large, coarse, true grindstone is used, holding the specimen firmly in the hand without pressing against the stone too hard and grinding on the side of the stone. This amounts to chipping away the charcoal in many places at once. To date no specimen has come apart under this treatment, although care must be exercised. This ground surface is absolutely illegible; additional processes must be used before the rings are legible.

1. If the specimen has not been saturated in an alvar solution it is well to do so. This solution should be a very thin one, and a few hours of total immersion should be sufficient.
2. Dry specimen; if desired, mount on a small board. After this much depends on the preferences and ingenuity of the worker who may develop some techniques of his own.
3. Shave off thin sections with a razor until surface is smooth.
4. Make a solution of alvar, acetone, and ambroid. This writer makes separate alvar and ambroid solutions, thin enough to run freely, and mixes about two thirds alvar solution with one third ambroid solution. This medium has been arrived at after experiments with paraffin, bakelite, collodion, alvar, and ambroid. None of these was quite satisfactory. Ambroid seems to give the alvar just enough support to make it work well.
5. By repeated applications build up a glazed surface of the above solution and let it harden.
6. Shave off surface until it is seen that very thin sections of the specimen are being removed (use a sliding cut).
7. Clear surface with pure acetone; a soft camel's-hair or sable brush is ideal for applying acetone.
8. An alternative to the above is to follow this procedure as far as step 5; then, instead of allowing coating to harden it is cut when it has sufficient body to hold the cells. The time for this varies very much and only experience can tell when the surface is right. The surface may be left as is or cleared with acetone, as desired. The writer has had more success with this method, and has used it on pinyon, pine, and Douglas fir with good results.
9. For rotted wood the procedures are the same, except that kerosene brings out the rings more clearly after a good surface has been obtained.

It is necessary to use the sharpest blades, and to discard them as soon as they are the slightest bit dull; several are often required for one specimen.

It should be possible to make thin sections and mount them. Very good thin sections of small size may be removed during step 6.

The method described above is not feasible for everyday dating as the time involved is too long, but it is useful where specimens must be prepared for photographing, or for measurement. What the dendrochronologist is looking for is a medium which will penetrate and give enough strength to the cell walls to prevent their collapse when cut, and which is not too hard to cut. It is possible that a chemist will have the final answer; in the meantime the method described here may be useful.

## PHOTOGRAPHY OF CHARCOAL

FREDERICK H. SCANTLING

The technique of photography of charcoal specimens has provided a fertile field for experimentation by dendrochronologists.* Recently a number of highly successful photographs have been obtained by the writer with the aid of modifications of earlier procedure.**

*A. E. Douglass, *Tree-Ring Bulletin*, 8:10-16, 1941.
H. F. Davis, *Tree-Ring Bulletin*, 2:12-16, 1935.
E. T. Hall, Jr., *Tree-Ring Bulletin*, 5:13, 1939.

**Part of the operations under a grant-in-aid to A. E. Douglass by the Society of the Sigma Xi.

*Untreated surfaces.*

It is often desirable to photograph a charcoal specimen in its original form before any attempt has been made to improve the surface. In this state the surface is usually very irregular and is likely to be discolored. It is possible to get a photograph under these conditions by cleaning the surface with a camel's-hair brush and photographing at a reduction of one third, using diffuse light in order to eliminate shadows caused by irregularities in the surface. In this manner it is possible to photograph a surface with variations as great as one centimeter from the mean and have the rings appear sharp and readable. Photographs of this kind are necessarily not detailed, but are valuable as records of the original state of the specimen (see Figure 1a).

A fresh fracture surface permits an even better photograph (see Figure 1d) than is possible with the best prepared surface thus far obtained, but as in the case of chipped surface treated below the area of good definition is limited.

*Chipped surface.*

The next stage at which photographs may be taken is when the surface has been chipped to facilitate the reading. This chipped surface is brilliant and provides excellent contrasts, but is uneven. Therefore, photographs of greater magnification than natural size are not satisfactory. In photographing a chipped surface the same procedure is used as for the original surface, except that the reduction need not be as great. It is possible to photograph a small portion of a chipped or original surface at a high magnification to show some particular detail, but the well-defined area is limited.

In order to photograph a charcoal specimen at any magnification it is necessary to have the surface as nearly plane as possible. Any method of surfacing charcoal for photography must have these characteristics: be plane, show details of the structure, give good contrast between the early-wood and latewood, and allow a cell count from one ring to another. This latter is necessary for the positive identification of rings. The following method, based on a method described by Hall, has these characteristics and the additional advantage that the specimen is preserved by being impregnated with paraffin.

*Properties of charcoal and paraffin.*

Charcoal is friable and very porous in contrast to wood. The porosity of charcoal is directly related to the cell size; thus, ponderosa pine is most absorbent, with Douglas fir, pinyon, and juniper following in that order.

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Figure 1: Photographs of various types of surfaces. Marked dates as follows: b—A.D. 664; c—A.D. 664; d—A.D. 320; e—A.D. 943; f—A.D. 1055.

a: F-3992 at N.A. 2798, ponderosa pine, A.D. 577-799, original fracture surface. x⅓. Exp. 25 sec. at f 16 on Panatomic X, 6-in. lens, tissue paper cone. Irregularities of the surface are minimized by the reduction in scale and the diffuse light. It is possible to get a complete reading on the negative with the aid of a x10 lens.

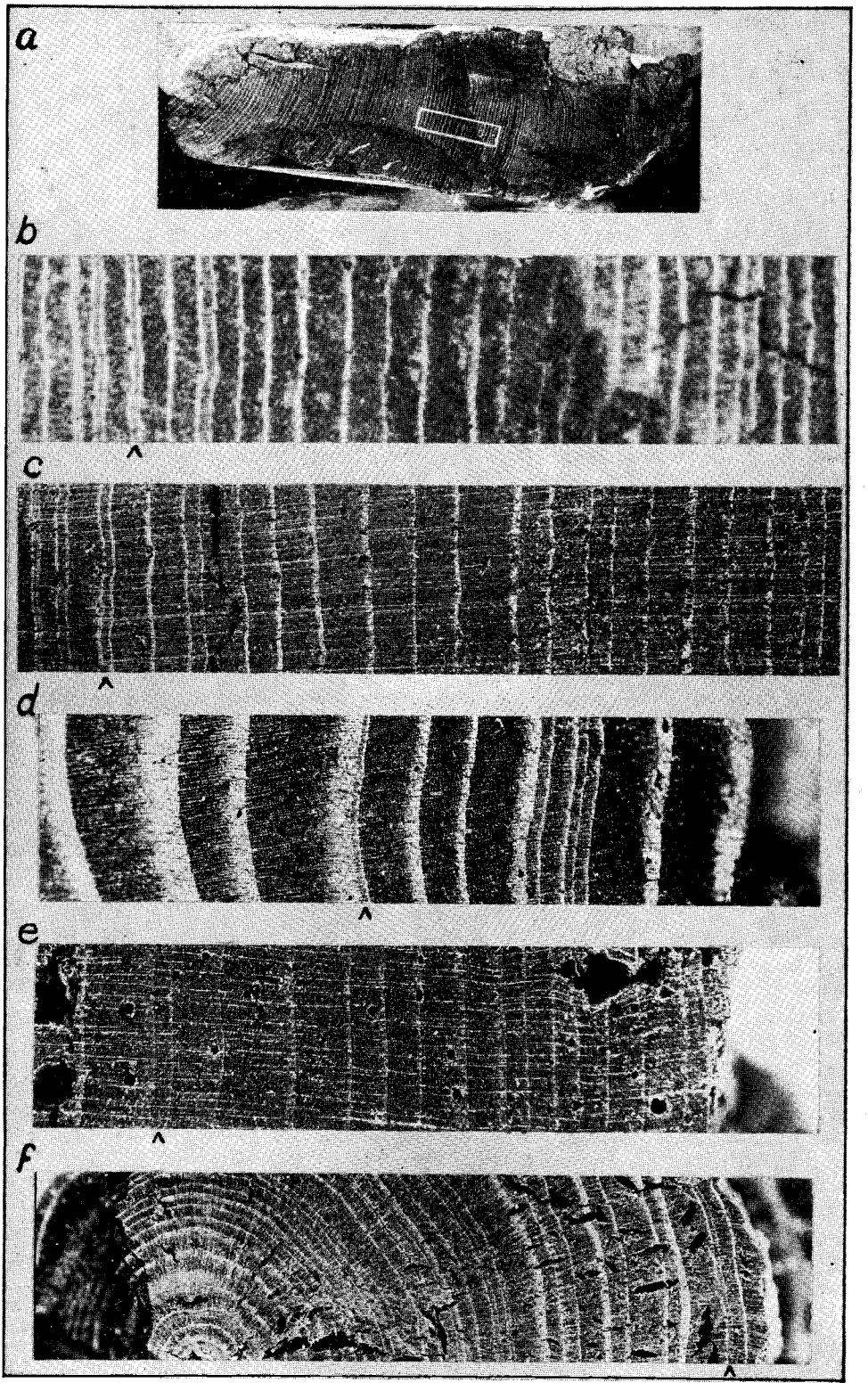
b: F-3992 at N.A. 2798. x9 enlargement of area outlined in white. Latewood is legible but details are lost. Rings fade out at ridgeline in right center.

c: F-3992 at N.A. 2798, prepared plane surface. x9. 50 sec. at f 12 on Eastman Commercial, 2-in. lens, Silverman Illuminator. Same area as 1b. Note sharpness of definition over entire print, in contrast to fuzziness of 1b.

d: M-110, Douglas fir, original fracture surface. x17. 50 sec. at f 9 on Isopan, 2-in. lens, overhead reflector. Central portion sharp but ends fuzzy.

e: F-1941 at N.A. 202A, pine, prepared plane surface. x10.5. 25 sec. at f 4.5 on Ansco Portrait, 2-in. lens, overhead reflector.

f: W35/7, Douglas fir, prepared plane surface. x3.9. 25 sec. at f 11 on Isopan, 4-in. lens, overhead reflector. Piece was badly checked but a satisfactory surface was obtained by the paraffin process described in the text.


a
b
c
d
e
f

Properties of paraffin worthy of note are its vaporizing point and flash point. The vaporizing point is 100°C, and care must be taken when using paraffin above this temperature to prevent the vapor coming in contact with an open flame. The flash point of paraffin is 185°C, making it necessary to work below this temperature to insure the safety of the operation. It has been found that the best working temperature for molten paraffin in a open pan is 150°C, and for the oven 160°C.

*Surfacing.*

To prepare the specimen for the paraffin treatment the surface to be photographed is reduced to a plane. In selecting a radius to surface, the longest continuous radius which includes the outside is desirable. However, since it is not always possible to find a continuous radius, one must often resort to surfacing two or more radii in order to photograph a complete series.

Any large knobs or irregularities of the surface can be removed with a hack-saw blade held in the fingers. Minor irregularities are removed with a razor blade. Final flattening is done with a large, flat file. In surfacing with a file a radial stroke from the outside of the specimen towards the center prevents the chipping of the outside ring. Also, better control is obtained by moving the charcoal along the surface of the file, rather than the file over the charcoal. Filing fills the cells with dust and this must be removed by carefully shaving away the surface with a razor blade. At this stage the surface should be tested with a straightedge, and any unevenness removed.

To guard against possible fracture of the specimen during the dipping and baking process it should be wrapped firmly with string, with particular care to secure the circumference of the surface to be dipped in paraffin. The original tag should be removed and a new one substituted during the paraffin treatment. This must be done because the heat of the oven causes the tags to become brittle, and portions may be lost in future handling.

*Paraffin treatment.*

The paraffin is heated in a shallow pan to the proper temperature. The prepared surface is dipped in the paraffin slowly, to a depth of one-half inch, and removed as soon as the bubbling stops. These bubbles in the molten paraffin are caused by the escaping air; the action serves to cleanse the surface of any dust particles. Care must be taken not to dip the charcoal too suddenly or checking of the surface will result. If the charcoal appears very friable the surface should be sized with molten paraffin applied with a small swab. The surface can then be dipped without danger.

Allow the specimen to cool thoroughly before preparing the final surface. The most important factor in preparing the final surface is the use of a *fresh* razor blade. A dull blade at this stage can ruin the surface by crushing the cell walls and destroying their reflecting quality. Shave the surface carefully, beginning at the center and drawing the blade radially towards the outside. After the final surface has been cut it should be inspected for any inclusions of dust in the cells and tested with a straightedge. At this stage the surface is glossy and the paraffin is readily visible, obscuring most of the details of the charcoal structure.

Preheat the oven to 150°C and place the specimen on the rack face down on wire gauze. This allows a free circulation of air, and the melting and vaporizing paraffin can carry away any extraneous material from the surface. The specimen should remain in the oven at constant temperature for twenty minutes (with substantially longer intervals, there may be some impairment of structure). During this time it should be checked at five

minute intervals to determine the progress of the vaporization. If the paraffin is collecting at one point on the surface and it seems likely that clouding of this portion will result, turn the specimen so that this portion will be raised and the paraffin will drain clean. If the surface should cloud on cooling, or portions be obscured by a concentration of paraffin or dust particles, dip the surface briefly in molten paraffin and bake as before. If this does not clear the surface, cut a fresh surface and repeat the process. When properly finished the surface should show no evidence of the paraffin and the cells should appear distinct. This surface can be photographed at a high or low magnification and all details of the structure of the charcoal will be discernable (see Figures 1c, 1e, and 1f).

The method described above was carried out in the laboratory but can be done very easily in the field by using as a source of heat a small gasoline stove with folding oven.

*Placement of the specimen for photography.*

The specimen should be placed under the lens so that the plane of the surface is parallel to the plane of the film. If available, a small stage with tilt top, and a knob for raising and lowering is desirable. With such a stage minute adjustments in the position of the specimen are possible. This is a great time saving device for photographs at great magnification where minute adjustments in the plane of the surface are necessary for proper alignment and sharp focus over the entire film.

*Lighting.*

Lighting is a most important phase in the photography of charcoal. By varying the intensity and direction of the light source it is possible to completely alter the details of the specimen that will appear on the film. The proper lighting for maximum detail and contrast is obtained from a vertical light source, which gives a specular reflection from the cell walls. There are several methods of supplying a vertical light source, but only three of the most suitable are discussed here.

When photographing an uneven surface it is necessary to diffuse and distribute the light evenly so that shadows are eliminated; this tends to minimize the irregularities in the surface and make it appear flat. This was done by constructing a cone of white tissue paper, the length of the cone depending on the working distance of the lens, *i.e.,* specimen-lens distance. The cone is suspended over the specimen large end down, and the camera lens inserted in the small end. Four desk lamps were then evenly spaced around the cone and so arranged that the lights were as near the top of the cone as possible.

The overhead reflector consists of a piece of cardboard faced with white paper or tinfoil. A hole is cut in the center to allow the insertion of the lens. The lights are arranged below the reflecting surface and shaded so that the direct rays do not reach the surface to be photographed. The reflector can either be suspended in a frame or else mounted directly on the lens. This device gives a bright, even illumination over the entire surface.

The Silverman Illuminator is a special circular bulb in a mount that clamps over the camera lens. The bulb is supplied with a special rheostat and switch for increasing the illumination while an exposure is being made. The quality of the negatives obtained with this lighting is excellent but is not materially different from that obtained with the overhead reflector.

*Mechanics of the photography.*

These are already published in the *Bulletin* in sufficient detail, except for a note on exposure. It is difficult to get the proper light reading with a

standard photo-electric type of exposure meter. The scanning field of the meter should be reduced so that only the actual surface to be photographed will register. This was done with a short length of cardboard tubing covered at one end with black paper in which a slot was cut. The photo-electric cell of the meter was inserted in the open end. By comparison of the readings on a bright surface with and without the tube the proper ratio of reduction can be found. The one used for these illustration gave a x2 factor.

*Conclusion.*

Charcoal prepared in the fashion described in this paper has yielded photographs which compare favorably with the best photographs of wood specimens. It has been found that an average of four specimens a day can be prepared and photographed in this manner.

## ERRATA

(Papers dealing with the Flagstaff area—contributed by the Museum of Northern Arizona).

COLTON, HAROLD S. Prehistoric Culture Units and their Relationships in Northern Arizona. Mus. North. Ariz. Bull. 17, 1939.
p. 26: "Distribution in time." N.A. 2551, 770-927 A.D., should read *685+X.*

DOUGLASS, A. E. The Central Pueblo Chronology. Tree-Ring Bull. 2 (4), 1936.
p. 34: Table, 2nd column. Delete Sunset Crater Area.
N.A. 1680, 990± should read *909±.*

DOUGLASS, A. E. Southwestern Dated Ruins: V. Tree-Ring Bull. 5 (2), 1938.
p. 11: Line 4. Sunset Crater should read *Antelope Valley.*
Line 18. N.A. 450 should read N.A. 405.

GLADWIN, HAROLD S. A Review and Analysis of the Flagstaff Culture. Medallion Papers 31, 1943.
p. 7: N.A. 1296, Bonito Terrace near Sunset Crater should read *Hill overlooking Medicine Valley.*
*p. 56: N.A. 1652 should read *1653B.*
*p. 67: N.A. 1680, 990 should read *909±.*
p. 75: N.A. 1224 should read *N.A. 1244.*
*p. 81: N.A. 1652 should read *N.A. 1653B.*
*p. 82. N.A. 1675, Medicine Valley should read *Bonito Park.* N.A. 1676, Medicine Valley should read *Bonito Park.*
p. 84: N.A. 1814, Medicine Valley should read *the terraces north of Deadmans Wash.*
p. 88: N.A. 2001 should be two sites, *N.A. 2001A, 2001B.*
p. 89: N.A. 2002, Deadmans Flat should read *Deadmans Drainage* or *Medicine Valley.*
*p. 91: N.A. 2551, 658 should read *685 A.D.*
770-927 should be deleted. It is an error in transcription by Colton. It refers to N.A. 2798.

McGREGOR, J. C. Additional Prehistoric Dates from Arizona. M.N.A. Museum Notes 5 (3), 1932.
p. 14: Table. N.A. 1652B should read *N.A. 1653B.*

McGREGOR, J. C. Culture of Sites Which Were Occupied Shortly Before the Eruption of Sunset Crater. Mus. North. Ariz. Bull. 9, 1936.
p. 20: Third paragraph, line 1. N.A. 3029 should read *N.A. 3028.*
Third paragraph, line 2. N.A. 3028 should read *N.A. 3029A.*

McGREGOR, J. C. How Some Northern Arizona Pottery Types Were Dated. Mus. North, Ariz. Bull. 13, 1938.
p. 6:Table 1. N.A. 1959, Sunset Pithouse should read *Coyote Range Pithouse.*

McGREGOR, J. C. Southwestern Dated Ruins: III. Tree-Ring Bull. 4 (4), 1938.
p. 6: N.A. 1570, Medicine Valley should read *Bonito Terrace.*
N.A. 538 should read *N.A. 358.*
N.A. 2630, date should read *1124-1130±3.*
N.A. 862, Pithouse should read *Fort.*

*Denotes errors copied from previous publications. See other authors in this list.