge of a yellow belly. At the bottom: a light blue dolphin with a yellow stripe along the lower edge of the belly, pink and white stripes along the center of the body and a pink tail. Traces of black outlines remain on the yellow and blue tail and along the blue body.

2. (F. 157A) Fig. 2, Pl. 56, b; three pieces joined;  $0.055 \times 0.065$ , th. 0.006 m. Parts of two dolphins. At the top: the body of a blue dolphin with a pink stripe along the side. At the lower right: the tip of a tail outlined in black with black cross-lines, possibly painted over a very light pink.

3. (F. 157B) Fig. 2, Pl. 56, b; three pieces joined;  $0.034 \times 0.031$ , th. 0.007 m. Part of the body of a yellow dolphin with blue and white stripes along the side. A trace of a black outline appears on the upper edge of the body.

4. (F. 157C) Pl. 56, b; single piece;  $0.039 \times 0.057$ , th. 0.008 m.; the surface stained by black spots. The upper part of a blue tail outlined in yellow.

The existing fragments are not numerous enough to permit a reconstruction of the scene, nor even to ascertain whether the fresco was a panel composition or a continuous frieze. Since there are no traces of other fish or underwater forms, probably the whole fresco was composed entirely of diving and leaping dolphins. No fragments of border bands were preserved.

The flying fish from Phylakopi (Middle Minoan III?) are painted in pastel colors like our dolphins, but clearly represent a different species.<sup>28</sup> The smaller fish in the Dolphin fresco from the Queen's Megaron at Knossos (Late Minoan I?)<sup>29</sup> are painted in the same light blues and yellows as our dolphins but they represent still another species with a striped body and fringed tail. The Knossos dolphins are outlined in black, painted bright blue with white bellies, each with a black wavy stripe along the side, quite unlike our dolphins in style and color.

Our fresco painters show scant interest in naturalistic detail. They represent the dolphins as flashes of pastel colors against an empty white background, identifying them as dolphins by their diving, arching poses. The design is probably derived, ultimately, from Crete; the composition, however, has been simplified, the setting

<sup>27</sup> These pieces were originally assembled and glued by M. A. S. Cameron on a visit to Ayia Irini in 1964.

<sup>28</sup> *Phylakopi*, p. 70, pl. III.

<sup>29</sup> *P. of M.*, I, fig. 394; III, London, 1930, pp. 377-79, fig. 251.

eliminated, and the principal figures, as in the Blue Bird fresco, left to create the entire pattern themselves. A Late Minoan I B date is not incompatible with the dates suggested for the other dolphin or seascape frescoes.

Simplified designs and a lack of interest in depicting details characterize the Ayia Irini paintings. We cannot be certain if this reflects the technical limitations of provincial artists or a conscious adaptation of well-known patterns to suit local taste. The style of the fragments seems to me to suggest the latter, a conscious aesthetic; but whether this aesthetic concept is Keian or Cycladic needs further study.

In order to explore the possibilities of Keian originality in color schemes, subject matter or composition, one must compare our frescoes with all potential models available to the artists at that time. Examples of the same miniature style are known in Crete but they are not numerous. On the mainland, no contemporary frescoes have been preserved. It is uncertain, however, due to the factor of accidental preservation, whether what paintings now exist represent the entire or nearly entire repertory of the early Late Bronze Age artists.

Some of the motives that occur in the Ayia Irini paintings are known from contemporary or earlier Cretan frescoes, others only appear in later mainland frescoes. Some elements are unique and significantly different from all known models. We should like to know if the Ayia Irini painters are consciously adapting available scenes, inventing new ones for their own patrons, or copying models now lost to us. Further investigation of the fragments to be discussed in "Frescoes from Ayia Irini, Keos, Part II" (the miniature figured scenes of a town facade, a deer hunt, men and women dancing and a procession) may help to clarify the problem of "Keian originality."

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#### ADDENDUM

In the summer of 1973 an important new piece of the Blue Bird fresco was studied which necessitates a different reconstruction for the birds in Figure 1. This fragment was recovered from a pithos in the southeastern corner of Room 31, House A in 1972 (F. 286). It preserves part of the body, the feet and almost all of the tail of a bird facing left, standing on the sandy ground. The tail fans out from the body at approximately a twenty-two degree angle, the center feathers are bright blue, and there is a single white feather at the top and bottom. The next article on the Ayia Irini frescoes will include a detailed description of this fragment with a photograph and a suggested new reconstruction for the frieze.

APPENDIX: TECHNICAL EXAMINATION OF FRESCO SAMPLES  
FROM EXCAVATIONS AT AYIA IRINI.

Fresco samples from the excavations at Ayia Irini were submitted to the Conservation Center for study and analysis. They are as follows:

- Sample: 1. Plaster with white paint, 6 fragments, *ca.*  $6 \times 4 \times 2$  mm. (M-6. 178).  
2. Plaster with white paint,  $18 \times 22 \times 9$  mm. (A Rm. 31).  
3. Plaster with light blue paint and white stripes,  $32 \times 30 \times 10$  mm. (A-6. 21).  
4. Plaster with red paint, 4 fragments, *ca.*  $9 \times 5 \times 2$  mm. (M-6. 111).  
5. Plaster with red paint,  $7 \times 6 \times 2$  mm. (M-6. 178).  
6. Plaster with light red paint,  $38 \times 35 \times 5$  mm. (House B, Room II).  
7. Plaster with red paint,  $35 \times 28 \times 5$  mm. (House B, Room II).  
8. Plaster with yellow paint,  $10 \times 7 \times 4$  mm. (M-6. 178).  
9. Plaster with yellow paint, 2 fragments, *ca.*  $12 \times 7 \times 5$  mm. (M-6. 135).  
10. Plaster with yellow paint, 3 fragments,  $9 \times 8 \times 5$  mm. (A Rm. 31).  
11. Plaster with yellow paint and a black stripe,  $9 \times 5 \times 5$  mm. (M-6. 143).  
12. Plaster with yellow paint, 3 fragments,  $25 \times 17 \times 5$  mm. (N 23. 193).  
13. Plaster with yellow paint,  $30 \times 26 \times 5$  mm. (M-6. 143).  
14. Plaster with yellow paint and light blue over paint, 5 fragments, *ca.*  $40 \times 32 \times 15$  mm. (A-6. 28).  
15. Plaster with yellow paint,  $15 \times 5 \times 9$  mm. (A Rm. 31).  
16. Plaster with yellow paint,  $26 \times 20 \times 9$  mm. (A Rm. 31).  
17. Plaster with light blue paint,  $8 \times 6 \times 8$  mm. (M-6. 150).  
18. Plaster with light blue paint,  $7 \times 5 \times 4$  mm. (A Rm. 31).  
19. Plaster with light blue paint,  $10 \times 5 \times 3$  mm. (M-6. 326).  
20. Plaster with light blue paint,  $10 \times 9 \times 4$  mm. (M-6. 178).  
21. Plaster with blue paint,  $20 \times 15 \times 11$  mm. (A Rm. 31).

The samples were studied by microscopy, microchemical analysis, X-ray diffraction analysis, and photomicrography. The colors were measured using the Munsell Book of Color Chips, and a standard illumination of a high intensity tensor lamp. Cross sections were made of sixteen samples by imbedding a small fragment in a synthetic resin; these sections were polished for microscopic study and for making photomicrographs. In addition, eleven samples of known fresco materials prepared at the Conservation Center in 1963 were studied in like manner for comparison.

## THE PIGMENTS

*White*—Samples 1, 2, 3. All samples have a thin layer of fine white paint which proved to be calcium carbonate, in microchemical tests. All samples were measured as 10YR 9/1 on Munsell Charts.

*Red*—Samples 4, 5, 6, 7. The colors vary somewhat in intensity and gloss. However, by X-ray diffraction analysis as well as by microchemistry all samples proved to be iron oxide, that is a red ocher mixed with varying quantities of calcium carbonate. The Munsell designations are: Sample 4, 10 R 5/6; 5, 10 R 4/4; 6, 10 R

6/5; 7, 10R 4/6. Sample 7 appears to have been burnished after application of the paint to the plaster.

*Yellow*—Samples 8, 9, 10, 11, 12, 13, 14, 15, 16. These samples varied considerably in tonality as well as gloss. Samples 8, 13, 15, 16 are all quite glossy, and may have been burnished. The other samples are rather mat. All were tested by microchemistry and three samples (12, 13, 14) were tested by X-ray diffraction. All proved to be a yellow oxide of iron, that is yellow ocher. Munsell color designations are: Sample 8, 7.5YR 6/6; 9, 10YR 7/6; 10, 10YR 7/4; 11, 10YR 6/6; 12, 10YR 7/4; 13, 10YR 6.5/6; 14, 10YR 6/5; 15, 10YR 6/6; 16, 10YR 6/6. The color variations appear to be due to the varying quantity of calcium carbonate present.

*Blue*—Samples 17, 18, 19, 20, 3, 14, and 21. All samples appear somewhat gray in tonality. In cross sections of samples examined at 100 X magnification, it appears that a layer of gray paint was generally applied over the plaster (a mixture of carbon black and calcium carbonate). On top of this is a rather powdery layer of a quite transparent blue pigment. By microscopy and X-ray diffraction the blue pigment was identified as a calcium copper silicate—that is Egyptian blue. The blue is applied over the dark underpainting to provide a more intense color with a smaller quantity of blue pigment. The Munsell color designations are: Sample 17, 7.5B 6/2; 18, 10B 7/1; 19, 5PB 5/1; 20, 10BG 7/2; 3, 10B 7/1; 14, 10BG 8/2; 21, 10B 7/2. There is considerable variation in tonality due to the depth of the gray underpainting as well as a pale yellow accretion in two samples, 20 and 14.

*Black*—Samples 22, 11. Both samples are a carbon black of very fine particle size. The pigment is of the lamp-black type—that is formed by collecting soot from a burning organic substance. This same pigment was found in varying quantities under the blue samples. Sample 11 is a black stripe over a layer of yellow paint. Munsell color designations: Sample 22, N4; 11, 10YR 3/1.

## PLASTER

The painted plaster samples vary in thickness from 2 mm. to 15 mm. They vary in color from almost pure white to pale yellow. The plaster consists of one layer with a fine “slip” of plaster beneath the paint in about half the samples, determined by the binocular microscope.

The plaster is almost entirely pure calcium carbonate with 2 to 13% siliceous material. It is possible some siliceous material was from accretions due to burial while a part may be of the original composition of the plaster. It does not appear that sand was added to the plaster. The small quantity of residue remaining after dissolving away the calcium carbonate with nitric acid proved to be a silicon dioxide by X-ray diffraction analysis. The plaster varies in hardness from a soft, powdery material to a hard, firm plaster.

## PAINTING TECHNIQUE

All samples were tested with a number of solvents by rolling cotton swabs containing the solvent on the surface. Solvents used were: acetone, cold and hot water, boiling water, dilute and concentrated ammonium hydroxide, and dilute sodium hydroxide. All proved to be insoluble except Samples 10 and 14. These were samples of yellow ochre paint which were somewhat soluble in all solvents used. Also the Egyptian blue layer in Sample 21 was slightly soluble in all the solvents. It is apparent that the frescoes are not painted in a water soluble medium such as a gum, with the possible exception of Samples 10, 14, and 21.

Cross sections were made of 16 samples of the Ayia Irini frescoes and of three types of known frescoes from the Conservation Center. The Conservation Center frescoes are: 1. True fresco consisting of pigment mixed with lime water and applied to a wet plaster. 2. *Secco fresco* consisting of pigment mixed with fresh lime and applied to a set plaster two days old. 3. *Secco fresco* consisting of pigment mixed with a beeswax-casein emulsion and applied to a set plaster two days old. In both of the *secco* types there is a clear line of demarcation between the plaster and the paint layer although the paint layer is firmly attached to the plaster (Pl. 57, a). In the true fresco, the plaster has been "disturbed" by the brush strokes and the pigment has penetrated into the plaster layer (Pl. 57, b).

From the Ayia Irini fresco cross sections, it is apparent that in some instances there is brush disturbance of the wet plaster layer from application of paint, and pigment has penetrated into the wet plaster. Other samples have a sharp line between paint and plaster which would indicate a *secco* technique. The observations of the various samples are summarized as follows:

<i>Sample</i>	<i>Color</i>	<i>Brush Stroke Apparent</i>	<i>Penetration (Average)</i>	<i>Apparent Technique</i>
1	White	White paint layer	not discernible	from plaster.
4	Red	Moderate	60 microns	<i>Buon fresco</i>
22	Black	Little or none	16 microns	Probably <i>secco</i> (Pl. 57, c)
17	Blue	Moderate	64 microns	<i>Buon fresco</i>
9	Yellow	Moderate	90 microns	<i>Buon fresco</i>
18	Blue	Moderate	48 microns	<i>Buon fresco</i>
5	Red	Great	60 microns	<i>Buon fresco</i> (Pl. 57, d)
11	Yellow and black	Moderate	32 microns (yellow)	The yellow was apparently <i>buon fresco</i> and the black <i>secco</i>
3	Blue	Great	80 microns	<i>Buon fresco</i>



<i>Sample</i>	<i>Color</i>	<i>Brush Stroke Apparent</i>	<i>Penetration (Average)</i>	<i>Apparent Technique</i>
12	Yellow	Moderate	64 microns	<i>Buon fresco</i> (Pl. 58, b)
13	Yellow	Moderate	32 microns	Probably <i>buon fresco</i>
14	Yellow	Great	110 microns	<i>Buon fresco</i> (Pl. 58, c)
6	Red	Moderate	110 microns	<i>Buon fresco</i>
7	Red	Moderate	60 microns	<i>Buon</i> and burnished (Pl. 58, d)
15	Yellow	Moderate	112 microns	<i>Buon fresco</i>
21	Blue	Great	112 microns	<i>Buon fresco</i> (Pl. 58, a)
16	Yellow	Moderate	80 microns	<i>Buon fresco</i>

Tests were made to determine if a layer of chalcedony had formed over the surface of the samples as had been reported by Duell and Gettens.<sup>1</sup> A firm layer that would remain intact upon dissolution of the plaster was not found. A thin scraping of the surface of Sample 21 was analyzed by X-ray diffraction and proved to be silicon dioxide. However, if this is chalcedony it is a very thin layer.

## CONCLUSIONS

The Ayia Irini frescoes appear to be largely of a true fresco type with brush strokes apparent where the brush was drawn over wet plaster. Many pigments have penetrated into the plaster for a depth up to 100 to 200 microns—a phenomenon not likely if the plaster were dry when the paint was applied. However, in Samples 22 and 11, the black paint seems to have been applied to a dry surface. It is also possible the blue was applied over a gray layer after the plaster had set.

The pigments used were: white—calcium carbonate, red ocher, yellow ocher, Egyptian blue and lamp black.

Acknowledgment: Much of the preliminary work in analysis and preparation of cross sections was carried out by Laurence Hoffman at the Conservation Center in 1969.

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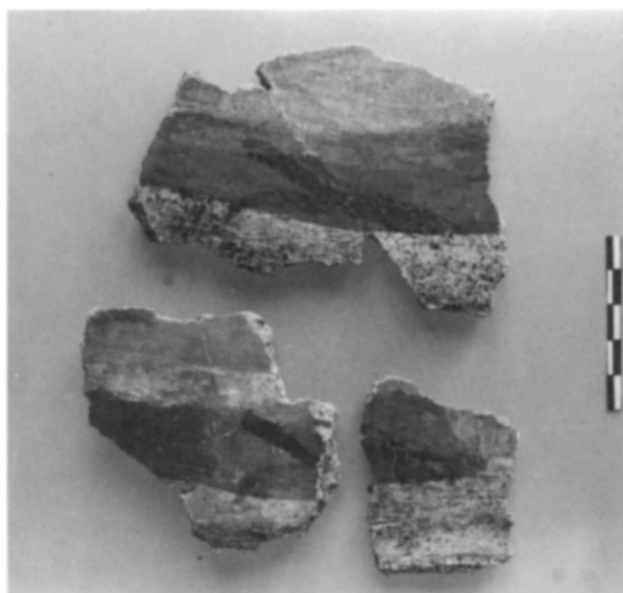
<sup>1</sup> P. Duell and R. J. Gettens, "A Review of the Problem of Aegean Wall Painting," *Technical Studies*, X, 4, p. 179 ff.



a. Blue Bird Fragments: Overlapping Birds (F.183).



b. Upper Border Bands (F.161, F.285).



c. Lower Edge of Sandy Ground (above, F.163;  
below F.162, F.283).

BLUE BIRD FRAGMENTS

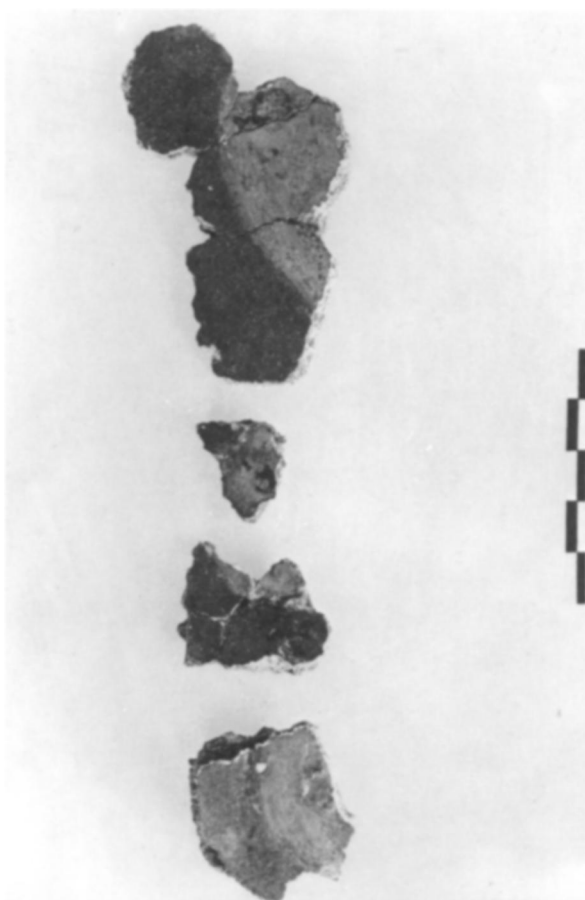
KATHERINE COLEMAN: FRESCOS FROM AYIA IRINI, KEOS. PART I.



a. Heads (left, F.176 + 184; right, above F.167, below F.182).



b. Flying Bird Fragments (above, F.168; below F.179, F.180).



c. Heads (F.169, F.273, F.175, F.171).



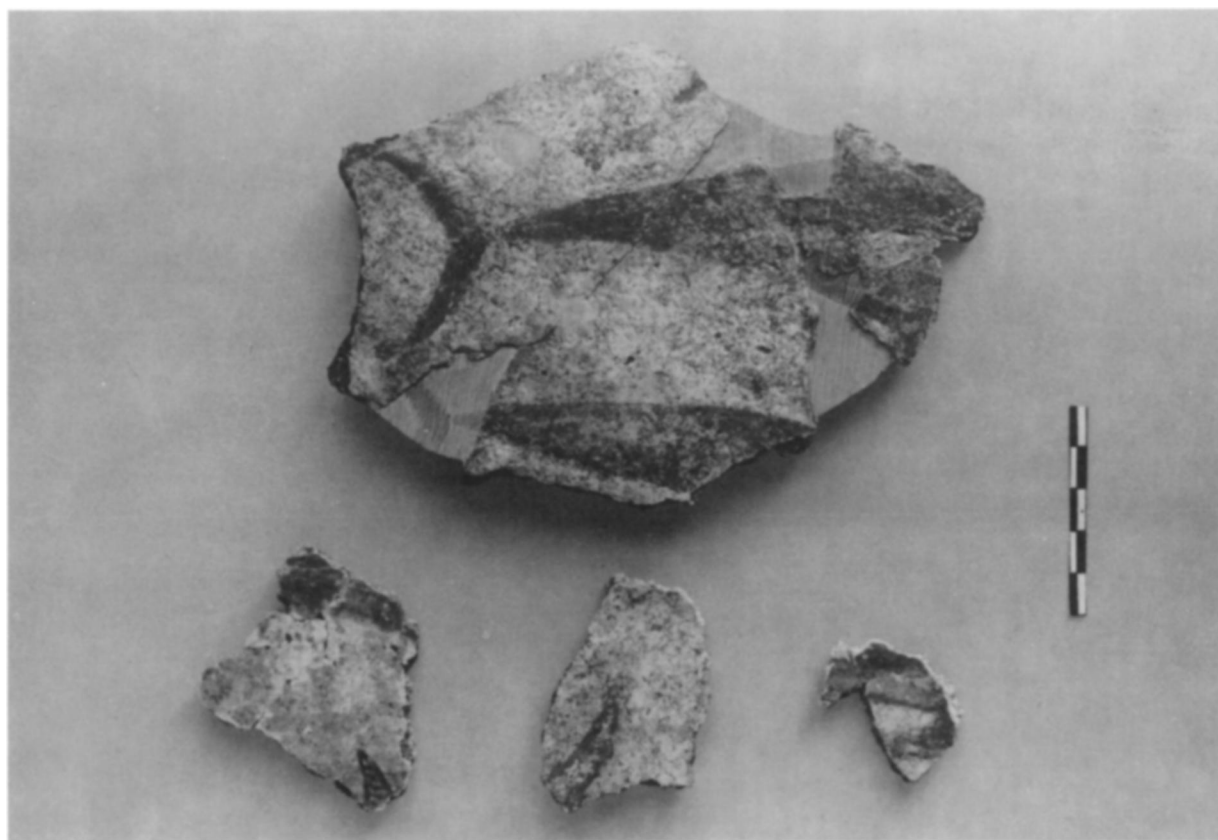
d. Body Fragments (F.275, F.181, F.177).

# BLUE BIRD FRAGMENTS

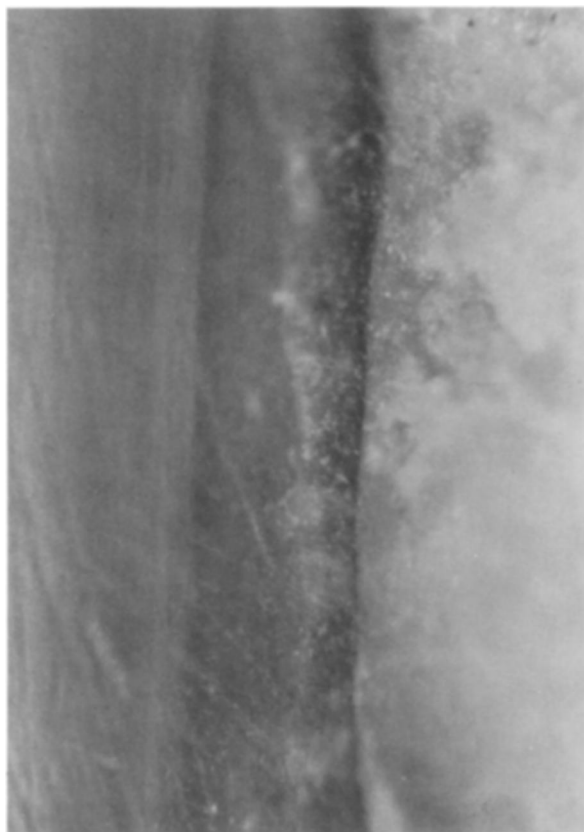
KATHERINE COLEMAN: FRESCOS FROM AYIA IRINI, KEOS. PART I.



a. Blue Bird Fragments: Wing, Belly, Body (left, above, F.272, below, F.277; F.274, F.276, F.178).



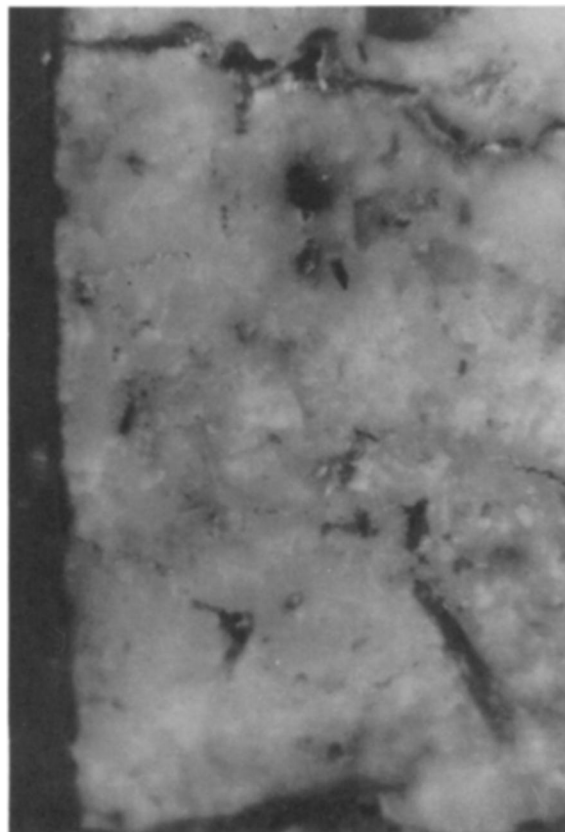
b. Dolphin Fragments (above, F.157; below, F.157A, F.157C, F.157B).



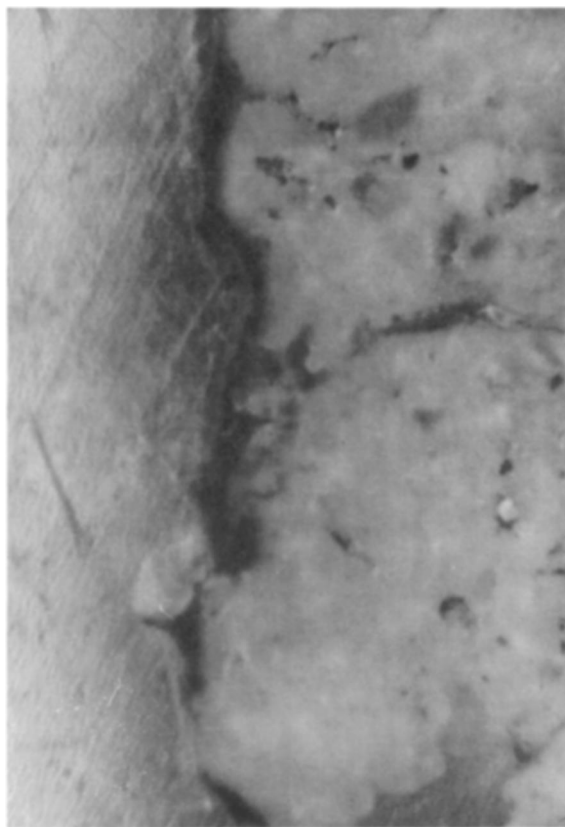
a. *Secco Fresco*. Conservation Center Sample. 100 X.



b. *Buon Fresco*. Conservation Center Sample. 100 X.

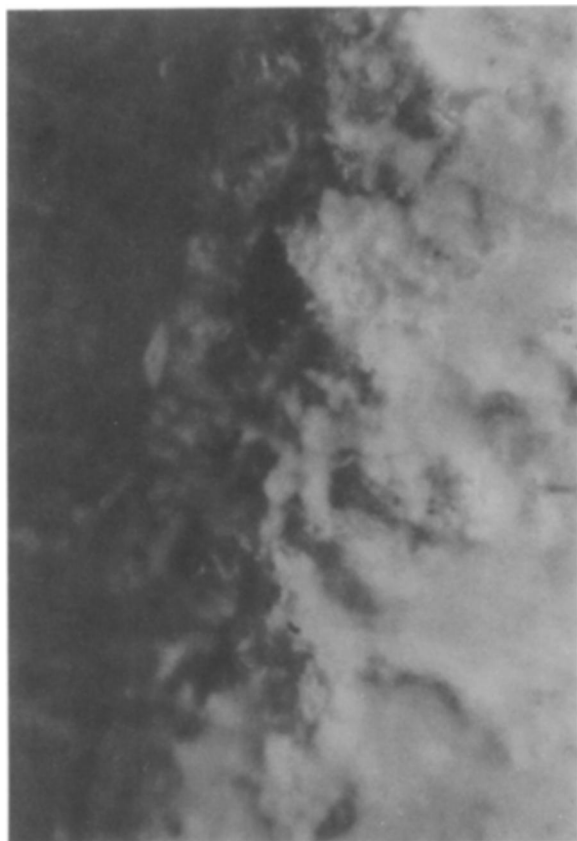


c. Ayia Irini Fresco Sample 22. 40 X.

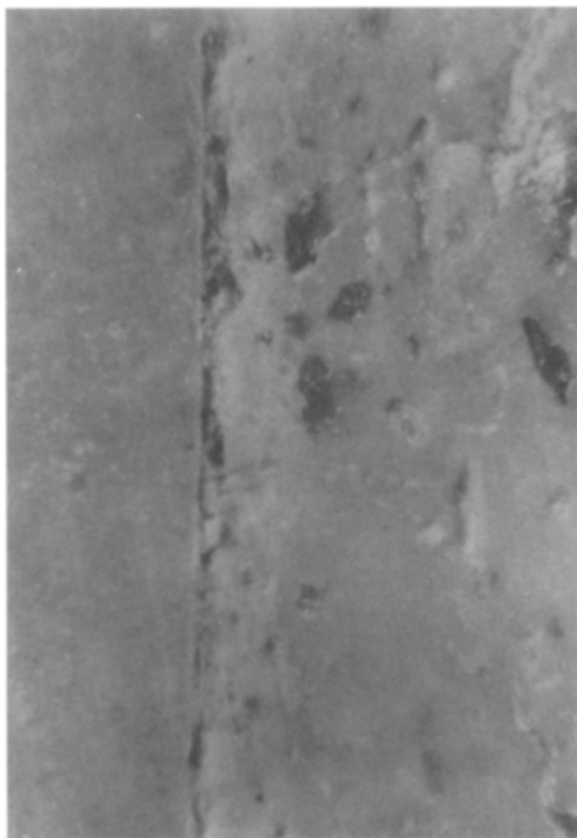


d. Ayia Irini Fresco Sample 5. 40 X.

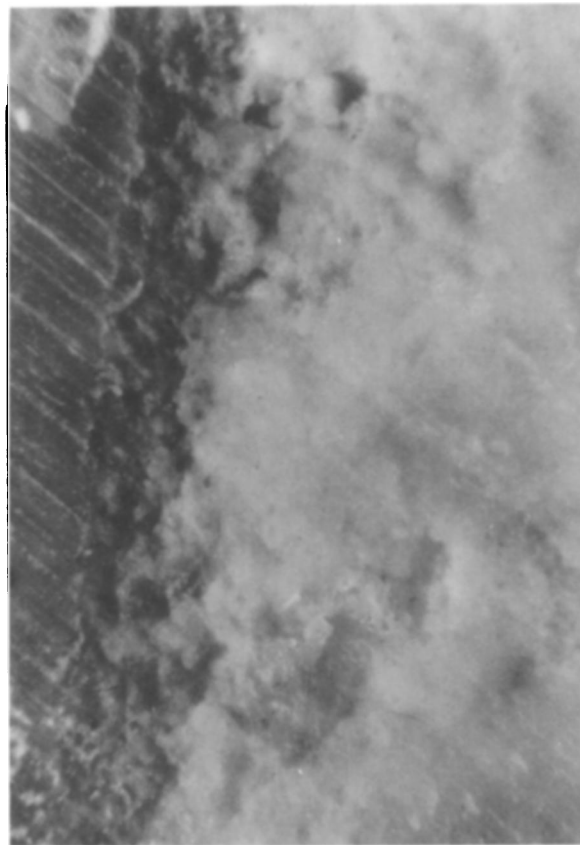
KATHERINE COLEMAN: FRESCOS FROM AYIA IRINI, KEOS. PART I.



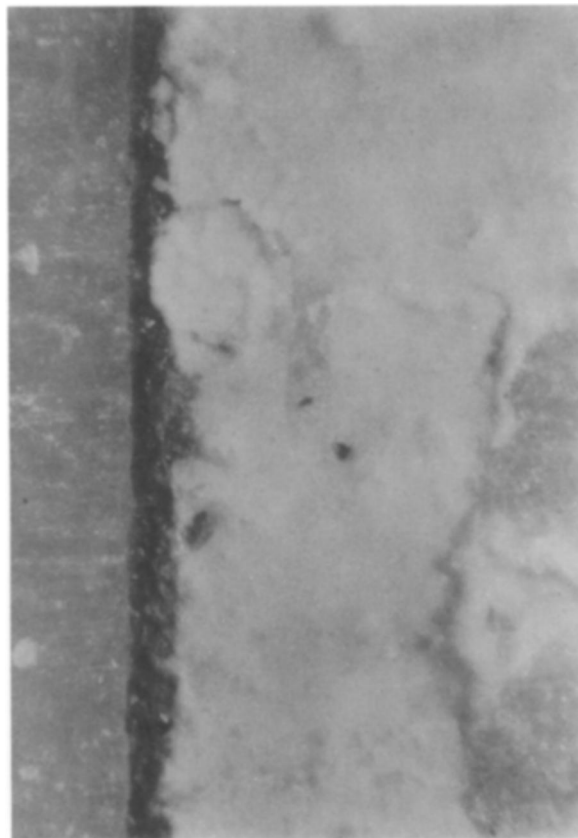
a. Ayia Irini Fresco Sample 21. 100 X.



b. Ayia Irini Fresco Sample 12. 40 X.



c. Ayia Irini Fresco Sample 14. 100 X.



d. Ayia Irini Fresco Sample 7. 100 X.