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NATIONAL GALLERY OF ART

RESEARCH PROJECT

on

ARTISTS' AND CONSERVATORS' MATERIALS

1950-1971

Mellon Institute
Carnegie-Mellon University
Pittsburgh, Pennsylvania

NATIONAL GALLERY OF ART RESEARCH PROJECT

ON ARTISTS' MATERIALS

Mellon Institute of Science
Pittsburgh, Pennsylvania

1950-1971

The principal objectives of the National Gallery of Art Research Project has been to engage in research on the causes of deterioration of pigments, dyes, paints, and varnishes and, through this research, to develop improved methods and materials for the artist and conservator. The results have been shared both nationally and internationally through more than 40 research papers, 20 didactic publications, and hundreds of lectures and consultations on individual subjects.

I. RESEARCH ON CAUSES OF DETERIORATION; DEVELOPMENT OF NEW MATERIALS

The Research Project has devoted major attention to the deteriorating effects of light on museum collections. The result has been the development of final and retouching varnishes that accelerated aging tests indicated will remain stable and colorless for more than 100 years under normal gallery conditions. Protective heat and ultraviolet filters have been tested and introduced in the National Gallery of Art as well as in other American Museums. New pigments and dyes are being introduced, and fugitive colorants rejected, in close cooperation with the American Artists' Professional League.

II. SERVICE TO NATIONAL GALLERY OF ART IN CONSERVATION

In its capacity as scientific advisor to the National Gallery of Art, the Research Project introduced ultraviolet filters over all the daylighted galleries and continues to monitor the levels of illumination throughout the Gallery. A special container was designed and tested for the transportation of Leonardo's Ginevra de' Benci from Lichtenstein in the height of winter. Reports and inspections regarding the conditions of storage and exhibition of prints, photographs, lead and bronze medals and tapestries have been prepared at the Director's request.

III. SERVICE TO NATIONAL GALLERY OF ART IN THE ANALYSIS AND STUDY OF OBJECTS IN THE COLLECTIONS

Prior to purchase, the Degas sculptures were inspected at the Director's request. Financial and professional support was given to Dr. Herman Kuhn's internationally significant investigation of 30 of 35 recognized

paintings by Vermeer, while the Research Project itself has begun extensive investigations of sculpture in the collections, being able to provide conclusive evidence that several doubtful pieces were properly classified, and providing analysis of wood, marble, bronze and alabaster to assist in the preparation of a major cataloque of the Kress Collection.

IV. SERVICE TO PUBLIC AND TO THE CONSERVATION PROFESSION

The Senior Fellow has served as editor of the Bulletin of the American Group-IIC and assistant editor to IIC-Abstracts for more than ten years, as well as serving on the advisory boards of about 8 national or international organizations. Besides numerous lectures, formal leaves of absence were granted in the spring term of 1961 to allow him to serve as visiting scientist in the newly created Conservation Center at New York University and again, for two months in 1967, to assist in the restoration of flood-damaged frescos in Florence, Italy, at the request of the Committee to Rescue Italian Art (CRIA).

V. NEW METHODS OF ANALYSIS

Besides the study of pigments and varnishes by traditional scientific methods, the National Gallery of Art broke new ground in 1964 by initiating studies in the characterization of artists' materials by techniques of nuclear science. A summary of these activities follows.

NEW METHODS IN ART IDENTIFICATION

I. "DATING" LEAD IN LEAD WHITE

A method of roughly dating the ubiquitous pigment, lead white has been developed which has proven useful in distinguishing between 20th-century forgeries and works produced before the 19th century. The method relies on the natural radioactive series that begins with uranium and involves the measurement of small residual levels of natural radioactivity in samples of lead white. The dating of the "time when the lead ore was smelted" is approximate.

II. "DATING" LEAD-BEARING METALS

The above method was adapted and extended to lead-bearing metals such as brass or bronze. It is generally successful in proving the modernity of such metals.

III. NEUTRON ACTIVATION ANALYSIS FOR TRACE ELEMENT DETERMINATION

Patterns of accidental trace element contamination act as a crude "fingerprint" for batches of pigment derived from the same source. Statistical analysis of the composition of pigments has shown that one can distinguish the lead white used by different artists and the ultramarine blue produced by two modern manufacturers. Various identification problems may be solved through the accumulation of a large amount of similar data.

IV. THE DETECTION OF RECENT FORGERIES THROUGH CARBON-14 DETERMINATION

Since the early 1950's, there have been very large increases in the carbon-14 content of the atmosphere due to the testing of nuclear weapons. This has been shown to be useful in detecting recently produced linseed oil, canvas, and paper in techniques adapted to the small quantities of sample usually available from artistic works.

V. X-RAY DIFFRACTION OF LEAD WHITE

The use of x-ray diffraction to distinguish four different types of compounds in lead white suggests that relative proportions of these will provide a rough indication of the manufacturing process (and hence the period) of its production.

VI. MASS SPECTROMETRY - LEAD ISOTOPES

Samples of lead white prepared prior to the early 19th century have been found to exhibit a relatively restricted isotope ratio in comparison with more modern samples. This is an indication of the modern usage of lead from newer geographical sources such as the Western Hemisphere and Australia, etc. Also, a possible "fingerprint" technique was indicated since a group of samples from one forger was quite similar to one another.

VII. MASS SPECTROMETRY - SULFUR ISOTOPES

It was shown that sulfur isotope ratios varied significantly in samples of ultramarine. It was found that one could distinguish: (a) sources of natural ultramarine, (b) dates of production of synthetic ultramarine, and (c) synthetic and natural material. Other sulfur bearing pigments can be treated by this analytical method as well.

VIII. MOSSBAUER EFFECT IN IRON-BEARING PIGMENTS

A new technique is under development in which the large family of iron-bearing pigments (ochres, siennas, umbers, etc.) may be classified by the chemical state of the iron therein. This can be done completely non-destructively with no harm to a painting undergoing analysis. It is believed that one may distinguish between natural and synthetic iron oxides in this way and perhaps to pin-point their geographical source.

APPENDIX I

SUMMARY OF SPECIFIC CONTRIBUTIONS OF THE RESEARCH PROJECT

I. Research

a. Processes of deterioration

Effects of light

- Crosslinking of polymers (4)*
- Chalking of paints and varnishes (2)
- Heating effects (1)
- Fading and discoloration of pigments (3)

Oxidation and antioxidants (1)

- Oxidation of damar varnish (2)

b. New materials and methods of conservation

Materials

- Non-aromatic petroleum (2)
- Acryloid B-72, B-67; Rhoplex (Acrylics) (1)
- Poly(vinyl acetate) AYAB and solvent (for retouching) (2)
- Light-fast dyes (1)
- Regal chrome yellow (1)
- Non-chalking titanium white (1)
- Ultraviolet absorbers (2)
- Oxidation inhibitors
- Heat-seal relining adhesive
- Infrared reflecting glass and lamps (1)

c. New methods of analysis

- Tests for crosslinking in coatings (2)
- Analytical uses of color measurement (3)
- Standards of lightfastness (2)
- Characterization of spirit varnishes (2)
- Nuclear methods of analysis (Keisch)
  - Lead white "dating" (4)
  - Isotope ratios in lead white, vermilion, and ultramarine (2)
  - Carbon-14 content of vehicles (1)
  - Neutron activation analysis of pigments

d. Investigation of artists' materials

- Damar varnish and Picture Varnishes (8)
- Study of Vermeer's pigments (Kühn) (1)

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*parentheses show the number of publications on the subject

d. Investigation of artists' materials (cont'd)

Specific Pigments:

Lead white (Keisch 2)
Ultramarine (Keisch 1)
Vermilion (2)
Alizarin (1)
Van Dyke brown

II. Conservation Services to NGA

Ultraviolet filters placed over all galleries
Consultation on heating effects of lamps (T.V., Degas statues, Ginevra display)
Compilation of library of technical books at NGA
Design and construction of the shipping case for Ginevra portrait
Advice to F. Sullivan, M. Modestini on solvents, pigments, varnishes
Advice on storage of photographs 1965, corrosion of bronze, removal of paint
Consultation on whitening of retouches
Consultation of illumination of Kress tapestries at Philadelphia and preservation of silk in Art Treasures of Japan exhibition
Elimination of the use of shellac (French Varnish) as an isolating coat in restoration practice

III. Training

a. Publication of journals, information bulletins

Bulletin of American Group-IIC (10 years)
Assistant Editor IIC-Abstracts (7 years)
Didactic publications (15, incl. book)

b. Advisory Boards (Winterthur, N.Y.U., American Artists' Professional League, ICOM, Museum of Primitive Art)

c. Direct teaching assignments

Visiting scientist, N.Y.U., spring 1961
CRIA assistance to Florence, Feb-Mar, 1967
N.Y.U. Intern at MI, spring 1969
Oberlin conference on varnishes 1957
NGA meeting on damage by light 1962
Lecture series at Museum of Modern Art 1960

IV. Examination Services to NGA

Study of whitened retouches (1)
Examination of Degas sculpture collection, 1956
Study of Vermeers
Benin Brass Cock
Examination of seven terracottas
Study of half-dozen individual paintings at various times
Examination of corroded medals

APPENDIX II

PUBLICATIONS ON VARNISHES, RESINS, AND PROBLEMS IN CONSERVATION

"The Conservation of Paintings", R. L. Feller, Carnegie Magazine, 26, No. 1, 370-373 (1952).

"Hardness and Flexibility of Natural and Synthetic-Resin Varnishes", R. L. Feller, Museum News, 29, No. 20, 7-8 (1952).

"Science Serving the Fine Arts", R. L. Feller, Carnegie Magazine, 26, No. 2, 46-50 (1952).

"Color Change in Oil Paintings", R. L. Feller, Carnegie Magazine, 28, 276-279, 281, 285 (1954).

"Dammar and Mastic Infrared Analysis", R. L. Feller, Science, 120, 1069-1070 (1954).

"Cross-linking of Methacrylate Polymers by Ultraviolet Radiation", R. L. Feller, A.C.S. Div. of Paint, Plastics, and Printing Ink Chemistry. Papers presented at New York Meeting, Sept. 1957, 17, No. 2, 465.

"Factors Affecting the Appearance of Picture Varnish", R. L. Feller, Science, 125, 1143-1144 (1957).

"Dammar and Mastic Varnishes - Hardness, Brittleness, and Change in Weight Upon Drying", R. L. Feller, Studies in Conservation, 3, No. 4, 162-174 (1958).

"Picture Varnish", R. L. Feller, in Clark, G. L., Encyclopedia of Chemistry. Supplement. N. Y.: Reinhold Pub. Co., 1958, 220-2.

"Identification and Analysis of Resins and Spirit Varnishes", R. L. Feller, Application of Science in Examination of Works of Art. Boston: Museum of Fine Arts, 1959, 51-76.

"On Picture Varnishes and Their Solvents", R. L. Feller, Elizabeth H. Jones, and Nathan Stolow. Reports presented to the Seminar on Resinous Surface Coatings Sponsored by the Intermuseum Conservation Association, April 2-5, 1957. Oberlin, Ohio: Intermuseum Conservation Association, 1959, 220.

Book Review: "The Discoloration of Coloured Objects under the Influence of Daylight, Incandescent Lamplight and Fluorescent Lamplight", by J. J. Balder, Museums Association, Leiden, 1956, R. L. Feller, Studies in Conservation, 4, 155 (1959).

"The Technical Examination of Museum Objects", R. L. Feller, The Indicator, 40, No. 9, 20, 22, 24, 26, 28 (1959).

"Considerations Regarding the Illumination of Museum Objects", R. L. Feller, in Catalog of Exposition of Painting Conservation, The Brooklyn Museum, (1962).

"Levels of Illumination and Action of Light on Oil Paintings", R. L. Feller, Intermuseum Conservation Association, Oberlin, Ohio, Information Bulletin No. 6, July 1962, 4.

"Spirit Varnishes and Thermoplastic Resins", R. L. Feller, Catalog of Exposition of Painting Conservation, The Brooklyn Museum, (1962).

"Wax", R. L. Feller, Catalog of Exposition of Painting Conservation, The Brooklyn Museum, (1962).

"New Solvent-type Varnishes", R. L. Feller, Recent Advances in Conservation. London: Butterworths, 1963, 171-175.

Book Review: "Recent Advances in Conservation" Washington, D. C.: Butterworths, 1963, R. L. Feller, Science, 142, 1565 (1963).

"The Use of Differential Spectral Curve Analysis in the Study of Museum Objects", Ruth M. Johnston and R. L. Feller, Dyestuffs, 44, No. 9, 1-10 (1963).

"Synthetic Materials Used in the Conservation of Cultural Property", R. L. Feller, G. Thomson, and A. E. A. Werner, Rome Centre, 67 pp. (1963).

"Control of Deteriorating Effects of Light upon Museum Objects", R. L. Feller, Museum, 17, 57-98 (1964).

"Detection of an Epoxy-Resin Coating on a Seventeenth-Century Painting", Sheldon Keck and R. L. Feller, Studies in Conservation, 9, 1-8 (1964).

"Critical Pigment Volume Concentration and Chalking in Paints", R. L. Feller and J. J. Matouse, Bulletin of the American Group-IIC, 5, No. 1, 25-26 (1964).

"The Deteriorating Effect of Light on Museum Objects", R. L. Feller, Museum News Technical Supplement, No. 3, i-viii (1964).

"The Use of an Electrically-Conducting Glass Panel as a Heating Surface", R. L. Feller and Jeanne L. Kostich, Bulletin of the American Group-IIC, 5, No. 1, 23-24 (1964).

"What's in a Name: Dammar, or Serendipity in the Library", R. L. Feller, The Crucible, 49, 214, 216, 218 (1964).

"Combining Art and Science, The National Gallery of Art Research Project in Artists' Materials", R. L. Feller, Rutgers Alumni Monthly, November 1965, 3.

"Polymer Emulsions", R. L. Feller, Bulletin of the American Group-IIC, 6, No. 2, 24-28 (1966).

"Studies of the Effect of Light on Protective Coatings using Aluminum Foil as a Support: Determination of Ratio of Chain Breaking to Cross-linking", R. L. Feller and Catherine W. Bailie, Bulletin of the American Group-IIC, 6, No. 1, (1966) 2.

"Problems in Retouching: Chalking of Intermediate Layers", R. L. Feller, Bulletin of the American Group-IIC, 7, No. 1, 32-34 (1966).

"Rediscovery of the Wheel", R. L. Feller, Color Engineering, 4, No. 6, 20-23 (1966).

"Dating and Authenticating Works of Art by Measurement of Natural Alpha Emitters", B. Keisch, R. L. Feller, A. S. Levine, and R. R. Edwards, Science, 155, 1239 (1967).

"A Solvatochromic Dye as a Convenient Indicator of the Solubility Parameter of Petroleum Solvents", R. L. Feller and Jean B. Page, Bulletin of the American Group-IIC, 7, No. 2, 29-30 (1967).

"Standards of Exposure to Light", R. L. Feller, Bulletin of the American Group-IIC, 4, No. 1, 10-12 (1963); ibid., 7, No. 2, 8, 32 (1967).

"Felt-tipped Markers and the Need for Standards of Lightfastness for Artists' Colorants", R. L. Feller, Bulletin of the American Group-IIC, 8, No. 1, 24-26 (1967); Inter-Society Color Council Newsletter, 192, 10-11 (January-February, 1968).

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"Studies of the Darkenting of Vermilion by Light", R. L. Feller, Report and Studies in the History of Art, National Gallery of Art, Washington, D. C. 99-111 (1967).

"Control of Deteriorating Effects of Light on Museum Objects: Heating Effects of Illumination by Incandescent Lamps", R. L. Feller, Museum News, 46, No. 9, 39-47 (1968).

"Problems in Reflectance Spectrophotometry", R. L. Feller, IIC-1967 London Conference on Museum Climatology, London, International Institute for Conservation of Historic and Artistic Works, 257-269 (1968).

"Solubility Parameters", R. L. Feller, Bulletin of the American Group-IIC, 8, (2), 20-24 (1968).

"Research on Durable Thermoplastic Polymers for the Conservation of Works of Art", R. L. Feller, in Atti della XLIX Riunione SPIS, Sienna, Italy 23-27 (September, 1967); Rome, Italy, 1099-1110 (1968).

"Polymeric Emulsions III", R. L. Feller, Bulletin of the American Group-IIC, 9 (2), 15-17 (1969); IV, ibid., 10 (2), 11-12 (1970).

"Transportation of a Panel Painting by Courier in Winter", R. L. Feller, Papers given at the Annual Meeting of IIC-American Group, Los Angeles, 13-14 (1969).

"On the Color Space of Sigfrid Forsius 1611", R. L. Feller and Å. S. Stenius, Color Engineering, 8, No. 3, 48-51 (1970).

"Solubility and Crosslinking Characteristics of Ethylene/Vinylacetate Copolymers", R. L. Feller and M. Curran, Bulletin of the American Group-IIC, 11, No. 2, (1970) 42-45.

Book: "On Picture Varnishes and Their Solvents", R. L. Feller, Elizabeth H. Jones, and Nathan Stolow. The Press of Case Western University, Oberlin, Ohio, (1971) 251.

NEW METHODS IN ART IDENTIFICATION

Related Publications

Keisch, B. and A. S. Levine, "Sample Preparation for Low-Level, Alpha-Particle Spectrometry of Radium-226", Analytical Chemistry 38, 1969 (1966).

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Keisch, B., "On the Use of Isotope Mass Spectrometry in the Identification of Artists' Pigments", Studies in Conservation 15, 1-11 (1970).

Keisch, B., "The Mysterious Box: Nuclear Science and Art", World of the Atom Series, U.S. Atomic Energy Commission, Washington, D.C., (1970).

Keisch, B., "Art and the Atom: Two Dating Methods Based Upon Measurements of Radioactivity", Paper presented at International Seminar: The Application of Science in the Examination of Works of Art, Boston, Massachusetts (June 15-19, 1970).

Miller, F. J., E. V. Sayre, and B. Keisch, "Isotopic Methods of Examination and Authentication in Art and Archaeology", Isotopes Information Center, Oak Ridge National Laboratory, Report No. ORNL-IIC-21, (October 1970).

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