EVE. BULLETIN (N.D)

Method of Dating Inorganic Matter Revealed at Meeting Here

By ADOLPH KATZ
Of The Bulletin Staff

After more than ten years of research, scientists have developed a method for accurately dating ancient pottery, it was announced here today.

The dating is accomplished through the technique of thermoluminescence, in which the object to be studied is subjected to gentle heating so that it emits a form of light that can be detected by instruments.

The announcement was made by Dr. Froelich G. Rainey, director of the University of Pennsylvania Museum, in a paper read before the autumn general meeting of the American Philosophical Society.

Pottery, made b yman for the past 6,000 or 7,00 years, is the most common artifact found on the sites of ancient civilizations. It has aided archeologists in tracing patterns of culture.

Yet up until now it has been impossible to establish the ages of pottery artifacts through scientific methods.

One of the most common mehtods of dating artifacts in use today is the Carbon 14 method. But Carbon 14 tests only work on the remains of organic matter — such as articles made of wood or cloth and other substances that once were alive.

Won't Apply

It cannot be applied to inorganic matter such as clay.

The thermo luminescence technique has been under investigation most recently at the Applied Science Center for Archeology at University Museum and at the Research Laboratory for Archeology and the History of Art at Oxford University, Dr. Rainey said.

Dr. Rainey described the method as follows:

"Radiation from minute traces of radioactive elements (primarily thorium and uranium) in pottery clay bombard other substances in the clay and raise electrons to metastable (slightly unstable) levels.

"When the clay is fired in the kiln, each electron falls back to its stable position and emits a photon of light.

"Then, when a fragment of ancient pottery is reheated in the laboratory, the amount of thermoluminscence observed is representative of the accumulated radiation damage, and hence of the time elapsed since the original firing of the pottery."

"As I understand it, the basic principal is straightforward, but there were many uncertainties and difficulties facing the scientists who have explored the adaptation to a dating technique for pottery."

Dr. Rainey gave much of the credit for developing the new method to Elizabeth K. Ralph, assistant director of the Applied Science Center here, and Mark Han, research associate at the center.

He said that with expected improvements in precision, the new method should be comparable to the Carbon 14 technique.

The Carbon 14 technique is based on the knowledge that radioactive carbon with an atomic mass number of 14 is absorbed by all living things. When they die, they can no longer absorb radioactive carbon.

The radioactive atoms have a half-life of 5,600 years. That is, they begin to decay at the moment of death, and disintegrate at the rate of 50 percent every 5,600 years.

11/13.1965

Radiation Used

New Methods Found for Dating Ancient Pottery

11-13-65

By DENNIS M. HIGGINS
Of The Inquirer Staff

A new method of dating pottery found at excavations of ancient civilizations was disclosed Friday by Dr. Froelich G. Rainey, director of the University Museum.

He said it is the most recent discovery in "the new order of technology" brought about since the Second World War by increased understanding of the atom by nuclear physicists and archaeologists.

COMMON ARTIFACTS

The new method, designated thermoluminescence, is a significant breakthrough in dating ancient civilizations because it uses pottery sherds, the most common of all artifacts. The most accurate and widely used dating technique of the "new order" until now has been the carbon-14 method, which works only with organic material — and potsherds are inorganic.

Dr. Rainey explained how thermoluminescence works in a paper delivered before the American Philosophical Society in Philosophical Hall, 104 S. 5th st.

LIGHT EMITTED

"Radiation from the minute traces of radioactive elements—primarily thorium and uranium—in pottery clay bombard other substances in the clay and raise electrons to metastable (precariously stable) levels. When the clay is fired in the kiln, each electron falls back to its stable position and emits a photon of light.

"Then when a fragment of ancient pottery is reheated in the laboratory, the amount of thermoluminescence observed is representative of the accumulated radiation damage and hence of the time elapsed since the original firing of the pottery."

Thermoluminescence

Un metodo scientifico per datare i vasi antichi

New York, 16 novembre

Un nuovo metodo scientifico per stabilire l'esatta datazione dei vasi antichi è stato definitivamente messo a punto dall'Università della Pennsylvania in collaborazione con il Laboratorio di ricerche per l'archeologia e la storia dell'arte dell'Università di Oxford. L'annuncio del nuovo metodo, chiamato « termoluminescenza », è stato dato a Filadelfia dal prof. Froelich Rainey, direttore del Museo dell'università di Pennsylvania, in occasione del convegno autunnale della « Società americana di filosofia ». Il metodo consiste nel riscaldare in laboratorio a bassa temperatura i vasi antichi in maniera tale che essi emanano radiazioni luminose le quali possono essere registrate da appositi strumenti. « La radiazione costante che deriva dalle minute traccie di elementi radioattivi nella creta dei vasi — ha spiegato il prof. Rainey — bombarda altre sostanze e porta gli elettroni a livelli di leggera instabilità. Quando la creta viene riscaldata nel forno ogni elettrone torna alla sua posizione di stabilità ed emette un fotone di luce. Di conseguenza quando un frammento di vasellame antico viene scaldato in laboratorio l'intensità di termoluminescenza osservata è proporzionale alle modifiche di radiazione accumulatesi nei secoli ed è quindi indicativa del periodo di tempo trascorso dal momento in cui il vaso venne immesso per la prima volta nel forno ».

Fino ad oggi era estremamente difficile stabilire la datazione dei vasi antichi giacché il noto metodo del « carbonio 14 » può essere usato dagli archeologi soltanto sui resti di materia organica, come il legno e gli oggetti di vestiario, e non sulle sostanze inorganiche.

see page 5

Calendar & Chronicle

UNIVERSITY of PENNSYLVANIA

Volume 2, Number 6 — DECEMBER 1, 1965

CALENDAR

WEDNESDAY, DECEMBER 1

FILM: (sponsored by the Documentary Film Laboratory of The Annenberg School) *Que Viva Mexico!,* Sergei Eisenstein. Auditorium, The Annenberg School, 3620 Walnut Street. 2 P.M.

COFFEE HOUR: Faculty and Friends of the University are invited as guests of the Catacombs. Musical entertainment and refreshments. Catacombs, basement, Christian Association, 3601 Locust Walk. 8 P.M.

BASKETBALL: Pennsylvania versus Rutgers University. New Brunswick, N. J., 8:30 P.M. Tickets may be purchased at the Franklin Field Ticket Office in Weightman Hall, 33rd and Spruce Sts. before the game.

WEDNESDAY, DECEMBER 1, THROUGH SATURDAY, DECEMBER 4

DRAMA: (presented by the Pennsylvania Players) Thorton Wilder's *The Skin Of Our Teeth.* Irvine Auditorium, 3401 Spruce St. 8:15 P.M. Tickets, priced at $1.50, are available in the Players' office in Irvine Auditorium. See article on page 5.

THURSDAY, DECEMBER 2

LECTURE: (sponsored by The Annenberg School of Communications and the Graduate School of Education) *Equal Time in Broadcasting.* A panel discussion moderated by Newton Minow, former chairman of the Federal Communications Commission. Room 126, The Annenberg School, 3620 Walnut St. 3 P.M.

LECTURE: (sponsored by the Astronomy Department and the Space Science Laboratory of the General Electric Company) *Is Helium a Primordial Element?* Dr. A. G. W. Cameron of the Goddard Institute for Space Studies, a branch of the Goddard Space Flight Center of the National Aeronautics and Space Administration. Conference Room M3021, General Electric Space Technology Center, King of Prussia. 3 P.M.

FILM: (Houston Hall Board Popular Film Series) *Hatari,* starring John Wayne, Red Buttons, and Bruce Cabot. Auditorium, The Annenberg School, 3620 Walnut St. Two showings, 7 and 9:30 P.M. Admission $.50.

READING: *An Evening of Reading from the Works of Dylan Thomas* by University students. Catacombs, basement, Christian Association. 8 P.M.

FRIDAY, DECEMBER 3

COLLOQUIUM: (sponsored by the Department of Geology) *Studies in Franciscan Metamorphism near Jenner, California.* Dr. W. A. Crawford, Bryn Mawr College, Room 8-C, Fine Arts Building, 33rd St. and Smith Walk. 2 P.M.

PROJECT MISSISSIPPI

Twenty University students and faculty members will spend their Christmas vacation in Mississippi this year building a community center for striking plantation workers.

Daniel J. Finnerty, a College junior who is coordinating "Project Mississippi," said the workers were forced to leave their homes when they went on strike in an effort to obtain the Federal minimum wage of $1.25 an hour. Jobless, the cotton pickers who were receiving $3 for a 12-hour day are now living near Tribbett, Miss., in tents.

"Project Mississippi" is trying to raise $10,000 needed to construct a community center which can be used as an emergency hospital, a classroom and a place for meetings. Present plans call for a wooden structure 24 feet wide by 48 feet deep that, unlike the workers' tent homes, will have heat and running water.

The student-faculty group hopes to reach their financial goal by Christmas Eve. Checks, made payable to "Project Mississippi," should be sent to Finnerty at project headquarters, 3601 Locust Walk. The volunteers will go to Mississippi right after the holiday, returning to the University in time for second semester classes which begin in mid-January.

FILM: (sponsored by the International Students Association) *Four Chimneys.* Directed by Kurosawa, this award-winning film attempts to present a realistic picture of life in modern Japan. Auditorium, The Annenberg School, 3620 Walnut St., 7:30 P.M. Admission: members, $.75; non-members, $1.

CONCERT: (presented by the Glee Club) Annual Christmas Concert. Irvine Auditorium, 3401 Spruce St. 8:30 P.M. Tickets, priced at $1.50, are available in Houston Hall, 3417 Spruce St., and in the music office in Irvine Auditorium, Monday to Friday, 9 A.M. to 5 P.M.

FOLK MUSIC: Songs by Roger Poole. Catacombs' basement, Christian Association, 3601 Locust Walk. 9:45 P.M. Refreshments available.

SATURDAY, DECEMBER 4

CONCERT: *Introduction to Strings.* Second in a series of Concerts for Young Audiences. Commercial Museum, 34th St. and Convention Ave. 2 P.M. Tickets free at the door.

BASKETBALL: Pennsylvania versus the United States Naval Academy, 7 P.M.; Temple University versus the University of Delaware, 8:45 P.M.—Palestra, 33rd St. below Walnut St. Tickets may be purchased at the Franklin Field Ticket Office in Weightman Hall, 33rd and Spruce Sts.

SUNDAY, DECEMBER 5

FILM: (University Museum Film Series) *Ancient Art of Peru, Heritage from Tula.* Color film studies of ancient Latin American Indian cultures. Auditorium, The University Museum, 33rd and Spruce Sts. 1:30 P.M.

FILM: (Houston Hall Board Classical Film Series) *Jules and Jim* by Truffaut. Irvine Auditorium, 3401 Spruce St. Two showings, 7 and 9:30 P.M. Admission $.50.

MONDAY, DECEMBER 6

LECTURE: (sponsored by The Annenberg School of Communications and the Graduate School of Education) *Children's Literature — Communication Between Generations.* John Rowe Townsend, editor of the Manchester Guardian Weekly and the author of novels for children and a study of English children's literature. Room 126, The Annenberg School, 3620 Walnut St. 3 P.M.

TUESDAY, DECEMBER 7

FILM: *The Jungle Queen.* Final three installments of serial. Catacombs, basement, Christian Association, 3601 Locust Walk. 9:30 P.M. Free popcorn.

WEDNESDAY, DECEMBER 8

FILMS: (sponsored by the Documentary Film Laboratory of The Annenberg School) *Sausalito,* Frank Stauffacher, 1947; *Childhood's Noon,* Documentary Film Laboratory, 1963; *In the Street,* James Agee, 1952; and *The Quiet One,* Sidney Meyers, 1948. Auditorium, The Annenberg School, 3620 Walnut St. 2 P.M.

COLLOQUIUM: (sponsored by the Towne School of Civic and Mechanical Engineering) *Applications of Plasticity Theory to Rock Mechanics.* Dr. Burton Paul, chief of Solid Mechanics Group, Ingersoll-Rand Research Center, Bedminster, N. J. Alumni Hall, Towne Building. 3 P.M.

LECTURE: *New Finds In Old Places.* Dr. Froelich G. Rainey, director of the University Museum. The Annenberg School, 3620 Walnut St. 7:30 P.M. Open to members of the Faculty Club and their guests. Follows Italian style buffet which will be served from 5:30 to 7:30 P.M. in the Faculty Club, 36th and Walnut Sts., at $2.75 per person.

THURSDAY, DECEMBER 9

LECTURE: (sponsored by The Annenberg School of Communications and the Graduate School of Education) *Reference Work in Communications.* Eleanor Blum, communications librarian at the University of Illinois. Room 126, The Annenberg School, 3620 Walnut St. 3 P.M.

LECTURE: (sponsored by the Astronomy Department and the Space Science Laboratory of the General Electric Company) *Quasars.* Dr. A. G. W. Cameron of the Goddard Institute for Space Studies, a branch of the Goddard Space Flight Center of the National Aeronautics and Space Administration. Auditorium A-2, David Rittenhouse Laboratory, 33rd and Walnut Sts. 3:30 P.M.

COLLOQUIUM: (sponsored by the School of Metallurgical Engineering) *The Spectrum from Fundamental Research to Engineering Development.* Dr. Lawrence S. Darken, director of the Fundamental Research Laboratory. United States Steel Corporation's Auditorium, Laboratory for Research on the Structure of Matter, 3231 Walnut St. 4 P.M. Coffee and tea served in the Faculty Lounge at 3:30 P.M.

FILM: (Houston Hall Board Popular Film Series) *Becket,* starring Richard Burton, Peter O'Toole,

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of city planning, will discuss *City Planning Around the Nation* in the thirteenth of a series of 17 University of the Air programs on city planning. WFIL-TV (channel 6). 7 A.M.

WEDNESDAY, JANUARY 12

CITY PLANNING: Edmund Bacon, executive director of the City Planning Commission, Robert B. Mitchell, chairman and professor of city planning, will discuss *City Planning Around the World* in the fourteenth of a series of 17 University of the Air programs on city planning. WFIL-TV (channel 6). 7 A.M.

BASKETBALL: Live coverage of Pennsylvania-La-Salle game. WPHL-TV (channel 17). 8:45 P.M.

FRIDAY, JANUARY 14

BASKETBALL: Live coverage of Pennsylvania-Harvard game. WPHL-TV (channel 17). 7 P.M.

DAILY

TELEVISION SEMINAR: A series of television courses offered by the College of General Studies. Mondays, Wednesdays and Fridays: English 270-TV, *The Art and Appreciation of Poetry,* Dr. Richard G. Bozorth, assistant professor of English. WCAU-TV (channel 10). 6:15 A.M. Course ends December 17. Tuesdays, Thursdays and Saturdays: History 149-TV, *Russian History in the 19th Century,* Dr. Alexander V. Riasanovsky, associate professor of history. WCAU-TV (channel 10) 6:15 A.M. Repeated on WHYY-TV (channel 12), Wednesdays, Fridays and Mondays, 4:30 P.M. Course ends December 20.

"The Skin of Our Teeth"

The Pennsylvania Players will present Thornton Wilder's *The Skin Of Our Teeth* Wednesday through Saturday, December 1 through 4, in the auditorium of Houston Hall.

Performances will begin at 8:15 P.M.

The Skin of Our Teeth will be directed by Susan McCosker, the Players' assistant director.

It will star Carole J. Smith, a senior in the College of Liberal Arts for Women, as Sabina; John Miglietta, a sophomore in the College of Arts and Sciences, as Mr. Antrobus, and Elizabeth Darr, a freshman in the women's college, as Mrs. Antrobus. The Antrobus' children, Gladys and Henry, will be played by Andrea Balis, a freshman in the women's college, and Harry Ringel, a freshman in the college. David Felser, a junior in the college, will play the fortune teller.

Others in the cast will include: William Schweers, a sophomore in the college; Andy Halper, a freshman in the college; William Rutenberg, a sophomore in the College; Frank Shanbacker, a sophomore in the college; Don Frederick, a freshman in the college; Grover Cronin, a freshman in the college; Marsha Inselman, a junior in the women's college; Donna Woolfolk, a freshman in the women's college, and Diana Niles, a freshman in the women's college.

Tickets for *The Skin of Our Teeth,* priced at $1.50, may be purchased in Houston Hall or in the Players' office in Irvine Auditorium.

Method Developed

Archaeologists and physical scientists of the Applied Science Center of Pennsylvania's University Museum and Oxford University have developed a method of accurately dating pottery by thermoluminescence.

Dr. Froelich G. Rainey, director of the Museum, announced the discovery at the autumn general meeting of the American Philosophical Society in Philosophical Hall.

The discovery is a significant break-through because pottery, a product made by man for the past 6,000 or 7,000 years, is the most common artifact found at sites of ancient civilizations, but it cannot be dated by the Carbon-14 method which is restricted to dating the remains of organic matter. Also, pottery is contemporaneous with ancient cultures, whereas remains of organic matter could antedate or follow the culture under investigation.

Dr. Rainey explained the technique thus:

"Radiation from the minute traces of radioactive elements (primarily thorium and uranium) in pottery clay bombard other substances in the clay and raise electrons to metastable levels. When the clay is fired in the kiln each electron falls back to its stable position and emits a photon of light. Then when a fragment of ancient pottery is reheated in the laboratory, the amount of thermoluminescence observed is representative of the accumulated radiation damage and hence of the time elapsed since the original firing of the pottery.

"As I understand it, the basic principle is straightforward but there were many uncertainties and difficulties facing the scientists who have explored the adaptation to a dating technique for pottery."

The University Museum's work with thermoluminescence was one of several methods of dating ancient cultures and artifacts that have been developed, or are in the process of development, as a result of new knowledge in the field of nuclear fission, by Museum scientists and those in a number of institutions in the United States and abroad.

John Gielgud, Donald Wolfit, Martita Hunt, and Pamela Brown. Irvine Auditorium, 3401 Spruce St. Two showings, 7 and 9:30 P.M. Admission $.50.

FRIDAY, DECEMBER 10

HOOTENNANY: Open to all members of the University community who play or sing folk music. Catacombs, basement, Christian Association, 3601 Locust St. 9 P.M. Refreshments available.

SATURDAY, DECEMBER 11

CHILDREN'S PROGRAM: (University Museum Series) *Tom Thumb In King Arthur's Court* and other color films of famous children's stories. Auditorium, The University Museum, 33rd and Spruce Sts. 10:30 A.M.

BASKETBALL: Pennsylvania versus the University of South Carolina, 7 P.M.; Villanova University versus Oregon State University, 8:45 P.M. Palestra, 33rd St. below Walnut St. Tickets may be purchased at the Franklin Field Ticket Office in Weightman Hall, 33rd and Spruce Sts.

SUNDAY, DECEMBER 12

FILMS: (University Museum Film Series) *Paintings From Vienna* and *French Tapestries*. World famous paintings and historical tapestries shown in color. Auditorium, The University Museum, 33rd and Spruce Sts. 1:30 P.M.

CONCERT: Philadelphia String Sinfonietta, conducted by Norman Black. Program will include: *A Piece for Strings,* a new work by Professor Constant Vauclain of the University of Pennsylvania's music department; Purcell's suite from *The Virtuous Wife;* Hindemith's *Trauermusick;* Benjamin Britten's *Simple Symphony;* Sammartini's *Concerto Grosso;* Buxtehude's *Chaconne in E Minor,* and Chajes' *Theme and Variations*. Commercial Museum, 34th St. and Convention Ave. 3 P.M. Tickets free at the door.

FILM: (Houston Hall Board Classical Film Series) *The Robe,* starring Richard Burton, Jean Simmons, Victor Mature and Michael Rennie. Irvine Auditorium, 3401 Spruce St. Two showings, 7 and 9:30 P.M. Admission $.50.

COFFEE HOURS

A regular opportunity for the exchange of ideas between students and faculty members is provided at coffee hours held from 3:30 to 4:30 P.M. Mondays through Fridays in the Bowl Room of Houston Hall.

Coffee is available at five cents a cup and doughnuts, at five cents each, at each session.

The program is being sponsored by the boards of directors of Houston Hall and Bennett Union.

MONDAY, DECEMBER 13

COLLOQUIUM: (sponsored by the Graduate School of Education) *Does Punishment Work After All?* Dr. Erling E. Boe of Brown University. Benjamin Franklin Room, Houston Hall. 2 P.M. Coffee will be served at 3:15 P.M.

LECTURE: (sponsored by The Annenberg School of Communications and the Graduate School of Education) *The Function of the Library in Communications*. Kathleen Molz, editor of the Wilson Library Bulletin. Room 126, The Annenberg School, 3620 Walnut St. 3 P.M.

COLLATION: Dean of Women's and Dean of Men's annual Christmas collation for faculty and students. The Annenberg School of Communications, 3620 Walnut St. 3:30 P.M. Admission by invitation.

BASKETBALL: Pennsylvania versus the University of Delaware. Dover, Del. 8:30 P.M. Tickets may be purchased at the Franklin Field Ticket Office in Weightman Hall, 33rd and Spruce Sts.

TUESDAY, DECEMBER 14

COFFEE HOUR: (sponsored by the Houston Hall Board) West Lounge, Houston Hall, 3417 Spruce St. 11 A.M.

BASKETBALL: Pennsylvania versus Washington and Jefferson. 8 P.M. Palestra, 33rd St. below Walnut St. Tickets may be purchased at the Franklin Field Ticket Office in Weightman Hall, 33rd and Spruce Sts.

SATURDAY, DECEMBER 18

CHILDREN'S PROGRAM: (University Museum Series) *Puppet Show—Professor Umpa and St. Nicholas.* Auditorium, The University Museum, 33rd and Spruce Sts. 10:30 A.M.

SUNDAY, DECEMBER 19

FILMS: (University Museum Film Series) *On The Twelfth Day* and *A Christmas Carol.* Two Christmas classics in film. Auditorium, The University Museum, 33rd and Spruce Sts. 1:30 P.M.

WEDNESDAY, DECEMBER 22

BASKETBALL: Temple University versus Canisius College, 7 P.M.; Pennsylvania versus Villanova University, 8:45 P.M. Palestra, 33rd St. below Walnut St. Tickets may be purchased at the Franklin Field Ticket Office in Weightman Hall, 33rd and Spruce Sts.

MONDAY, DECEMBER 27

BASKETBALL: Pennsylvania versus the University of Pittsburgh. Pittsburgh, Pa. 8:15 P.M. Tickets may be purchased at the Franklin Field Ticket Office in Weightman Hall, 33rd and Spruce Sts.

WEDNESDAY, DECEMBER 29

BASKETBALL: Pennsylvania versus the University of Wisconsin. Madison, Wis. Tickets may be purchased at the Franklin Field Ticket Office in Weightman Hall, 33rd and Spruce Sts.

FRIDAY, JANUARY 7

BASKETBALL: Pennsylvania versus Brown University, Providence, R. I. 8 P.M. Tickets may be purchased at the Franklin Field Ticket Office in Weightman Hall, 33rd and Spruce Sts.

SATURDAY, JANUARY 8

CHILDREN'S PROGRAM: (University Museum Series) *1001 Arabian Nights,* an animated cartoon story of Aladdin and Mister Magoo. Auditorium, The University Museum, 33rd and Spruce Sts. 10:30 A.M.

BASKETBALL: Pennsylvania versus Yale University. New Haven, Conn. 8:30 P.M. Tickets may be purchased at the Franklin Field Ticket Office in Weightman Hall, 33rd and Spruce Sts.

SUNDAY, JANUARY 9

FILM: (University Museum Film Series) *Of Stars And Men.* A color film account by Dr. Harlow Shapley on man's relationship to space, time, matter and energy. Auditorium, The University Museum, 33rd and Spruce Sts. 1:30 P.M.

WEDNESDAY, JANUARY 12

BASKETBALL: St. Joseph's College versus Wake Forest College, 7 P.M.; Pennsylvania versus La Salle College, 8:45 P.M. Palestra, 33rd St. below Walnut St. Tickets may be purchased at the Franklin Field Ticket Office in Weightman Hall, 33rd and Spruce Sts.

FRIDAY, JANUARY 14

BASKETBALL: Pennsylvania versus Harvard University, 7 P.M.; Drexel Institute of Technology versus West Chester State College, 8:45 P.M. Palestra, 33rd St. below Walnut St. Tickets may be purchased at the Franklin Field Ticket Office in Weightman Hall, 33rd and Spruce Sts.

EXHIBITS

THROUGH TUESDAY, DECEMBER 7

THE ART OF PHILADELPHIA MEDICINE: An exhibition portraying two centuries of American medical history. Includes sculpture, prints, drawings, paintings and instruments assembled in honor of the bicentennial anniversary of the founding of the nation's first medical school—the University's School of Medicine. Philadelphia Museum of Art, 25th St. and the Benjamin Franklin Parkway. Daily, 9 A.M. to 5 P.M. Admission: $.50, except on Mondays when admission is free.

THROUGH WEDNESDAY, DECEMBER 15

PAUL WESCOTT: An exhibition of paintings by Paul Wescott loaned by Philadelphia's Newman Galleries. Bowl Room Gallery, Houston Hall, 3417 Spruce St. Mondays through Fridays, 9 A.M. to 5 P.M.

THROUGH SATURDAY, JANUARY 15

TREASURES OF TIKAL: An exhibit of art objects and artifacts representative of the lost Maya civilization in Guatemala. Includes pottery vessels, masks, beads and articles of bone, shell and obsidian. The University Museum, 33rd and Spruce Sts. Weekdays, 10 A.M. to 5 P.M. Sundays, 1 to 5 P.M. Closed Mondays.

TELEVISION

SATURDAY, DECEMBER 4

BASKETBALL: Live coverage of Pennsylvania-Navy game. WPHL-TV (channel 17). 7 P.M.

TUESDAY, DECEMBER 7

CITY PLANNING: Peter Schauffler, deputy director of commerce of the Port of Philadelphia, and George Qualls, associate professor of city planning, will discuss *Planning for a Port City* in the eleventh of a series of 17 University of the Air programs on city planning. WFIL-TV (channel 6). 7 A.M.

SATURDAY, DECEMBER 11

BASKETBALL: Live coverage of Pennsylvania-South Carolina game. WPHL-TV (channel 17). 7 P.M.

TUESDAY, DECEMBER 14

CITY PLANNING: Robert B. Mitchell, chairman and professor of city planning, and David Longmaid, executive director of the Delaware Valley Regional Planning Commission, will discuss *The City and the Region in Planning* in the twelfth of a series of 17 University of the Air programs on city planning. WFIL-TV (channel 6). 7 A.M.

WEDNESDAY, DECEMBER 22

BASKETBALL: Live coverage of Pennsylvania-Villanova game. WPHL-TV (channel 17). 8:45 P.M.

WEDNESDAY, JANUARY 5

CITY PLANNING: David Crane, associate professor of civic design, and Dr. David Wallace, professor

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Pennsylvania's Financial Report For 1964-65

The University's payroll, including benefits, averaged more than $1,000,000 weekly last year.

Salaries and wages totaled $51,513,121 during the year ending June 30. Annuities, group insurance, and social security payments by the University totaled $2,170,503 last year. Comparative figures for 1963-64 were $46,509,219 and $2,452,857.

Expenditures for student aid, exclusive of loans, increased nearly $1,000,000 during the year as the 1963-64 figure of $4,481,971 rose to $5,465,554 in 1964-65. This covered scholarships, fellowships, and other student aid.

While current income increased 11 per cent to $89,371,680 (from the previous year's total of $80,670,246), expenditures in 1964-65 totaled $90,556,722 (compared to $81,384,583 a year earlier). The resulting operating deficit of $1,185,042 was covered by an appropriation from unrestricted gifts from alumni and others.

The book value of the University's assets passed the quarter-billion dollar mark during the year, totaling $253,792,000 on June 30.

Pennsylvania's income during the fiscal year came from the following sources: federal government reimbursements for training and research projects, $25,511,746 (29 per cent); student fees, $20,381,486 (23 per cent); hospital and clinic receipts, $16,200,683 (18 per cent); sales and services from auxiliary enterprises such as dining halls, dormitory rooms, and book stores, and miscellaneous sources, $8,852,555 (10 per cent); the Commonwealth of Pennsylvania, $7,362,280 (eight per cent); gifts and grants from foundations and private sources for immediate use, as distinguished from gifts for capital purposes, $6,590,943 (seven per cent); and income from endowment and other invested funds applied to operations, $4,471,987 (five per cent).

Sponsored research expenditures during the year totaled more than $25,000,000, representing 28 per cent of the total operating budget. The federal government supported 85 per cent of this effort, the remaining 15 per cent coming from gifts and grants, the income from endowment, and other funds.

The market value of all endowments, the University's perpetual and equivalent trust funds, was $140,245,000 at the close of the fiscal year. Market value of all University investments on June 30 was $164,252,000, of which outside fiduciaries held the sum of $12,500,000 in trust for the benefit of the University. The Associated Investments Fund, the University's pooled fund, had investments with a market value of $103,396,000 on June 30.

During the year the ledger value of Pennsylvania's physical plant increased $5,000,000 to a total of $125,480,417.

The principal buildings completed during the year were the Veterinary Research and Instruction Building and the Parking Garage, while major renovations were completed at the School of Medicine, School of Dental Medicine, and Graduate Hospital.

Volume

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OF ATOMS AND MEN

Strange Behavior of Elves May Be a 'Powerful Tool'

BY IRVING S. BENGELSDORF, Ph.D.

Imagine an enormous air conditioned building containing millions of elves. Their behavior is strange. For although the building is multistoried, all of the elves want to stay in the rooms on the ground floor.

A few of the elves have violent tempers and when their anger "explodes," they throw a rock. Any elf hit by a thrown rock immediately jumps upstairs to an upper room. But he really doesn't want to stay there, and so, after a short time, he returns to the ground floor.

But, every once in a while, an elf who has jumped into a room on an upper floor finds that the room is "defective." It has no staircase or elevator to permit his return. And so, that elf is trapped. He must remain in the upper room and cannot return to the ground floor.

Elf's Yell 'Geronimo'

This gives rise to an interesting situation. Obviously, over a long period of time the number of trapped elves will increase. And, therefore, if one knew the number of elves trapped in upper floors, one could then get some idea of how old the building was.

But how can one find out how many elves are trapped? Easy. These elves do not like heat. So, shut off the air conditioning. The temperature in the building now goes up and the trapped elves frantically want to return to the ground floor. In desperation, they jump. And as he jumps, each elf yells "Geronimo."

If you listen carefully, you can hear how many "Geronimos" are yelled, and thus can count the number of elves that were trapped. If one knows the number of "Geronimos" shouted, the number of defective upper rooms, and how many angry elves threw rocks each year, one can calculate the age of the building.

It's No Fairy Tale

Is this a Rube Goldberg fairy tale? Not at all. It is a description of a technique that may prove to be a powerful tool in archeology in establishing the age of earthenware utensils—dishes, pots, jars and flasks used by ancient peoples.

Instead of a building, we have a piece or fragment of ancient pottery. And instead of containing millions of elves, it contains millions of atoms. Instead of a few elves with violent tempers, any earthenware utensil contains a small number of naturally occurring radioactive atoms. And instead of throwing rocks, radioactive atoms emit radiations.

And when these radiations strike an atom, one of the atom's electrons gets "kicked upstairs" to an "energy level" higher than its normal or ground state. Usually, this "high energy" electron returns in a short time to the ground level. But, sometimes, it becomes trapped in an atomic defect of the clay used to make the pottery. And so, over the years, the number of trapped electrons, with energies greater than normal, accumulates in the pottery.

Light Measured

If the pottery now is heated to high temperatures, the trapped electrons suddenly return to their normal, ground energy state. And as it "jumps," each electron does not yell "Geronimo," but instead sends out a tiny flash of light. Using very sensitive light-measuring instruments, one can count how many trapped electrons had accumulated in the pottery by counting the flashes of light.

Knowing the number of trapped electrons, the number of defective centers in the clay, and the number of radiations tossed out by its radioactive atoms each year, one can calculate the age of the pottery.

Because one measures the age of earthenware objects by heating them to make them give off light, this technique is known as "thermoluminiscent (TL) dating of pottery" (Greek: therme means heat; Latin: lumen means light). Some of the pioneering experiments in TL-dating were carried out by Dr. George Kennedy at UCLA.

TL-Dating Experiments

Two separate and recent TL-dating experiments now are reported by Drs. E. K. Ralph and M. C. Han of the University of Pennsylvania and Drs. R. B. Mazess and D. W. Zimmerman of the University of Wisconsin. The Pennsylvania group TL-dated Iranian and Italian pottery, while the Wisconsin scientists TL-dated sherds (fragments of pots) obtained from arid coastal regions of Peru. The results are encouraging indeed.

At the moment, the TL-dating technique still is experimental. But it looks exceedingly promising. For its big advantage is that it requires only tiny amounts of sample for an age-determination.

If it proves to be practical on a routine basis, TL-dating will be a boon to archeologists mainly as a supplementary technique to verify the ages of ancient settlements as determined or suggested by other means.

The atoms — contained in clay once worked by a potter of old— then indeed will "speak" to us as beacons of light flashing across the time span of centuries and millenia.

Los Angeles Times
Thursday Morning, July 21, 1966
Part II-5

THE BULLETIN (PHILA.) 4/2/67

UNIVERSITY of PENNSYLVANIA
PHILADELPHIA 19104

2,500-Year-Old Figurine Tests Out as a Forgery

By ADOLPH KATZ
Of The Bulletin Staff

She stands on a pedestal at the University Museum of the University of Pennsylvania, clad in a Greek-type garment and with an inscrutable smile on her terracotta face.

She came to the museum labeled as an Etruscan antique, supposedly fashioned 2,500 years ago by a sculptor who lived in the Tuscany region of Italy long before Rome was founded.

That smile, it turned out yesterday, held a secret that was just recently unmasked.

The lady is a fake.

15 Inches High

Modern science has established that the diminutive, beautifully executed statuette, about 15 inches high, was the work of a clever forger who created her in modern times, between 1850 and 1915.

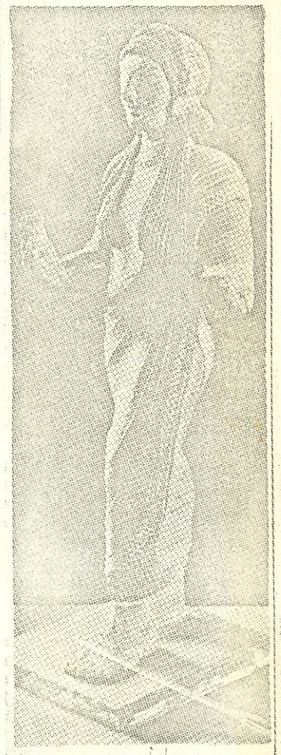
The story of the unmasking is told by Dr. Ellen L. Kohler, lecturer in classical archeology at the museum, in the current issue of "Expedition," the museum's quarterly publication.

Had Own

The statuette was given to the museum in 1950 by T. S. Quinn, of Lebanon, Pa., who had bought it from a New York city antique dealer. The dealer, according to Dr. Kohler, had told Quinn that it came from near Orvieto, in central Etruria, and that it had been executed about 500 years before Christ.

For some time the statuette

Continued on Page 8, Col. 6



Forger's creation

Old Figurine a Fake

Continued From First Page

occupied her own case in the museum's Etruscan gallery.

The first inkling that something was wrong came from experts who viewed her on visits to the gallery. Some objected to the hair style. Others said the size of the statuette fell awkwardly between the larger and smaller types that were known.

"Still another visitor," Dr. Kohler writes, "came up with the shattering discovery that the lines which indicate the direction of the draped fall of the chiton (garment) across her right shoulder seem to get lost (as indeed they do), and that therefore this must be the work of a modern copyist.

New Testing Process

Faced by all of this criticism, the museum withdrew the statuette from exhibition. For several years the statuette remained in obscurity.

A few months ago the museum decided to test the age of the statuette with the aid of a newly developed process of dating pottery, called thermoluminescence.

The process was developed in the museum's Applied Science Center for Archeology by Elizabeth K. Ralph, associate director, and Mark C. Han, research chemist.

Natural Process Slow

The process is based on the phenomenon that many minerals, subjected to natural radiation from their own trace elements such as uranium and thorium, emit light when stimulated by heat. At temperatures of 200 to 300 degrees Centigrade, the glow is bright enough to be photographed in color.

"What is most important for us," Dr. Kohler writes, "is the fact that if this glow is not redosed by artificial irradiation, the glow will not be replaced except by the slow natural process of redosage.

"So it is with clays. The firing of a pot by ancient man provides a clean beginning date for the slow reaccumulation of this measurable energy."

In other words, the heat originally applied in making a clay object removes all of the trace elements. New ones then begin to form by natural process. By measuring the rate of this redosage through a complicated process, it is possible to measure the age of the object.

'Mixed Feelings'

This was done with the terracotta figurine. For purposes of control, readings taken from this statuette were compared with readings taken from genuine artifacts.

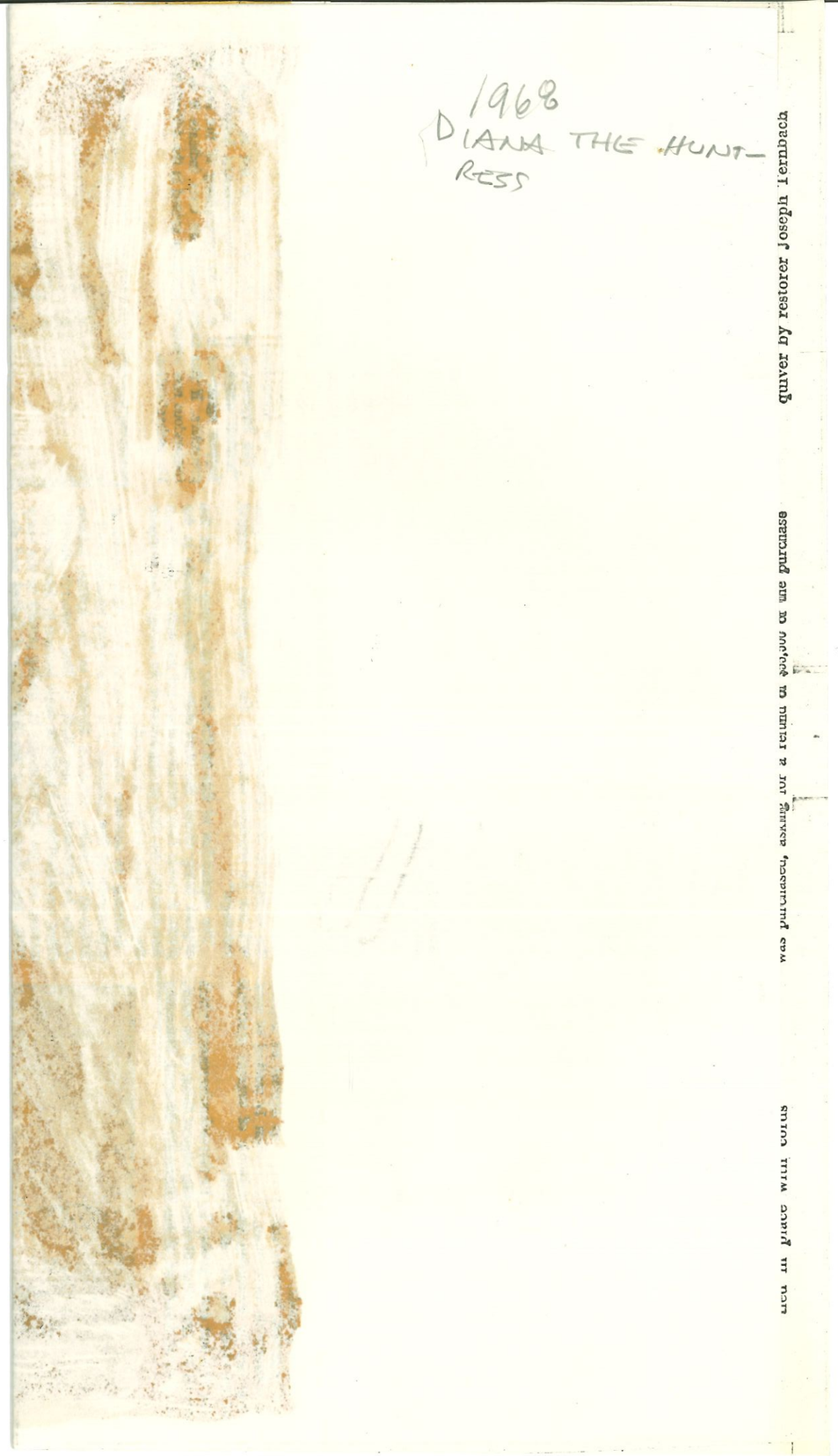
The result was unmistakable. The "Etruscan" maiden was not Etruscan at all.

"With mixed feelings," Dr. Kohler writes in conclusion, "we placed our statuette back in storage, labeled surely a forgery. To all the original critics of her genuineness, congratulations, and to the terracotta-forgers still loosing their spurious wares on the world, thermoluminescence issues an ultimatum."

Tough Climb

Trunks of mahogany trees reach a height of 60 to 80 feet before the first branches appear.

1968
DIANA THE HUNTRESS



quiver by restorer Joseph Fernbach

was published, once for a time, in Philadelphia

sun shone with extra

ST. LOUIS POST-DISPATCH
D. 375,154 SUN. 601,534

JUN 2 1968

New Dating Technique That Threatens Diana the Huntress

By GEORGE McCUE

IT MAY BE THAT THIS TIME Diana has had it. The terra cotta figure of the huntress deity, purchased by the City Art Museum for $56,000 in 1952, has been challenged several times since then by authorities in classical antiquities. Its authenticity, upheld by the museum on the strength of still persuasive documents, seems to have been jolted by a new process for dating fired materials. If the new test is accurate, the sculpture that had previously been identified as an Etruscan work, circa 470 B.C., is more like early nineteenth century. In short, to come right out with the word that one employs with such sorrow when it applies at home, "Diana the Huntress" may indeed be a fake.

Previous doubts of the work's authenticity have been argued on stylistic grounds. Chemical and physical tests of the age of art materials have heretofore come up against an impenetrable barrier in terra cotta. The Carbon 14 method of computing age by measuring the radiation of organic materials does not work with ceramic objects.

The new test dates pottery by its thermoluminescence, which indicates the time elapsed since the original firing of the work. This process, developed at the University Museum, University of Pennsylvania, shows possibilities of clearing up a good many mysteries in the authentication of art objects made of clay and fired in a kiln.

"THE PROCESS IS BASED on the fact that many minerals, subjected to natural radiation from their own trace elements such as uranium and thorium, emit energy in the form of light when stimulated by heat," wrote Ellen L. Kohler in the museum's journal, "Expedition," last winter. Miss Kohler is registrar of the University Museum.

"This is the result of the bombardment by alpha- and beta-particles upon the other constituents (of the clay). For instance, irradiated crystals of calcite emit 'cold light' visible to dark-adapted eyes even at room temperature. At temperatures of 200 to 300 degrees Centigrade the glow is bright enough to be photographed in color. But what is most important for us is the fact that if this glow is once driven off by heating and if the mineral is not redosed by artificial irradiation, the glow will not be replaced except by the slow process of natural redosage."

The application of this to the dating of pottery is that the original firing cleans the time slate for the materials in the piece. A newly fired ceramic object will not emit a glow. From that time on, the slow accumulation of the energy that produces the glow again can be measured.

Learning to measure this glow factor took three years of experiments by two members of the University Museum staff—Elizabeth K. Ralph, associate director of the Applied Science Center for Archeology, and Mark C. Han, research chemist. Other art scientists had begun to show interest in thermoluminescence as a possible technique for dating pottery in the early 1950s, and laboratories at the University of Oxford and elsewhere have been investigating it.

AS DEVELOPED IN PHILADELPHIA, the technique requires a three-gram sample of the material to be tested. This fragment, removed from an inconspicuous place—but one in which the material is original, not a patch—is finely ground, mixed with silicone oil and applied to aluminum foil. This spot of powder is placed in a light-tight box, a miniature furnace. As the heat is increased, both temperature and light emission are plotted simultaneously as curves on a chart. The shape of the curves can be interpreted in terms of years since the piece was fired.

The test is not, however, simply a matter of putting a sample in a box and reading a chart. The glow curve has to be read against two other points of information before it can be a determination of age. One is the rate of bombardment by the inherent radioactive elements in the material, which is measured in an alpha counter as the first step in the procedure; the other is to determine how susceptible the particular clay is to radioactive bombardment — a means of correcting inconsistencies in the other two observations.

The susceptibility test helps to indicate the degree to which the material can replenish its natural radioactivity. An artificial bombardment with X-rays, a second reading from the heat-light procedure and a comparison of this glow curve with the one obtained from the measurement of inherent radioactivity completes the calculation. A number of tests of Italian pottery have indicated that the thermoluminescence test has accuracy—or as the technicians express it, "average uncertainty"—within plus or minus 300 years.

"If the consistency of the measurements is improved, the precision may be comparable with Carbon-14 dating," Miss Ralph and Han said in a report published in Nature magazine. "It affords the extra advantage that the pottery itself . . . may be dated rather than something (such as charcoal) associated with it."

"To the terra cotta forgers still loosing their spurious wares on the world, thermoluminescence issues an ultimatum," writes Miss Kohler triumphantly in her account.

THE CITY ART MUSEUM has not said where its Diana was tested. The museum, in fact, has said almost nothing. News of its doubts of its object's authenticity bounced back all the way from Los Angeles, where the museum filed a suit last week against Adolph Loewi, the dealer from whom the sculpture was purchased, asking for a refund of $55,500 of the purchase price on the basis of "a mutual mistake of fact." The acquisition was under a guarantee of genuineness.

The museum's attorneys asked the Board of Control to maintain silence about the suit involving this art object owned by the citizens of St. Louis because of possible prejudice to the serenity of the pleadings, or something like that. It is hard to understand how an issue of fact could be prejudiced by such an announcement, or by the foregoing condensed description of the thermoluminescence procedure, obtained fro ma museum spokesman after considerable soul-searching on Art Hill.

The most dramatic previous repudiation of supposedly Etruscan objects was the acknowledgement by the Metropolitan Museum of Art, New York, in 1961 that three famous terra cotta warrior figures were fakes. In this case, the evidence was in spectographic tests by James V. Noble, an expert on ancient ceramics, that proved a black glaze to have been produced by modern manganese dioxide.

The importance of the Diana issue is not so much in the "mutual mistake of fact"—it has happened before and will happen again—as it is in the spotlighting of the new dating procedure. If this is as reliable as tests indicate it to be, a tremendous new resource has been gained in the difficult field of art authentication.

Diana the Huntress, as she appeared for the first time in the art market, uncleaned, unrestored, her 21 pieces tied in place with cords

Diana, as exhibited at City Art Museum, with provision of missing parts and speculative addition of bow and quiver by restorer Joseph Ternbach

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TL 10/2/69

Thousands of years ago, when ancient craftsmen baked their pottery to harden it, they unwittingly rendered a major service to archaeology that has only recently "come to light" with the aid of modern physics.

For about the last decade, research scientists at the University of Pennsylvania Museum's Applied Science Center for Archaeology (MASCA) have been probing the mysteries of thermoluminescence in pottery -- its tendency to glow under special conditions. Now, with the help of a $61,000 grant from the National Science Foundation, they hope to refine existing knowledge into a routine system that will supplement and in some ways surpass, the widely-known carbon-14 method as a precise and useful archaeological dating tool.

One of the more obvious benefits of thermoluminescent dating (TL) is that it allows pottery, the artifact itself, to be dated, rather than merely related to the age of organic material it is associated with when excavated. This, coupled with the universal use of pottery for the last 9,000 years, plus TL-dating's near-infallibility in detecting forgeries, endow the technique with some advantages over carbon-14 dating.

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The goal of the Pennsylvania team, headed by Dr. Froelich Rainey, Museum director, Elizabeth K. Ralph, associate director of MASCA, and research specialist Mark C. Han, is to resolve the intrinsic questions and uncertainties that have so far limited this potential and hampered absolute age determinations.

The phenomenon of thermoluminescence was first noted by the English physicist and chemist, Robert Boyle, in 1663. Its basic principle is that energy, absorbed and stored in inorganic material, can be stimulated by thermal agitation and released in the form of light. In the case of pottery, traces of radioactive impurities (uranium, thorium and potassium) within the potter's clay bombard its other constituents with alpha, beta and gamma rays and raise certain electrons to metastable, or slightly unstable, levels. When the clay is heated, these metastable electrons fall back into stable positions--emitting photons of light as they do so--and become trapped in "faults" in the crystal lattice of the clay.

Thus, when the initial firing dissipated the natural thermoluminescence accumulated during geological time, the pottery's "TL clock" was set at zero from an archaeological point of view. As the centuries pass, however, the pottery gradually reacquires its TL sensitivity at the rate of about 100 rads a century. (By way of illustration, the radiation emitted in a dental x-ray equals about 1000 rads.)

Consequently, when the pottery is reheated in the laboratory, the level of TL observed by photomultiplying devices is indicative of the accumulated radiation damage, and therefore, the amount of time that has

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elapsed since the pot was originally fired. The older the pottery, the greater the glow that can be observed.

During 1968, more than 40 tests of "unknowns" and checks for authentication were made at MASCA that have already proved of value to archaeology. In addition, TL dating methods are now both supplementing and supplanting radiocarbon dates for some objects.

For example, because of fluctuations in carbon-14 dates for the period between 1500 and 1700 A.D., TL dates have been accepted as the more reliable ones for samples from a shipwreck off the north coast of Jamaica, placing it at an age appropriate for Columbus's flagship, the Santa Maria.

TL dates are also becoming important for early sites in Greece and Turkey where archaeologists previously had to rely entirely on carbon-14 dating which has recently become suspect for certain time periods. A cup purported to have come from Haçilar, Turkey, for instance, was TL-dated to 5100 B.C. which indicates that the cup may well have come from that site. In other cases, especially with Etruscan statues on display in museums for decades, TL-dating was able to determine that the objects were fired only within the last 100 years, and thus exposed them as fakes.

But making the system work is far more complicated than it seems, and perfecting it may prove even more difficult.

For one thing, it is essential that rapid, controlled heating of thin, uniform layers of powdered potsherds take place so that the comparatively weak TL light can be detected and measured before it is burned away by the onset of heat radiation.

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In addition, age correspondences for known-aged samples based on natural TL glow curves and alpha particle bombardment rates alone yield extremely poor results. Metastable electron accumulations that cause the glow in ceramics depend upon variations in their susceptibility to radiation damage, so it is necessary to obtain a correction factor by duplicating this original radiation damage in a much shorter time.

This is accomplished by bombarding the depleted natural TL sample with artificial radiation, then reheating it after a two-week delay that permits the newly-trapped electrons to stabilize. This artificial glow curve is then used to construct the correction factor for subsequent natural TL measurements of the same family of samples.

In this manner, a "specific glow" level can be established for the age of the pottery through a formula which roughly calls for the natural glow level to be divided by the artificial glow level times the natural dose rate.

If the sample involved happens to be of known-aged pottery, then its specific glow can be used for absolute dating of all its contemporary artifacts regardless of pottery type or site of origin.

Significant changes in MASCA's techniques in recent years, including better sample preparation, and the installation of a linearly-programmed heating control system and a more sensitive thermoluminescence reader, have improved results to the point where the age deviatio for fine-grained pottery dating back to 700 B.C. is now on the order of ± 100 years. A more precise calibration curve for measuring samples of unknown age has also been established.

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"We feel that we have now demonstrated that TL will provide a reliable method of dating pottery," says Dr. Rainey, "but as with all techniques, there are still many questions to be answered and experiments to be performed."

One of the major problems to be solved, according to Miss Ralph, is the clarification of the quantitative theory of the fundamental mechanism of thermoluminescence: "Contributions from radioactive elements in the soil, and possibly cosmic rays, are complicating factors," she notes. "Also, since the inherent natural radioactive bombardment consists of a variety of radiation, their effects in producing radiation damage may differ."

In clays, she points out, the predominant elements are uranium, thorium and potassium. The first two emit alpha, beta and gamma rays in their decay series, while potassium-40 emits mostly beta, plus a small fraction of gamma rays. Most of the work at MASCA has been confined to studying the effects of alpha, beta and x radiation, the latter being used in connection with artificial dosages.

"One of our more serious intrinsic problems," says Miss Ralph, "is that most of the thermoluminescence in pottery is due to the quartz components of the clays, whereas most of the inherent radiation is contained to a large extent in the other components." Presently, magnetic separations are being made on samples of course-grained pottery to see if there is a difference in the behavior of quartz in pottery and quartz alone.

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Because it has been well-established that alpha radiation accounts for a large part of the total dose received by ceramic artifacts, attempts are underway at MASCA to irradiate pottery samples with a pure alpha source to measure its effects without the interference of gamma and betas. The short range of the alpha particle makes such experimentation exceedingly difficult in comparision with measuring the effects of other particles.

It is believed, however, that the alpha effect differs both quantitatively and qualitatively from the effects of other radiations, mainly because its short range compared to its energy, results in the whole of its energy being converted within a relatively small volume. This could lead to the formation of new defects and trapping centers in the crystal lattices of ceramics at dose levels that would be insignificant for other radiation.

In addition, says Miss Ralph, although the connection between the inhomogeneity and coarseness of ancient ceramics with the alpha dose rate is believed to be important, it has been little investigated until now.

"It is important to know the range of alpha particles in clay so we can assess the effect of variable grain sizes and inhomogeneity," she says, "and this has never been determined."

At present, MASCA and the Research Laboratory for Archaeology and the History of Art at Oxford University under the direction of Dr. M. J. Aitken, are the most actively engaged in the applications of

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thermoluminescence for archaeological purposes, and both laboratories are now demonstrating with the dating of ceramic materials of an unknown age just how significant the technique will eventually be for archaeology in general.

MASCA's analysis of ceramic materials of unknown age is now providing the first dates for prehistoric West African cultures. In Iran, where radiocarbon materials are unavailable for long sequences of Neolithic cultures, thermoluminescence is filling in the gaps. And in the Mediterranean area, TL-dating for cultural sequences from Neolithic and Bronze age epochs is just getting underway.

"This is a stage in which archaeologists are just beginning to learn about the successful applications of thermoluminescence," says Dr. Rainey, "but with only two laboratories available for dating it will be some time before it reaches the general acceptance of carbon-14 techniques. There is little doubt, however, that within the next few years the number of thermoluminescent dating stations installed for archaeology will be comparable to those currently engaged in radiocarbon dating."

Almanac, University of Pennsylvania, Vol. 16, No. 3, November, 1969

Thermoluminescence Is Researched at Museum

Scientists at the University Museum's Applied Science Center for Archaeology have received a $61,000 National Science Foundation grant to explore how the phenomenon of thermoluminescence in pottery —its tendency to glow under certain conditions—may be used as a precise, archaeological dating tool.

They hope to refine existing knowledge into a routine system that will supplement and in some ways surpass, the widely-used carbon-14 method.

Thermoluminescent dating allows pottery itself to be dated rather than relating it to the age of the organic material in which it is found. In addition, the fact that pottery has been in universal use for the last 9,000 years, plus TL-dating's near infallibility in detecting forgeries, give the new technique important advantages over carbon-14 dating.

The phenomenon of thermoluminescence was first noted by the English chemist and physicist, Robert Boyle, in 1663. Its basic principle is that energy, absorbed and stored in inorganic material, can be stimulated by thermal agitation and released in the form of light.

In the case of pottery, traces of radioactive impurities (uranium, thorium and potassium) within the potter's clay bombard its other constituents with alpha, beta and gamma rays and raise certain electrons to metastable, or slightly unstable levels.

When the clay is heated, these metastable electrons fall back into stable position—emitting photons of light as they do so—and become trapped in "faults" in the crystal lattice of the clay.

Thus, when the initial firing dissipated the natural thermoluminescence accumulated during geological time, the pottery's "TL clock" was set at zero from an archaeological point of view. As the centuries pass, however, the pottery gradually reacquires its TL sensitivity at the rate of about 100 rads a century. (By way of illustration, the radiation emitted in a dental x-ray equals about 1000 rads).

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For example, because of fluctuations in carbon-14 dates for the period between 1500 and 1700 A.D., TL dates have been accepted as the more reliable ones for samples from a shipwreck off the north coast of Jamaica, placing it at an age appropriate for Columbus's flagship, the Santa Maria.

In other cases, especially with Etruscan statues on display in museums for decades, TL-dating was able to determine that the objects were fired only within the last hundred years, and thus exposed them as forgeries.

"Archaeologists are just beginning to learn about the successful applications of thermoluminescence. There is little doubt, however, that within the next few years the number of thermoluminescence dating stations installed for archaeology will be comparable to those currently engaged in radio-carbon dating," Dr. Froelich Rainey, Director of the University Museum, said.

Library users are now required to present their University identification cards to check out books from the Van Pelt Library.

The policy change is the result of a switch-over from a manual record keeping system to an automated charging system.

To speed transition, those who currently have books charged from the library are requested to return them to the circulation desk to recharge them under the new system.

Free School . . .

(Continued from page 1)

University to the Board of Education, is expected to open in December after its teachers receive special training and its 200 students choose a name for the unit.

The Free School system plan calls for five such scattered houses eventually, each with a maximum of 200 students led by eight teachers. An ungraded experimental curriculum will be offered in two principal parts: one consisting of core subjects taught at the house including mathematics, English, science, history, and foreign languages; the other providing a "floating" elective-enrichment program taught on-location by volunteer personnel in business, industrial, civic and educational institutions in the immediate neighborhood. Studying at a bank, for example is encouraged for the exposure to basic mathematics skills needed in the field rather than as vocational training. This reflects the emphasis in the project on the "Three R's" plus a fourth one called "Relevance", said Dr. Aase Eriksen of the Graduate School of Education who planned the Free School system at the request of parents and community leaders in West Philadelphia who were dissatisfied with present patterns of education.

The Free School system is named for the "friskoler" system of Dr. Eriksen's native Denmark, where such schools have been established by parents or community groups according to their own interpretations of their children's educational needs.

Parents and community leaders from West Philadelphia are involved at all stages of development of the Free School system, Dr. Eriksen said. Working with her and with Francis M. Betts III, Assistant to the President for External Affairs, has been the West Philadelphia High School Advisory Board, which is currently helping select teachers and will later provide teacher aides for the Free School houses. Basic operating costs will be from the School Board's allotment to West Philadelphia (at a citywide average of $750 per pupil per year). Remodeling and start-up costs, about $15,000 to $20,000 per house, are now being sought by University volunteers on behalf of the Free Schools. Indirect contributions include those of companies and institutions which absorb the overhead of courses taught on-location by their employees.

At the University, an early volunteer was the athletic department, which surveyed its use of recreational facilities and has now offered them at morning hours when high-school students need them most but college students use them least.

The Reading Clinic also found it could fit high school remedial work into its schedule, and numerous physical-science laboratory courses are expected to be available as individual faculty members volunteer their time and then secure school permission to use their laboratories at hours convenient both to the Free School and to the University.

The University Plaza Merchants' Association—made up of retailers who sell mostly to students and faculty of the University—voted to start a retailing course for some 15 high school students. Ben Orloff, head of Jos. A. Banks Clothing, expects to teach the basics of small busi-

(Continued on page 5)

Land Use . . .

(Continued from page 1)

for Unit III nor the practicality of its implementation within the timing and dollar constraints set forth in the report;

3. The Executive Board recognizes that the University cannot unilaterally change the plan for Unit III nor could it even effectively advocate a change without the clear concurrence of all affected parties including City and Federal agencies, the designated redevelopers, and a sufficiently broad segment of the community.

4. However, in an effort to be responsive to the recommendations of the Quadripartite Commission, the Executive Board will direct appropriate University officers to initiate discussions with the concerned City agencies as well as with representatives of the organizations under contract with the Redevelopment Authority to act as redevelopers in Unit III in order to determine the effect both legally and practically of the specific proposals of the charrette and any modifications thereof which would give effect to the concept referred to in No. 1 above and at the same time be consistent with the basic objectives of the currently approved Urban Renewal Plan.

The Charrette's plan to revise land use in Unit Three was completed following a two-week intensive planning session which included consultation with agencies, institutions and community groups involved in present redevelopment projects there.

The new proposal calls for approximately 400 units in addition to the 185 already scheduled for Unit Three, and it outlines some approaches to making these units available in the low-income housing range.

It also includes recommendations for commercial services needed for a residential development of the area, which was set up as all-institutional under the urban renewal concept of the early 1960's.

To secure land for additional housing and services, it would be necessary for the appropriate government agencies to reassign some 9.7 acres of land now scheduled for institutional use, and to go outside Unit Three for one site of 2.1 acres.

Reassignment would subtract 3.4 acres from the University City Science Center for 156 housing units; 1 acre from the University City High School for 40 units; 4.5 acres from Presbyterian Hospital-University of Pennsylvania Medical Center for 112 units; and 0.67 acres from the Working Blind for 22 units.

The plan would also seek to purchase under the Federal "Write-Down" Program the 2.1 acre Saunders House site north of Powelton Avenue, to provide 72 housing units. Saunders House, a private retirement home, has announced that it intends to relocate, probably in the next two years.

These new sites would be in addition to three tracts already scheduled for low-income housing in Unit Three. One is a 2-acre site at Filbert and 36th, reassigned from Science Center holdings to Renewal Housing Inc. for 66 housing units. Another Renewal Housing parcel, a one-acre block for 37 units at Warren and 36th, had been University City High School land before reassignment. The third low-income housing site was the Presbyterian Center's 1.9 acres at 40th and Powelton, where a Center subsidiary had scheduled 82 units.

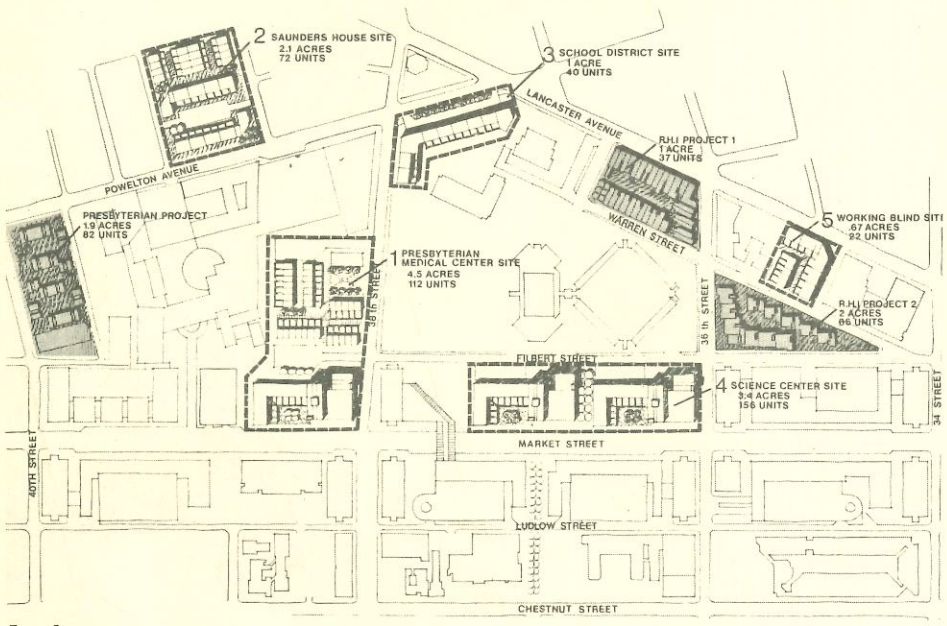
A mixture of financing methods would be required to implement the Charrette Plan. In its report, the Charrette points to the 1968 Federal Housing Act's sections 235 (for single-family homes owned by residents) and 236 (for multi-family apartment buildings rented to low-income families). Section 235 subsidizes mortgages from the normal 7½% down to 1% on homes the Charrette projects at $16,000 for families earning $5000-$7000.

Section 236 works much the same, and the Charrette Plan would create apartments of two or three bedrooms at around $120—suitable for the $5500-$8000 income range. Federal rent subsidies are available to bring these apartments within the range of true low-income families ($3000-$6000), the Charrette points out, but by law only 20% of the units in a given project can have rent supplements.

A third financing method suggested in the report is the Turn-key III public housing program which allows a portion of the tenant's rent to be held toward a down-payment to purchase the property, enabling families in the $4200-$4500 range to become home-owners.

The Charrette Report is being circulated to interested institutions and groups which have no official status in Unit Three, such as the University, as well as to the developers directly involved there.

The actual decision to re-schedule land use in the unit would require approvals to be obtained successively from the Redevelopment Authority, the City Planning Commission, the City Council and the federal Department of Housing and Urban Development.



In the proposed development plan for Unit Three, the three shaded areas above are sites now planned for low-income housing. Five additional sites are recommended by the Charrette Report submitted this month to the Trustees' Executive Board.

Dr. James E. Allen Gets Special Education Award

The 1969 National Award of Distinction was presented to Dr. James E. Allen, Jr., U. S. Commissioner of Education, at a dinner November 21, by the Alumni Association of the Graduate School of Education.

Dr. Allen, who also is an Assistant Secretary of Health, Education and Welfare, was cited for leadership and courage in a time of controversy in education, said Dr. Helen Bailey, chairman of the Alumni Association's awards committee.

Before appointment as Commissioner, Dr. Allen was for 14 years New York State Commissioner of Education.