REVIEWS

CONTRIBUTIONS TO THE HISTORY OF GEOLOGY, edited by George W. White, a series of classical works in geology, reprinted in facsimile with introductory biographical and bibliographical commentaries by the editor and other distinguished students of the history of geology. These volumes are handsomely and skillfully reproduced and are carefully selected to make essential but nearly unobtainable works available to students and historians at relatively modest cost. Published by Hafner Publishing Company, Inc., New York and London.

5. James Hutton's SYSTEM OF THE EARTH, 1785; THEORY OF THE EARTH, 1788; OBSERVATIONS ON GRANITE, 1794; together with Playfair's BIOGRAPHY OF HUTTON: facsimiles of the original editions, with an introduction by Victor A. Eyles and a foreword by George W. White, New York, 1970, xv + 203 pp., portrait, 2 pls., $12.95

This volume presents all of James Hutton's geological writings that have not been previously reprinted, making available to modern readers a complete collection of the geological works of the founder of geology. These works are virtually impossible to obtain in the original today, thus the importance of this volume cannot be overstated. Hutton set forth the principles of the Vast Continuum of geologic time, uniformity in geologic process, the role of heat and igneous activity as well as that of sedimentary process and erosion in shaping the earth, and the concept of the unconformity. Upon these fundamentals, through the medium of the important and explanatory *Illustrations of the Huttonian Theory of the Earth* (John Playfair, 1802), Charles Lyell based his *Principles of Geology* (1830-1833). Modern geology began (or was codified) with this series of works by Hutton, Playfair, and Lyell. Doctor Eyles discovered Hutton's unsigned and undated *Abstract* which is here reproduced and in the introduction summarizes his evidence that Hutton was the author and establishes the earlier date, 1785, for the first appearance of the Huttonian philosophy. This, the fifth of the classical reprint series, is one of the most important primary sources to have been reprinted in recent years.

6. TRAVELS THROUGH THE WESTERN COUNTRY IN THE SUMMER OF 1816, by David Thomas: facsimile of the 1819 edition. With an introduction by John W. Wells; a foreword by George W. White; and, *Notes on Thomas's Geological Observations* by John W. Wells and George W. White, New York, 1970, xviii + 338 pp., 3 folding charts, $14.95

This is one of the earliest books to describe and report on the origin of many geological features in western New York, northwestern Pennsylvania, Ohio and Indiana. Further, Thomas traveled entirely overland rather than by way of the Ohio River, thus observing regions previously unseen by anyone with scientific ability. His observations are geologic, economic, geographic, physiographic, and climatological, including such good descriptions of strata that they can be considered the first descriptions of geological formations in these areas. Doctor Wells's introduction reveals his intense interest and insight into David Thomas and his importance and influence on early science. Thomas was primarily devoted to agriculture and horticulture but his wide interest in other fields and his speculations about the origins of geological and other features makes his book quite significant and a worthy addition to the classic reprint series. Maps illustrating Thomas's route are included and his extensive notes which were not keyed to his text have been cross-indexed by professors Wells and White with marginal page numbers at the appropriate place in the text indicating where the notes appear in this version. A bibliography listing works cited or referred to by Thomas is appended.

H.C.S.

SCANNING ELECTRON AND OPTICAL MICROSCOPE PROCEDURE FOR VIEWING OF INDIVIDUAL COCCOLITHS

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ABSTRACT

A procedure is described for transferring specific nannofossil specimens from the light microscope to the scanning electron microscope. This technique permits high quality photomicrographs and scanning electron micrographs to be made of the same nannofossil specimen.

INTRODUCTION

It is axiomatic that special problems accompany the study of calcareous remains of nannofossils simply because of their small size (2-30 μ). One of these problems concerns the transfer of particular specimens from the stage of the light microscope to the sample grid or stud of an electron microscope so that the possibility of referring each of the two images to different taxa may be avoided. The technique described here permits one to examine and photograph a single specimen with both types of magnification systems.

TRANSFER OF SELECTED SPECIMENS FROM THE OPTICAL MICROSCOPE TO THE SCANNING ELECTRON MICROSCOPE

In 1967, Katharina Perch-Nielsen described a method for transferring particular specimens originally recognized by light microscopy to the specimen grid of the transmission electron microscope. The method described below differs considerably from the Perch-Nielsen method, and was developed for the scanning electron microscope.

1. Dilute sample to about 1 gram per 100 cc of distilled water, or until a droplet of suspension appears only slightly turbid. This dilution insures a sparse distribution of specimens and facilitates their relocation at later steps in the procedure.

2. With a capillary tube, add a drop or two of the suspension to a 12 mm diameter circular cover glass (No. 1 thickness, Thomas Scientific Apparatus Co.), which has been previously covered with a cushion of distilled water (Fig. 1a). Mix the fluids by blowing gently through the tube onto the liquid surface. Permit the suspension to dry. Three circular cover glasses can be placed on a microscope slide and prepared simultaneously. The glass containing the best distribution of specimens can then be retained for further processing.

3. The cover glass selected above is affixed to the center of a microscope slide by means of two tiny spots of Elmer's glue (Fig. 1c). (The smaller the amount of glue, the better.)

4. Place a drop of immersion oil (Cargille, R.I. 1.540) on the circular cover glass containing the dried sample.

5. Using a knife edge on a flat surface, break a No. 2 cover glass into thin shards, and glue these onto the microscope slide on either side of the circular cover glass.

6. Spot glue a 22 X 40 mm No. 1 cover glass onto the support shards. (Again, only a small amount of glue should be used since this rectangular cover glass must be removed later.) The SEM sandwich slide is now complete (Fig. 1b-c) and will provide excellent viewing and photography of coccoliths.

7. The SEM sandwich slide is next placed on the stage of the light microscope, one end is marked so that the slide can be replaced in the microscope in the same orientation during subsequent examinations. A traverse of the slide is made, noting the mechanical stage coordinates of clean, undamaged specimens.

8. After ten to fifteen specimens have been located, they are photographed.

9. Remove the sandwich slide from the microscope and cut the glue holding the rectangular cover glass to its shard supports. This should be done carefully with a razor blade.

10. Place the slide back on the microscope stage and, using the coordinates recorded in step 7, return to each selected specimen. (They will appear less distinct because of the absence of a cover glass.)

11. After centering the specimen at 500 X, inscribe a circle around it with a Leitz Object marker. This diamond-tipped tool should be set to inscribe the smallest circle possible (0.7 mm), (Fig. 1d).

12. After circling the desired specimens, remove the slide from the microscope, flush away the immersion oil with a stream of Ethanol, and allow to dry. This will also wash away loose particles which might settle on circled specimens. It has been our experience that not more than 10% of the circled specimens are lost during this flushing process.

13. Release the circular cover glass from the microscope slide by cutting the glue with a razor blade.

14. Place the cover glass with its circled specimens on a standard scanning electron microscope specimen stud and affix it to the stud on opposite sides with Elmer's glue. After the first glue spots have dried, completely encircle the exposed contact between the stud and cover glass with glue. Permit the glue to dry.

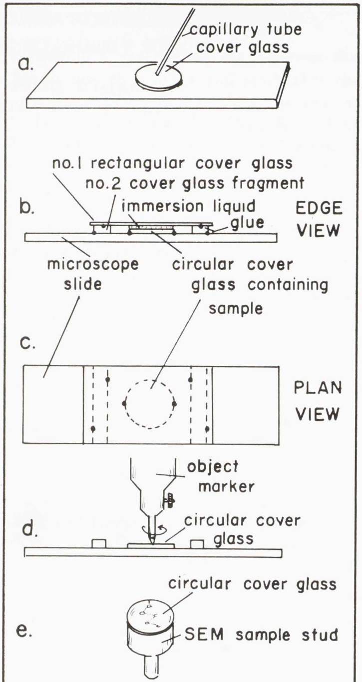

Fig. 1

15. Following standard procedures, coat the stud-mounted cover glass with carbon followed by gold, silver, or chromium.

PLATE 1. a. Scanning electron micrograph showing actual size of inscribed circle as seen in the SEM at 45 X. White arrow points to specimen of *Discoaster lodoensis* (same specimen in b, c, and d.) Note silver paint tangent to the right side of the inscribed circle. Point of black arrow indicates line made by diamond object marker. *b.* scanning electron micrograph, actual size of circle as seen in the SEM at 90 X, with specimen visible in the center of the circle. Note silver paint at far right of photo. *c. Discoaster lodoensis* Bramlette and Riedel, SEM micrograph, 3600 X. *d. Discoaster lodoensis* Bramlette and Riedel, phase contrast, oil immersion micrograph of specimen shown in Figs. a-c, 1800 X. Photograph of specimen taken on SEM sandwich slide mount. *e. Discoaster mirus* (Deflandre) Stradner and Papp, phase contrast, oil immersion micrograph, 1665 X. Taken of specimen on SEM sandwich slide mount. *f. Discoaster mirus* (Deflandre) Stradner and Papp, SEM micrograph, 4500 X, same specimen as in *e.*

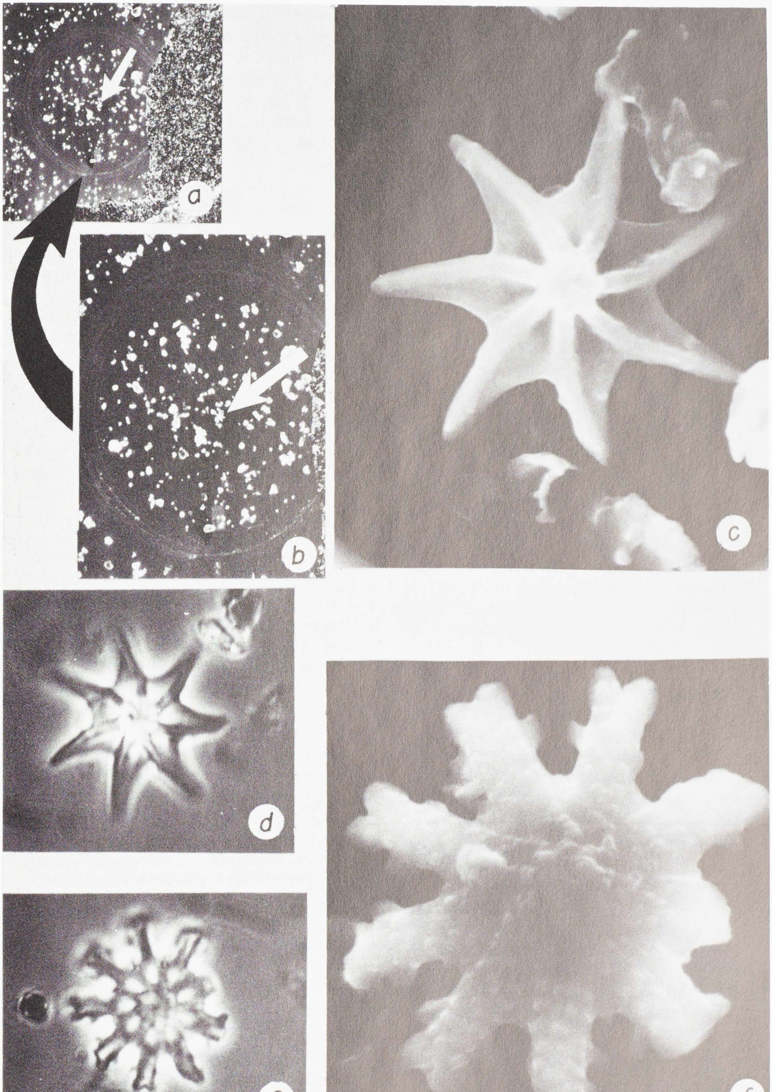

PLATE 1

16. Examine the coated stud with a low magnification stereoscopic microscope and place small drops of printed circuit silver paint next to the circles (Pl. 1, Figs. a,b). This will permit rapid relocation of the circles in the SEM. (Only very small amounts of silver paint should be used to prevent a charging problem.) A sketch of the position of the circles relative to some orientation mark will also facilitate relocation of the circles.

17. Place the sample in the SEM. At a magnification of 20 X, locate a circle on the stud. The circle will almost fill the field of view of the SEM at 200 X (Pl. 1, Figs. a,b). At 500 X, the specimen contained within the circle can be readily recognized.

Several advantages are realized by using this technique. First, the time-consuming scanning of samples can now be done with the light microscope and not consume SEM time. Second, the same specimen can be photographed with both the SEM and light microscope. Third, relocation of specimens is fast and accurate when subsequent examination is desired. Fourth, much of the tedious manipulation required in changing inclination and rotation of specimens during SEM photography is eliminated. Such changes may now be completed in one or two steps. Adjust the rotation and inclination controls to obtain the desired settings, focus on the stud, return to the circle containing the specimen, refocus, and photograph.

In 1971, Leffingwell and Hodgkin published an excellent technique for preparing palynomorphs for SEM study. The Leffingwell technique uses a micromanipulator to pick selected palynomorphs from dried residues. The picked palynomorphs are positioned on a circular cover glass previously ringed with guide circles. The cover glass is then attached to an SEM specimen stud, coated, and viewed in the SEM. While it is possible to pick nannofossils with the micromanipulator, there are several problems which we believe make the Leffingwell procedure less practical for nannofossil study than the one we have just presented.

In the dry state it is difficult to identify the much smaller (generally 5-20 μ) nannofossils; misidentification may reach fifty percent. Photomicrographs cannot be obtained of the specimens examined in the SEM and changing the orientation of specimens during SEM photography remains a tedious procedure.

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