Museum Experts Uncover 22 Egyptian Tombs

By BOB GROSCH

Second in a series.

The University Museum, credited with possessing one of the finest collections of Egyptian antiquities in the country will soon receive additions through the work of Lanny Bell and his colleagues who spent last spring excavating tombs along the Nile River.

Bell continued an excavation started by the University in 1967. After overcoming the problem of no electricity with carefully directed mirrors which reflected light to working areas, the expedition uncovered 22 tombs, several hundred burial pits, and the temple of an Egyptian king.

The site chosen had been partially excavated by the museum earlier this century. However, when Bell and his associates found the tombs, most had been poorly explored.

Before beginning extensive work on the tombs, Bell had to replace disintegrating pillars which supported a 15 foot ceiling. To study the tombs effectively, Bell also had to remove nests of mud-dauber wasps, paintings by early Christians, and soot from recently used bread ovens which covered the roof and walls of the tomb.

The ovens belonged to villagers who lived in the tombs until 1910 and supported themselves by making and selling fake antiquities.

Several mummies were unearthed, and the sarcophagus of the tomb-owner's wife was discovered. Bell believes the tomb-owner's mummy is in Liverpool Museum, although exact identification is difficult.

One of the most exciting results was the discovery of a black granite statue of the owner's wife which was in excellent condition and also a perfectly preserved offering table. In addition, they found a Book of the Dead, one of the best preserved specimens salvaged to date. Mummy wrappings, coffin fragments, amulets, and beaten electrum decorations were among other discoveries.

Cars replaced camels to provide local transportation for the researchers, who had to contend with the sweltering Egyptian heat. Bell admits jokingly the temperature never exceeded 115 degrees. He described the villagers, government officials, and the Cairo Antiquities Service as "very cooperative."

The expedition was financed through a grant of the United States government, administered through the American Interests Section of the Spanish Embassy in Cairo, under the Foreign Currency Program of the Office of International Activities of the Smithsonian Institution. A private endowment to the University by Eckly B. Coxe also aided in financing the trip and in updating the library at Pennsylvania.

The University's collection is only partially on display. An additional sixty to seventy thousand artifacts are kept in the museum's storeroom for use by student researchers.

A group of undergraduates, high school students, and interested adults called "The Mummy Dusters" aid the museum in some of the less technical tasks involved in effective maintenance of such a large archaeological collection.



A MEMBER OF the University Museum expedition team examines the walls of an Egyptian tomb along the Nile River. Hampered by the absence of electricity, the archaeologists used mirrors to shed reflected light on their diggings.

[N.D.]

16

MASCA. **Newsletter. Applied Science Center for Archaeology.** The University Museum. Philadelphia. Pennsylvania. Froelich Rainey, Director. Elizabeth K. Ralph, Associate Director.

Les sciences « exactes » sont de plus en plus au service de l'archéologie. Depuis 1965, cette excellente publication préparée par les soins de Miss Jeannette Flamm, fait connaître les plus récents procédés d'investigation et leurs applications. Dans le « volume » 2, nº 2, décembre 1966, on trouve par exemple des renseignements sur l'utilisation des magnétomètres à protons (expériences faites aux Dardanelles, Saint-Jean-d'Acre), au cesium (Grèce, Crète, Italie), sur la dendrochronologie (Nevada, Californie), sur l'archéo-magnétisme (intensité du magnétisme rémanent observée à Bylany en Tchécoslovaquie), sur la datation grâce à l'obsidienne (travaux du Dr. Joseph W. Michels de l'Université de Pennsylvanie, du Dr. Robert Heizer de l'Université de Californie, du Dr. Colin Renfrew de Sheffield) enfin sur l'analyse de l'or préhistorique, qui décèle une proportion de cuivre. Le « volume » 3, nº 1, mai 1967 traite de la datation des céramiques par la thermoluminescence, et à nouveau de la prospection archéologique à l'aide de divers magnétomètres. Notices sur les procédés de conservation des objets à l'intérieur des musées, les analyses isotopiques du plomb, l' « analysis activation » des monnaies, tessons, verres, calcites, enfin renseignements sur les progrès des études pétrographiques, secteur où les archéologues se sentent généralement parfaitement démunis. Nous l'avons encore tout dernièrement éprouvé quand des géologues ont reconnu pour une « calcite », une pierre que l'on appelait invariablement dolérite, celle du Gudéa au « vase jaillissant » acquis récemment par le Louvre (*Revue du Louvre*, 1967, pp. 89-90). Sur le même sujet, excellent exposé de M. Henry O. Thompson, *Science and Archaeology*, dans *BA*, XXIX, 1966, pp. 114-125, qui, entre autres publications, utilise largement celles de *Masca* (pour ceux que ce sigle intriguerait, disons qu'il est formé de la première lettre de *Applied Science Center for Archaeology*, précédé de M, car ASCA déjà retenu, était impossible).

A. P.

raissent pas à Samos avant l'an 700.

L'objet essentiel du livre est néanmoins de présenter une étude stylistique et chronologique de chaque pièce. Les analyses sont extrêmement soignées et assorties de rapprochements instructifs. Peut-être l'auteur aurait-il gagné à isoler ses descriptions et à les distinguer du commentaire par la typographie.

Le premier en date des ivoires grecs est un torse de sphinx appartenant encore à l'époque mycénienne. Des comparaisons nous sont offertes avec des ivoires de Mycènes, d'Argos et [illegible]

métope II A du temple C de Sélinonte et insiste sur la supériorité du relief d'ivoire : Athéna est ici vue de profil; Persée forme un groupe avec Méduse. A propos des images du combat de Persée et de la Gorgone, avec ou sans l'assistance d'Athéna, B. F.-S. reprend et précise certaines des observations qu'avait présentées K. Schauenburg dans son livre sur *Perseus* (1962). N° 8, planche 9 : petit relief où l'on distingue à gauche un personnage vêtu à la grecque, tenant en main une lance, faisant face à un cavalier qui porte des pantalons longs et un carquois double, interprété comme un Scythe. Ce relief, qui date du second quart du VI^e siècle, nous offrirait l'une des plus anciennes images de l'archer scythe et une image restée isolée. Comme l'a montré Vos les représentations athéniennes, contemporaines de ce relief, représentent le Scythe sous les traits d'un hoplite grec.

Dans le groupe des ivoires « orientaux », qui vient ensuite, l'auteur attache un prix particulier à un petit relief décoré de deux figurines masculines assises face à face sur des sièges qui seraient faits en osier. Ce serait jusqu'à présent le seul specimen recueilli en Grèce d'un groupe de reliefs en ivoire largement représenté à Nimrud et à Samarie : il dénoncerait l'influence de l'Égypte sans qu'on puisse en déterminer l'exacte provenance. La trouvaille de Samos pose en tous cas un problème de date : le milieu dans lequel le relief a été recueilli appartient à la seconde moitié du VII^e siècle. Les orientalistes avaient tendance jusqu'ici à rapporter les garisés ». Période tout aussi marquante, celle révélée par les « tombes royales » d'Alaca Höyük, avec des mobiliers, tels ces « étendards », emblèmes religieux, « éclipsant, écrit Akurgal, et il a raison, le « trésor de Priam » dégagé par Schliemann ». Cette puissante civilisation *hatti*, va subir un temps

GAZZETTA DEL SUD; 27 GIUGNO, 1963

Pag. 5

CALABRIA

DALL'INSEGNANTE CARLO MORELLI

Uno «stradivario» del 1726 rinvenuto a Castrovillari

nità la festa di San Giovani Battista, suo protettore.

Per l'occasione il piccolo centro del cosentino presentava un aspetto inedito: le vie tutte pavimentate ed allargate, le facciate delle case ripulite: merito della saggia, operosa attività del giovane sindaco, prof. Gino Pagliusi, col quale si sono congratulati indistintamente tutti i forestieri convenuti a Maione.

Ha tenuto il pergamo l'alato conferenziere padre Matteo da Castiglione, che ha felicemente unito i tanti temi dei suoi argomenti con quello, attualissimo, dell'ascesa al Soglio di Papa Paolo VI e del ritmo prodigioso che attende la marcia trionfale della Chiesa di Cristo.

Resti archeologici a Spezzano Albanese

Sono state rinvenute anfore, tombe e monete antiche

Spezzano Alb., 26 giugno

In contrada Fragolia del nostro comune e precisamente nella località di Torre del Morbillo, di proprietà dei fratelli Arguri di Spezzano Albanese, sono venute alle luce delle antiche mura che per la loro struttura, presumibilmente, dovrebbero risalire ad un periodo che va dal IV al II secolo avanti Cristo.

Gli scavi intrapresi alcuni giorni fa sotto la direzione del professore Rajnerj, direttore del museo dell'università di Pensylvania e dall'assistente alla sovraintendenza alle antichità per la Calabria di Reggio, signor Villelli, oltre alle mura, hanno permesso il rinvenimento di numerose anfore, di molte tombe, di tre monete di bronzo su una delle quali è coniata una piccola conchiglia, di tubi in argilla che per la loro disposizione, fanno credere alla esistenza di un piccolo acquedotto, di alcune cisterne e vasche da bagno in terracotta, di statuette e di altri oggetti in terracotta.

Il materiale raccolto è stato giudicato dagli studiosi e dagli esperti presenti di notevole importanza archeologica.

L'ampiezza dell'aia, nell'ambito della quale le ricerche condotte hanno portato alla luce il materiale archeologico e le mura, lascia presumere che nella zona giacciono i resti di una antica città ellenica, fiorente tra il IV e II secolo a.C.

Di quale città si tratta? Sarà Durio o qualche zona residenziale degli antichi sibariti? Data la posizione amena e la bellezza del paesaggio la seconda ipotesi potrebbe essere la più accettabile.

Saranno gli esperti chiamati a studiare gli oggetti reperiti che sveleranno il mistero che avvolge la città ellenica di Torre del Morbillo.

ΑΝΑΣΚΑΦΙΚΑΙ ΕΠΙΤΥΧΙΑΙ ΜΕΓΑΛΟΥ ΕΝΔΙΑΦΕΡΟΝΤΟΣ ΔΙΑ ΤΗΝ ΑΡΧΑΙΟΛΟΓΙΑΝ

ΑΝΑΣΚΑΦΙΚΑΙ ἐπιτυχίαι μεγάλου ἐνδιαφέροντος διά τήν Ἀρχαιολογίαν καί γενικώτερον διά τήν Ἀρχαιογνωσίαν ἀσημειώθησαν τελευταίως μέ τήν ἀποκάλυψιν ἐκτεταμένων τμημάτων τῆς ἀρχαίας πόλεως Ἤλιδος, τά ὁποῖα ἀνήκουν καί εἰς πυκνοκατοικημένας συνοικίας τοῦ κέντρου αὐτῆς. Ἡ ἀπροσδόκητος ἀποκάλυψις τῶν ἐπραγματοποιήθη κατά ἐξαιρετικόν τρόπον καί ἐξακολουθεῖ ἀκόμη εἰς διάφορα τμήματα τῆς διαβρομῆς, τήν ὁποίαν ἐπρόκειτο νά ἀκολουθήσῃ ὁ δυτικός τῆς σχηματιζομένης ἤδη τεχνητῆς λίμνης τοῦ Πηνειοῦ Ἤλείας κατασκευαζόμενος κύριος ἀρδευτικός ἀγωγός πλάτους ἑξι μέτρων.

Ἡ ἔκτασις, εἰς τήν ὁποίαν ἀποκαλύπτονται τά ἀντιτυπωσιακά καί ἐπιμελημένης κατασκευῆς κτίρια τῆς ἀρχαίας πόλεως, εἶναι περί τά ἑπτά χιλιόμετρα δυτικῶς τοῦ μεγάλου φράγματος, ἔχει συνολικόν μῆκος περίπου δύο χιλιομέτρων καί εὑρίσκεται μεταξύ τῶν ὁρείων προσβάσεων τοῦ λόφου Ἁγίου Ἰωάννου, (ὅπου ἦτο ἡ ἀκρόπολις τῆς ἀρχαίας πόλεως) καί τῶν χωρίων Νέα Ἤλις (=Ἁλάσιον), Καλύβια καί Λογεῖον (=Μπουχιώτι).

Ἐκατέρωθεν τῆς προαναφερθείσης διαδρομῆς ἀπεκαλύφθησαν δύο χῶροι ἀρχαίων νεκροταφείων οἱ ὁποῖοι εἶναι ἐνδεχόμενον νά ἀριζουν καί τά ἄκρα τῆς ἀρχαίας πόλεως εἰς τήν περιοχήν τήν εὑρισκομένην βορείως τοῦ χωρίου Παλιόπολις καί νοτίως τοῦ ἀρχαίου θεάτρου τῆς Ἤλιδος πού ἦρχισε νά ἀποκαλύπτεται μαζί μέ τμήματα τῆς Ἀγορᾶς τῆς πόλεως πρό τοῦ 1ου παγκοσμίου πολέμου δι' ἀνασκαφῶν τοῦ Αὐστριακοῦ Ἀρχαιολογικοῦ Ἱνστιτούτου τῆς Βιέννης.

Εἰς τό θέατρον καί εἰς τήν Ἀγοράν αἱ ἀνασκαφαί ἐσυνεχίσθησαν καί μετά τόν 2ον παγκόσμιον πόλεμον διά τῆς Ἑλληνικῆς Ἀρχαιολογικῆς Ἑταιρίας, ὑπό τήν διεύθυνσιν τοῦ κ. Νικ. Γιαλούρη μέ τήν συνεργασίαν τοῦ Αὐστριακοῦ Ἱνστιτούτου καί ἐκπροσωπεῖται ἤδη ἡ ἀρχαιολόγος κ. Βερόνικα Λεάν - Μητροπούλου.

Ἡ κατασκευή τοῦ ἀρδευτικοῦ ἀγωγοῦ εἰς τήν προαναφερθεῖσαν περιοχήν ἔγινε ἀφορμή νά ἀρχίσῃ ἀπροσδοκήτως διά πρώτην φοράν ἡ ἀποκάλυψις καί σημαντικῶν τμημάτων τῆς ἀρχαίας πόλεως. Μεταξύ ἄλλων ἀπεκαλύφθησαν ἤδη εἰς τήν ἀρχικῶς προγραμματισθεῖσαν διαδρομήν τοῦ ἀρδευτικοῦ ἀγωγοῦ μέτρια τοιαῦτα κατασκευῆς μέ ψηφιδωτά δάπεδα διασῳζόντα θαυμασίας καλλιτεχνικάς παραστάσεις, ποικίλαι ἐγκαταστάσεις, κλίβανοι κατασκευῆς ἀγγείων, πηλίνων ἀγαλματιδίων καί κεράμων λουτρά, πισινοί, δεξαμεναί, φρέατα, ἀγάλματα, ἀφιερώματα, κοσμήματα, νομίσματα, διάφορα ἄλλα ἀντικείμενα καί γενικῶς ἀρχαιότητες, αἱ ὁποῖαι ἀκόμη καί κατά σπάνιον τρόπον δίδουν πολύ ζωντανήν εἰκόνα τῆς ὑλικῆς καί τῶν λεπτομερειῶν τῆς ζωῆς μιᾶς ἀρχαίας πλουσιωτάτης πόλεως.

Ἰδιαιτέρων ἐντύπωσιν προκαλεῖ ἡ καλαισθησία καί ἡ ἐξαιρετική φροντίς μέ τήν ὁποίαν εἶχαν γίνει αἱ περισσότεραι κατασκευαί καί ἐγκαταστάσεις τῆς πόλεως αὐτῆς, ἡ ὁποία εἶχε συνοικισθῇ ἐκ διαφόρων κωμῶν τῆς περιοχῆς κατά τάς ἀρχάς τοῦ 5ου π.Χ αἰῶνος καί εἶχε ἀναλάβει τήν ὀργάνωσιν τῶν Ὀλυμπιακῶν Ἀγώνων.

Ἀξιοθαύμαστος εἶναι καί ἡ διατήρησις τῶν ἀποκαλυπτομένων ἀρχαιοτήτων τῆς πόλεως, τοῦτο δέ ὀφείλεται εἰς τό γεγονός ὅτι ἡ ἔκτασις τῆς ἀρχαίας πόλεως ἔμεινε ἕως τώρα ἀκατοίκητος κατόπιν καταστροφῆς καί ἐγκαταλείψεώς της πού συνέβη κατά τούς πρώτους Βυζαντινούς αἰῶνας.

Η ΣΠΟΥΔΑΙΟΤΗΣ ΤΗΣ ΗΛΙΔΟΣ

Δια τά μεχρι τοῦ 1965 ἀρχαιολογικά εὑρήματα τῆς περιοχῆς αὐτῆς ὑπάρχουν κατατοπιστικαί πληροφορίαι εἰς τό σύγγραμμα τοῦ καθηγητοῦ κ. Νικ. Παπαχατζῆ «Παυσανίου Ἑλλάδος περιήγησις».

Μεταξύ ἄλλων ὁ κ. Παπαχατζῆς ἀναφέρει ὅτι ἡ πόλις "Ηλις εἶς τάς ρωμαϊκούς χρόνους Ὀλυμπιακῶν Ἀγώνων με τεθάλλετο ζαφνικά εἰς κοσμοπολιτικόν κέντρον, διότι οἱ ἀθληταί που ἤθελαν τά μετάσχουν εἰς αὐτούς ἦσαν ὑποχρεωμένοι ἀπό τούς κανονισμούς τῶν ἀγώνων νά ἔλθουν διά τετραημέρου, φίλοι καί συγγενεῖς τούς συνόδευαν. καί ἡ πόλις ἐπλημμύριζε ἀπό τό ἄθος τῆς ἠπειρωτικῆς καί νησιωτικῆς Ἑλλάδος καί ἀπό πλουσίους ἀποίκους τῆς Μικρᾶς Ἀσίας καί τοῦ Πόντου, τῆς Μεγάλης Ἑλλάδος καί τῆς Ἀφρικῆς.

Ὁ κ. Παπαχατζῆς εἰς τό σύγγραμμα του «Παυσανίου Ἑλλάδος περιήγησις» ἀναφέρει ἐπίσης: Κατά τήν ἀρχαιότητα ἡ "Ηλις ἦτο ὄχι μόνον ἡ μεγαλυτέρα πόλις τῆς "Ηλείας, ἀλλά καί ἀπό τά πιό ἐνδιαφέροντα κέντρα ὅλης τῆς Ἑλλάδος. Ὀθνικός, συνεδέετο μέ τάς ἀξιολογωτέρας πόλεις τῆς "Ηλείας καί μέ τήν Ὀλυμπίαν: ὑπῆρχε ἕνας ὁρεινός δρόμος πού περνοῦσε ἀπό τήν πλειακήν Πύλον (ἡ θέσις τῆς ὁποίας πράκειται νά καταπλωσθῇ ἀπό τά ὄδατα τῆς σχηματιζομένης τεχνητῆς λίμνης), ἀπό τήν Οἰνόην, τήν Σαλμώνην, τήν Ἡράκλειαν καί κατέληγε εἰς τήν Ὀλυμπίαν, καί ἕνας πεδινός δρόμος πού περνοῦσε ἀπό τό Δυσπόντιον καί τούς Λεπρεάτας.

Ἡ "Ηλις ἦτο εἷς τῶν μεγαλυτέρων ἀκμήν τῆς κατά τά ρωμαϊκά χρόνια, ὁπότε ὁλόγυρα πόλεις ἠμπροδῶσαν νά συγκριθοῦν μέ αὐτήν εἰς τόν ἀριθμόν καί εἰς τό μέγεθος τῶν θημοσίων οἰκοδομημάτων, ὅπως φαίνεται καί ἀπό τήν περιγραφήν τοῦ Παυσανίου. Μνημεῖα κα ὅμως κτίσματα δέν ἔλειπαν καί κατά τά Ἑλληνιστικά χρόνια.

Ὅλα τά νέα ἐντυπωσιακά εὑρήματα τῶν πυκνοκατοικημένων τμημάτων τῆς ἀρχαίας πόλεως ὀφείλονται εἰς τήν ἐξ ὑπογρεώσεως ἀνασκαφικήν ἔρευναν τήν ὁποίαν ἀνέλαβε κατά τά τελευταία ἔτη ἡ Ἀρχαιολογική Ὑπηρεσία μέ τήν ἐνίσχυσιν τῆς Τεχνικῆς Ὑπηρεσίας τοῦ ὑπουργείου Δημοσίων Ἔργων εἰς τά σημεῖα ἀπό τά ὁποῖα εἶχε καθορισθῇ ἀρχικῶς νά περάσῃ ὁ κύριος ἀρδευτικός ἀγωγός τοῦ μεγάλου φράγματος. Ἡ διαδρομή τοῦ ὑπό κατασκευήν ἀγωγοῦ δέν εἶναι εἰς ὅλην τήν περιοχήν εὐθύγραμμος, ἀλλά ρυθμίζεται σύμφωνα μέ τάς ἀνάγκας ἀρδεύσεως τῶν ἀγρῶν, ἀναλόγως πρός τήν διαμόρφωσιν τοῦ ἐδάφους καί ὅσας τῶν ἀπαιτήσεων τῆς Ἀρχαιολογικῆς Ἐπιστήμης. Ἐδῶθη τοιουτοτρόπως πεδίον ἐπειγούσης δράσεως εἰς τούς "Ελληνας ἀρχαιολόγους πρός ἀνασκαφικήν ἔρευναν καί προέκυψαν πράγματι ἀπροσδόκητα ἀποτελέσματα ἀπό αὐτήν.

Τό 1965 ὁ κ. Ν. Παπαχατζῆς καθώρισε ὡς ἐξῆς εἰς τό προαναφερθέν σύγγραμμά του τά μέχρι τότε ἀρχαιολογικά πορίσματα περί τῆς θέσεως τῆς ἀρχαίας "Ηλιδος : "Ἀπό τήν διήγησιν τοῦ Παυσανίᾳ φαίνεται ὅτι δημιουργός τῆς πόλεως "Ηλιδος ἦτο ὁ τελικιτέρων ὑπῆρχε κατά τήν ἀρχαιοτέραν ἐποχήν. ἀλλά καί εἰς ἐκτασιν, εἰς τήν ὁποίαν εἶχε πραγματοποιηθῇ ἡ κατασκευή ἀναρρυθμιστικῆς δεξαμενῆς διαστάσεων 170 Χ 170 μέτρων.

Αἱ ἀνασκαφαί αὐται εἶχαν ἀρχισει τό 1964 ὑπό τοῦ ἀρχαιολόγου κ. Νικ. Γιαλούρη, ἐσυστηματοποιήθησαν δέ ἀπό τό 1966 ὑπό τήν διεύθυνσιν τοῦ κ. Γ. Παπαθανασοπούλου καί διεξάγονται ἤδη μέ τήν ἐποπτείαν τῶν ἀρχαιολόγων κ.κ. Ἥλιε Ἀνδρέου, Γεώργ. Μάντζιου καί "Εφης Σακελλαράκη καί τῶν δεσποινίδων Σοφίας Ἐλευθεριάδου καί Γιάννας Ψυχογιού. Ἐπί ἀριθμήμην περίοδον συνεργάσθη εἰς τάς ἐφετινάς ἀνασκαφάς τῆς "Ηλιδος καί ὁ ἀρχαιολόγος κ. Ἰωάννης Σακελλαράκης.

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ΑΙ ΑΡΧΑΙΑΙ ΝΕΚΡΟΥΠΟΛΕΙΣ

Ὅλη ἡ ἐρευνωμένη ἤδη ἔκτασις εὑρίσκεται μεταξύ δύο ἀρχαίων νεκροταφείων, τοῦ «Ἀνατολικοῦ» καί τοῦ «Δυτικοῦ». Τό «Ἀνατολικόν» εὑρίσκεται εἰς τούς πρόποδας τοῦ λόφου Ἁγίου Ἰωάννου καί εἶναι τῶν Ὑστερορωμαϊκῶν καί Ρωμαϊκῶν χρόνων. Εἰς τήν θέσιν του ἀπεκαλύφθησαν καί οἱ προαναφερθέντες δύο ὑπομυκηναϊκοί τάφοι τοῦ 10ου π.Χ. αἰῶνος.

Ἰδιαιτέρα προσοχή ἐπεδείχθη τελευταίως εἰς τήν ἀνασκαφικήν ἔρευναν τοῦ Δυτικοῦ νεκροταφείου παρά τά χωρία Νέα "Ηλις καί Αὐγεῖον, εἰς τό ὁποῖον ἀνεσκάφησαν ἑφέτος περίπου 200 τάφοι τῆς Κλασσικῆς περιόδου. Αἱ ταφαί εἰς τό νεκροταφεῖον αὐτό ἐγίνοντο κατά διαφόρους τρόπους, μέσα εἰς μεγάλα πιθάρια, ἢ εἰς κιβωτιοσχήμους καί εἰς κεραμοσκεπεῖς τάφους, ἦσαν δέ κατά τό πλεῖστον μέ πλουσιώτατα νεκρικά στολίδια («κτερίσματα»).

Εἰς διαφόρους τομεῖς εὑρέθησαν ὄχι μόνον λουτρῶνες, ἀλλά καί μικρές πισίνες, τοῦτο δέ ἐξηγεῖται ἐκ τοῦ γεγονότος ὅτι εἰς τήν πόλιν τῆς "Ηλιδος παρέμενον ἀκόμη καί προγυμνάζωνται πρό τῆς τελέσεως τῶν Ὀλυμπιακῶν Ἀγώνων ἐπί ὡρισμένην περίοδον οἱ ἀθληταί ποὺ ἐπρόκειτο νά μετάσχουν εἰς αὐτούς.

Ἐπί ρωμαιοκρατίας διά τούς Ὀλυμπιακούς Ἀγῶνας ἐνδιεφέροντο καί οἱ αὐτοκράτορες τῆς Ρώμης, οἱ ὁποῖοι ἐπεδίωκον ἀκόμη καί συμμετοχήν εἰς αὐτούς. Διά τοῦτο ἡ πόλις "Ηλις πού ἐφρόντιζε διά τήν ὀργάνωσίν των ἦτο ἑτοίμη νά ἐξασφαλίζῃ καταλύματα πού θά ἱκανοποιοῦσαν καί τούς πλέον ἀπαιτητικούς ἐπισκέπτας της.

ΤΑ ΑΛΛΑ ΕΥΡΗΜΑΤΑ

Ἰδιαιτέρου ἐνδιαφέροντος εἶναι ἕνα τμῆμα τῶν ἀνασκαφῶν μέ πηγάδι πολύ ἐπάνω καί πλησίον εἰς τό ἀρδευτικόν ἀγωγόν, ἀλλά καί εἰς ἐκτασιν, εἰς τήν ὁποίαν εἶχε πραγματοποιηθῇ ἡ κατασκευή ἀναρρυθμιστικῆς δεξαμενῆς διαστάσεων 170 Χ 170 μέτρων.

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PHILADELPHIA lawyer in the Near East: Mr. Robert Dechert (above), of Gulph Mills, walks past Roman ruins in Baalbek, Lebanon. Mr. and Mrs. Dechert were on the University of Pennsylvania Museum's tour of Eastern Mediterranean lands.

ON THE EXPEDITION: From left, Mrs. N. S. Lamont, of Chestnut Hill; Mrs. Richard O. Rex, of Chestnut Hill; former Philadelphian Mrs. Thomas Willing Balch, of Baltimore, and Miss Margery Schuler, of Hatboro.





RAVELER from center
ity: Mrs. Margaret R.
ischer, at Baalbek.

N THE GARDEN of
ethsemane (right,
ove) Mrs. Robert R.
eigs, of Chestnut Hill.

The Philadelphia Scene

Camel Is the Entree in Near East But Back Home They Eat Monkey

By RUTH SELTZER
Bulletin Society Editor

People are still talking about the four ladies who shared a hotel suite with a bathtub that was almost the size of a swimming pool. They still chuckle when they recall the afternoon that New York architect Ed Maverick lingered too long in the Palestine Archaeological Museum in Jerusalem. He was locked in. Ed is a cousin of the late Maury Maverick, the famous Texas congressman.

POSITIVELY no camel or goat meat was served at the Gala Fair in the University Museum's Roman Gallery. However, Mexican monkey meat was a hot hors d'oeuvre at Wednesday's invitational party there. The fair, which featured offbeat wares as well as exotic foods, was sponsored by the women's committee of the museum.

At the fair, we caught up with a more far-reaching project of the women's committee—the just-concluded University Museum members' tour of North Africa and the Near East. The three weeks' tour included visits to archaeological sites in Tunisia, Libya, Jordan, Lebanon, Syria and Turkey. Our tour-takers tell us that monkey meat wasn't served anywhere en route but they did eat camel and goat.

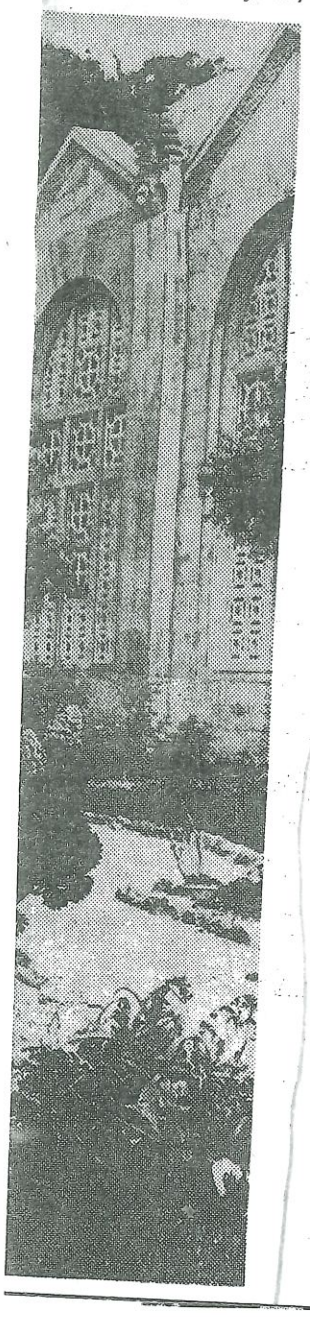
"I have a passion for archaeology. I'm still very enthusiastic about the trip," said Mrs. N. S. Lamont, of Chestnut Hill. "The only thing we missed was Palmyra. The airfield was under water."

We saw Miss Margery Schuler and University Museum archivist Geraldine Bruckner at the fair. They, too, had been on the journey to the Near East. Miss Bruckner is editor of Expedition, the museum's magazine.

There were 17 on the trip. In Jordan, all but two rode on horseback to Petra, the famous Rose City of the Dead, where the first-century tombs of the Nabataean robber barons were seen. It took our Philadelphia horseback riders 45 minutes to get to Petra. They made their way across the dried-up bed of a river.

Dr. James B. Pritchard, the University Museum's curator of Biblical archaeology, welcomed the tour-takers to Tell-es-Saidiyeh, where he is conducting a dig." He gave a luncheon for the visitors on the site. But before lunch was over, a severe windstorm blew up. Jim Pritchard advised his guests to get out of the tent as fast as possible and stretch out on the ground.

Sand swirled. The wind raged. "We rolled around in a Moslem graveyard," said Mrs. Robert Dechert, of Gulph Mills.



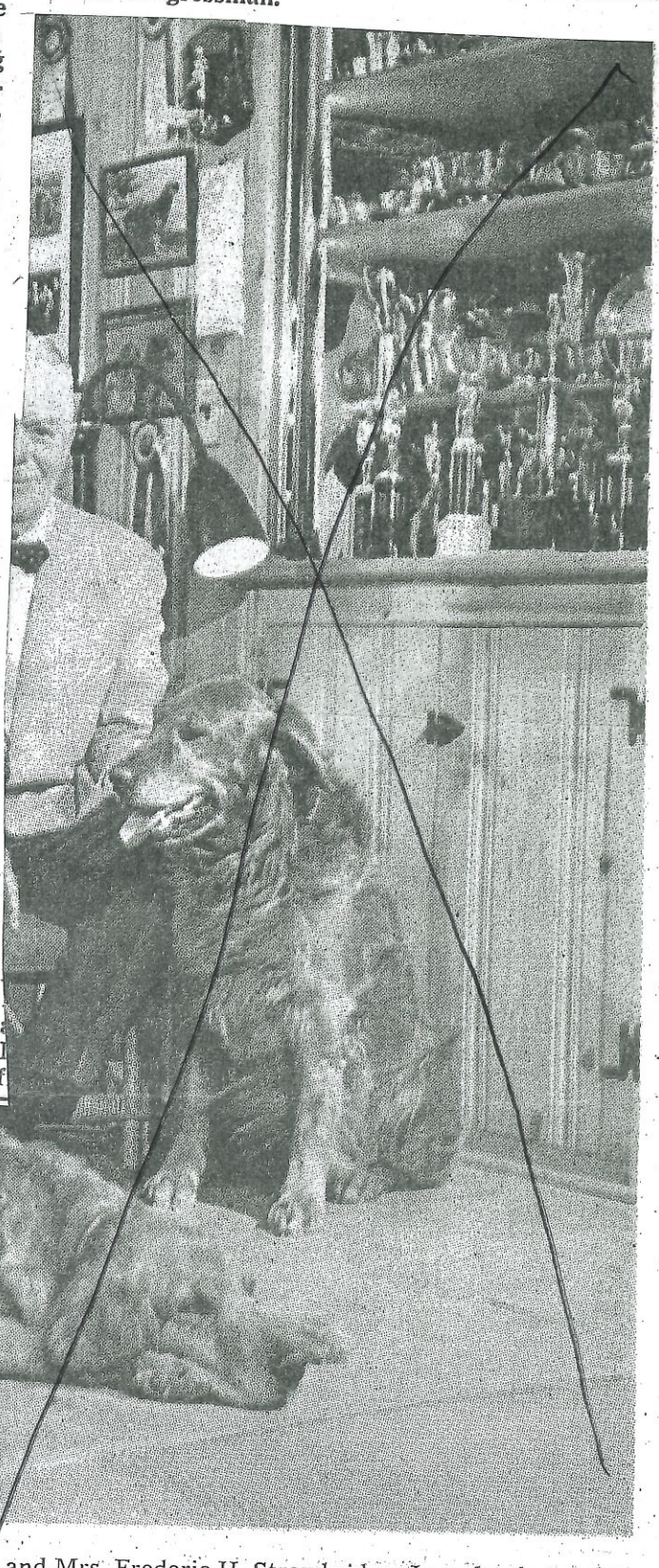
Helen Dechert and her husband, Bob (the well-known Philadelphia lawyer) were on the University Museum's trip to Egypt and Greece last year. They went on this spring's expedition to the Eastern Mediterranean.

Dr. and Mrs. Richard O. Rex, of Chestnut Hill, also took both trips. So did Miss Schuler, Mrs. Lamont and Dr. Kenneth D. Matthews, the University Museum's education director. Ken Matthews steered the tour-takers from site to site. "He's brilliant and he's fun to be with," said one of the travelers.

At Gordion, Turkey, the University Museum's Dr. Rodney S. Young gave a warm welcome to the Philadelphians. He personally escorted them into the tomb of King Midas' father. At Gordion, the tour-takers also met the University Museum's Ellen Kohler, Elizabeth K. (Beth) Ralph and Rodney Young's pet sheep dog.

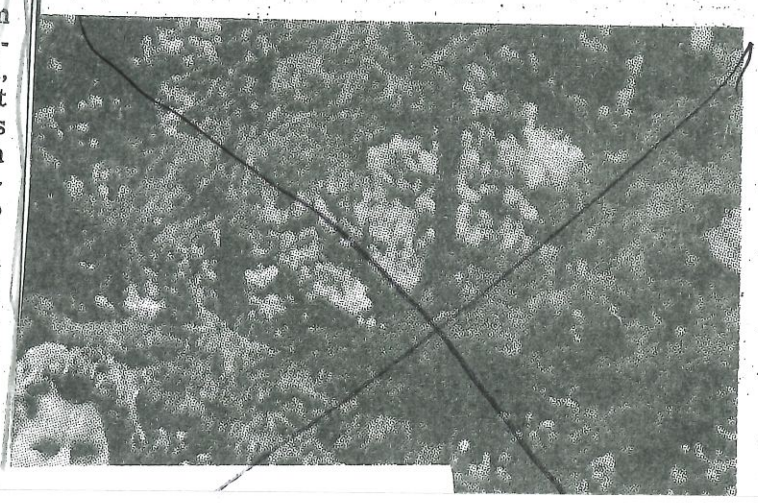
Beth Ralph is locating archaeological sites with her magnetometer. "Fifteen new spots are waiting to be dug," said Mrs. Lamont.

There were many laughs along the way.



Mr. and Mrs. Frederic H. Strawbridge, Jr., relax in trophy room; a Cairn terrier, is on Mrs. Strawbridge's lap.

Bulletin Staff Photos by Joseph F. Wiedelman



The New Haven Register
NEW HAVEN, CONN.
D. 101,413 SUN. 113,377

OCT 15 1965

Ancient Houses Are Discovered On Alaska Site

PROVIDENCE, R.I., (AP) — A Brown University expedition has uncovered the remains of three ancient houses in Alaska that are among the oldest in North America and flint knives believed to be 8,000 years old.

The expedition, headed by Prof. Froelich Rainey of the University of Pennsylvania, was to the Onion Portage on the Kobuk River in Northwestern Alaska, 50 miles above the Arctic Circle and 100 miles inland from the Chukchi Sea that separates Alaska and Siberia.

The discoveries may unlock the mysteries of the migrating tribes that have passed through Alaska since the end of the Ice Age, when a land bridge is believed to have connected Alaska and Siberia, a university announcement said today.

Remains of two of the circular houses were found at the 4,000-year-old level along with flint tools. The third was found two and a half feet below the first two. All three houses belong to the so-called Denbigh Culture.

The third house "is among the oldest yet found in the Arctic," said Mrs. J. Louis Giddings, curator of Brown's Haffenreffer Museum, where the artifacts brought back from Alaska will be studied.

The expedition reported finding 30 "cultural levels" at the site, including thick pockets of Charcoal from man - made hearths and tiny stone knives and chips indicating that people had camped on the riverbank in immediate post-glacial times 6,000 years before Christ.

At the top of the site was found remains of a large 13th Century house. Inside was the skelton of a man believed to have been a "shaman," or wise man with magical powers, the university said.

Dallas Times Herald
D. 205,498 SUN. 221,016

OCT 19 1965

Alaska Relics May Date Back 8,000 Years

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The Arizona Daily Star
TUCSON, ARIZ.
D. 41,709 SUN. 59,757

OCT 15 1965

3 Ruins May Solve Mystery

8,000-Year-Old Alaska Sites Found

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Penn Rebuilds Phoenician City

The Evening Bulletin
PHILADELPHIA
Wednesday, April 20, 1966

Penn Rebuilds Phoenician City

The University Museum of the University of Pennsylvania has undertaken a ten-year restoration project at an ancient African city from which Julius Caesar once exacted an annual tribute of 300,000 measures of oil.

The city is Leptis Magna, located on a promontory along the Mediterranean coast in Libya, about 60 miles east of modern Tripoli.

Arrangements for the project, one of the largest of its kind ever undertaken, were completed recently by John Dimick, of Washington, a trustee of the museum, and Aubrey Trik, the museum's expert on restoration.

Both conferred with Abdul Gibril, Undersecretary of the Libyan Department of Antiquities. Trik is now back in Libya to make a detailed study of the great Basilica and other buildings in order to prepare plans and costs of the project.

The ruins of Leptis Magna are spread out over a mile of terrain. It will be the job of the experts to restore some of the principal structures.

The city was one of the oldest and most flourishing under Phoenician rule. It was founded by the Sidonians and the people of Tyre, and once was a tributary of Carthage, to which it paid a contribution of a talent a day.

Later, it became an important port under the Romans during the reign of Septimius Severus (193-211 A.D.). The port, a mile in circumference, was marked by a lighthouse from which an avenue lined by Corinthian columns led up to the city.

The city was provided with baths with cold, hot and tepid water. These, a spacious forum, an amphitheatre and a circus are some of the ruins awaiting restoration.

Leptis Magna was captured by the Vandals in the Fifth Century. A little more than a century later the Byzantines under the Emperor Justinian recaptured it. It fell into the hands of Arab invaders in the Seventh Century.

The invasions, several earthquakes and centuries of neglect finally brought the city to ruin.

Libya by providing the labor, housing and maintenance, will make the major contribution to the project. The work, if it progresses as planned, also is expected to provide training of the natives in masonry, carpentry, scaffolding techniques and simple engineering methods.

Trik has had wide experience in this sort of work in Tikal, Guatemala, where he helped to restore some of the archeological remains left by the ancient Maya Indians.

3½-Pound Jade Head Of Jaguar Is Found At Guatemala Diggings

By ADOLPH KATZ
Of The Bulletin Staff

A 1,200-year-old tomb at Tikal, Guatemala, has yielded the biggest piece of carved jade ever found in Central America.

The artifact, representing the head of a jaguar, is eight inches long and weighs three pounds, eleven ounces.

It was removed from one of two tombs excavated in recent months by a joint archeological expedition of the University Museum of the University of Pennsylvania and the Guatemalan government.

A wealth of other artifacts discovered in two tombs, including furniture, pottery, ornaments and figures carved from alabaster, shed new light on the customs of the Maya Indians who flourished in the Guatemala lowlands long before Columbus discovered America.

Ironically, the archeological treasure was discovered as the University Museum was winding up an 11-year agreement to excavate at Tikal.

The first Penn diggers arrived at Tikal in 1956, and digging started the following year. The excavation work will terminate at the end of this year.

Restoration Project

However, a three-year project for consolidating and repairing the Tikal architecture already dug up, will begin next year and continue through 1969 under the direction of Dr. Alfred Kidder, 2d, associate director of the museum. George F. Guillemin, of Guatemala, will continue as field director.

"Tikal could be mined for ever and ever, said Dr. William R. Coe, associate curator of the American section of the University Museum. "It is somewhat discouraging to have to call a halt in an excavation like this."

Dr. Coe observed that the "dramatic finds," coming at the end of a decade of digging, "makes it difficult to leave off and to say, finally, 'This is it.'"

Tikal was the ceremonial center of the ancient Mayas who flourished there since the days before Christ.

Home for 10,000

An estimated 10,000 people lived in the six square miles of central Tikal about the 8th Century, AD, just before the Maya civilization declined.

The jade carving of the jaguar was found in a tomb cataloged as Burial 196 under a pyramid structure on the Great Plaza, south of a larger pyramid known as Temple 2.

Dr. Coe said that the jaguar was one of the gods of the Mayas, symbolizing such things as water and power. The rain forests of the Maya lowlands abounded in jaguars in ancient times, and the animals are still found there.

The Mayas evidently got their jade from a region near Mazanal, located between Guatemala City and Puerto Barrios. The jade deposits there were rediscovered by geologists about a decade ago.

On Leave from Harvard

Burial 196 was excavated by Nicholas Hellmuth, 21, of St. Louis, who became a member of Penn's archeological team last summer while on leave from Harvard University.

In addition to the jaguar figure, a vast quantity of other jade artifacts were found by Hellmuth. These included bracelets, necklaces and beads.

"New and fascinating objects were brought to light every day," Hellmuth's report states. "Toward the end, when the grave furniture was thought to have been thoroughly cleaned, additional finds were not anticipated.

"It was during the removal of the offerings that the true richness of the tomb was realized, for under many a piece of jade or pot lay buried a new and unexpected offering. In one place six pots were found stacked on top of one another."

Skeleton in Tomb

There was a skeleton in this tomb, and another found in the second tomb, cataloged as Burial 195 and located in the Great Plaza fronting the North Acropolis, north of Temple 1.

Burial 195 was 23 feet the surface and was in the shape of a corbelled vault. The skeleton was probably that of an adult male about five feet, ten inches in height—tall for a Mayan.

There was evidence that the tomb, dating to about AD 600, had been flooded by a heavy rain before it could be covered up. This caused wooden objects to float about and finally come to a rest in unnatural positions.

Body on Boards

Among the items found in this tomb were four wooden figures, each about a - foot- and - a - half tall, representing the Maya rain god Chac; two alabaster figures, or rodents, each about a foot long; bowls bearing scenes and hieroglyphs inside and out; a tripod pottery plates with elaborate painting inside and bands of hieroglyphs in the borders.

The skeleton was on four large floor boards, each more than five feet long and each coated with a gluey plaster. On each floor board were four large hieroglyphic cartouches, while in the center was an elaborate red-painted carved scene in the form of a quatrefoil.

Also found in this tomb was the first wooden "ball-game yoke" ever uncovered, a device that was worn around the waist and wrapped with textiles. Another item was a sma wooden, four-legged bench, haps a throne, about fou long and covered with blue stucco.

In addition to exca museum workers have ed their exploration and mapping of Tikal beyond the central portion, going out more than seven miles, looking for a "greater Tikal."

Already, Dr. Coe said, this work, which is under the direction of Dr. William A. Ha land, of the University of Ve mont, and Dennis Puleston, the University of Penns vania, has disclosed that Ti was far larger than previou suspected.



CARVED JADE ARTIFACT, representing the head of a jaguar, is held by Carlos Larios (right) as he and George F. Guillemin examine some of the objects removed from two tombs excavated at Tikal in Guatemala.

The Museum of the University of Pennsylvania
33rd and Spruce Streets
Philadelphia, Pa. 19104
David Crownover, Executive Secretary
EV 6 - 7400

(Through The Beacon Agency, Inc.)

MASCA
P.4

January 1, 1968

THE UNIVERSITY MUSEUM
of the
UNIVERSITY OF PENNSYLVANIA

The article herewith is intended as an answer to the query: "What is the University Museum?" While informal, it is up-dated and reliable. We urge that you put it in your reference files. Additional copies are available on request.

The material is for writers, editors and specialists among all the media, and for free lance writers. It is, so to speak, the University Museum's "obit," if you'll pardon the phrase for an institution 80 years old and looking forward to a vigorous future in the years ahead. Only two areas of activity -- underwater archaeology and the Tikal project in Guatemala -- are singled out for summary treatment and this only because they serve as an example of the Museum's current activities in a field extending worldwide. Detailed material is available in all areas of the Museum's program.

The Beacon Agency is always ready to supply additional and specialized information, and photos, relating to the Museum's activities. We welcome your inquiries.

For the University Museum,

The Beacon Agency, Inc.
Joseph P. McLaughlin, President.
Western Saving Fund Building
Broad and Chestnut Streets
Philadelphia, Pa. 19107
KI 6 - 1830

THE UNIVERSITY MUSEUM

of the

UNIVERSITY OF PENNSYLVANIA

The University Museum, one of the world's great archaeological treasure houses and a vigorous research institution, was founded in 1887, a decade after the great Centennial Exposition in Philadelphia. Since 1899 it has occupied a handsome structure at 33rd and Spruce Streets, Philadelphia, on the Penn Campus. The building -- designed by the architects Wilson Eyre, Jr., Walter Cope and Emlyn L. Stewardson -- is an adaptation of North Italian Romanesque, its two stories above ground fanning out from a taller round tower element containing a two-story amphitheatre topped by the lovely Chinese Rotunda.

The physical structure is worthy of note, for this gracious axis area offers a suitable setting for many museum functions, both scholarly and social, both public and a few for the Museum's thriving membership of more than 2,000. Nor is the Museum too austere to preclude its private jokes and whimsies, as when recently it plumped a tiny submarine, veteran of underwater archaeological expeditions, on the fish pond before its ivy-covered facade, to the surprise, but not inconvenience, of a year-round population of golden carp and pond lilies.

Despite an occasional private membership function after hours, the University Museum is open to the public and admission is free. Only infrequently do the expenses of mounting a special exhibition -- as the Dead Sea Scrolls exhibit and the rich Art Treasures of Turkey of recent seasons -- make it necessary to charge a quite nominal fee to the special exhibition sector, and even then with lower rates for school classes and other groups.

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While a department of the University of Pennsylvania, the University Museum has its own Board of Managers and the benefits of endowments and private gifts. Many of its expeditions and areas of research also receive support from the National Science Foundation, the National Geographic Society and many others.

Its Director for the past twenty years has been Froelich Rainey, Ph.D. and its curators are teaching members of the University of Pennsylvania faculty in anthropology, archaeology, ethnology and other academic disciplines. Both graduate and undergraduate students of the University constantly use its classrooms and library and its rich collection of materials. Scholars in fields as diverse as the American Woodland Indians and the Babylonians of antiquity are constant visitors, as they are participants in the Museum's far-flung activities.

The archaeological collections of the University Museum parallel those of the venerable British Museum and its activity in expeditions and research far exceeds Britain's. From its first excavation, or dig, at Nippur in Southern Babylonia in 1887, it has conducted more than 250 digs in its 80 years of existence, crowned by a banner season in 1967-68 of thirty expeditions, both archaeological and ethnographic, in all parts of the world.

The Museum's collection from Ur of the Chaldees is unique. Its collection of Chinese objects from the first millenium of our era -- A.D. 1 to 1,000 -- is world renowned. There are literally thousands of artifacts on public display at the Museum, and even more stored away in its lower regions.

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The Museum's Sections, each with a curator who is also a member of the University faculty, each active in expeditions, are: African, American (embracing North, Middle and South America), Egyptian, Biblical (the Holy Land), Far East, Near East, Southeast Asia, Oceania, and Underwater Archaeology.

In the last named the University Museum is a pioneer in applying land techniques of archaeology to the vast areas under the sea. There has been wide public interest during the 1960's in the work of its youthful underwater archaeologist, Dr. George Bass, still continuing vigorously at the bottom of the Aegean Sea off the coasts of Turkey and Greece.

Using a tiny submarine -- the one that visited the Museum's fish pond in the Fall of 1967 -- named the Asherah for a Phoenician sea goddess, Dr. Bass and an international team of archaeologists, including graduates students from Penn, Yale, Bryn Mawr and other institutions, have explored the ocean depths among the hulks of Roman, Greek and Byzantine ships sunk in antiquity. The two-man Asherah, built for the Museum in 1964 by the Electric Boat Division of General Dynamics, in Groton, Conn., is a mere 17 feet long and 7½ feet from keel to the top of its hatch. It has a range of depth of 600 feet, makes dives of four hours' duration, and can support life (for its navigator and observer) for 48 hours.

The work of the sub is assisted by scuba and aqua-lunged divers, and by specially designed sonar equipment for locating and plotting the hulls of ships sunk more than 2,000 years ago, from which the Museum people are bringing forth bronze statues, roof tiles, coins, implements, jars and other pottery in a state of pretty good preservation for their long stay in the watery deep freeze. One clever device that has caught the public fancy is an "underwater telephone booth," being a large plastic hemisphere lowered to the sea floor into which underwater workers can repair and remove their masks for a breather and even talk by phone to a base on a nearby island.

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The current activity in underwater archaeology is here cited as an illustration of the modernity and liveliness of much of the activity of the University Museum.

Traditional scholarship and the latest scientific tools work hand in hand at the Museum in the interpretation of man's past. On the traditional side, the Museum possesses a notable collection of ancient records -- papyrus and clay tablets in cuneiform, hieroglyphs and other ancient scripts -- and it has also world famous scholars for their translation.

But ultra-modern science reigns at the Museum's Applied Science Center for Archaeology (MASCA) which employs the services of physicists and chemists as well as archaeologists. For one thing, the Applied Science Center is a pioneer in the accurate dating of objects of antiquity. Its patient experts are now applying the technique of thermoluminescence, still in the experimental stage, to the dating of non-organic objects of antiquity, to supplement the now well-known radio carbon (Carbon 14) procedure for establishing the dates of organic materials.

Thus, many objects of pottery, whose original firing centuries ago left traces detected by thermoluminescence, are now receiving their baptismal certificates relating to eras long before Christ. Archaeological knowledge is hard to come by, but the rewards to scientists are great and the advancement of knowledge of human lore and past cultures are significant in the never-ending study of man and his environment.

MASCA, which publishes an informative Newsletter about twice a year, was established in the early 1960's. To museums, archaeologists, geo-physicists and others interested throughout the world the Newsletter carries information out of its own experience and the experience of others contributing to its pages. The publication reports on the development of instruments for archaeological prospecting, the investigation of new dating methods and new applications of established methods, and investigation of various analytical methods. MASCA thus serves as a valued

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information center for scholars in these fields. The dating methods include, besides the application of thermoluminescence and Carbon 14, the application of dendrochronology and volcanic-ash chronology.

Archaeological prospecting in the field includes the use of rubidium and proton magnetometers and, latterly, a cesium magnetometer, to locate buried ruins and ancient objects even before the first spade bites into the earth, furnishing guidelines for a dig that may prove fruitful. Thus, the Museum's employment of a cesium magnetometer at the site of ancient Elis in Greece recently served to fix the existence of ruins that will later be excavated. This magnetometer records changes in magnetic intensity below the earth's surface and properly interpreted can delineate the outline of walls and the presence of roof tiles and pottery that reveal buried temples and villas, in effect an entire city plan of past centuries.

Allied with the MASCA activities is the Museum's conservation center for the preservation of artifacts both in the Museum's collections and brought in from the field. The trained conservator, who must possess a knowledge of chemistry and metallurgy to assist the patient skill of hands, brings the object of metal, ivory, wood or bone back to its essential construction, without patching up or adding anything, which "restoration" implies.

The Tikal project in Guatemala, now in its final stage of shoring up and preservation after eleven years of Museum digs, is another star in the Museum's crown, a notable contribution to knowledge of the Maya civilization that disappeared more than a thousand years ago. Here crested temples surmount pyramidal structures that rise more than 150 feet above the jungle rain forest of the northern Guatemala lowlands, actually the southern beginning of the Yucatan peninsula. The work at Tikal has been directed and financed by the University Museum in cooperation with the Guatemalan government, the latter now financing the final phase under Museum supervision.

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The University Museum has perhaps a half-dozen special exhibits each year. While these are well supported by its own membership, the major continuing patronage is from the University community and the public at large from throughout the Delaware Valley, from Trenton, N.J., through greater Philadelphia down to Wilmington, Delaware. Closed only on Mondays and with admission free, its general popularity is attested by the buses continually pulling up to its doors, disgorging school children and older groups by the thousands, getting their first taste of the fascinating story of man. Led by classroom teachers -- and present facilities unhappily mean that some requests are turned down -- the groups of young and adults are conducted through the Museum by knowledgable volunteer guides.

The Museum's department of education conducts a busy program. Through the winter months there is a free series of Saturday concerts, known as Music at the Museum, which include the small but talented Museum String Orchestra, a chamber music group led by William Smith, assistant conductor of the Philadelphia Orchestra. These concerts are presented in part by a grant from the Recording Industries (Music Performance) Trust Funds in cooperation with the local branch of the American Federation of Musicians.

With support of the State of Pennsylvania, the education department recently initiated a series of travelling exhibits for display in the 29 free library centers of the Commonwealth. Daily life in Ancient Athens, the Story of the Alphabet, the Land of the Egyptians were early subjects. As each of the State's library centers -- Lancaster, Pa. is a typical example, which was host to the Life in Athens display early in the program -- is the center for perhaps a dozen satellite libraries in smaller surrounding communities, this statewide program has enormous possibilities

for bringing to smalltown residents a sampling of the treasures of a great urban museum.

A supply of leaflets accompanies each exhibit -- which are attractive three-panelled affairs with self-contained lighting and in each panel several authentic artifacts from the Museum collection -- along with a series of colored slides and accompanying narration that groups may borrow for use with a projector to make up a half-hour lecture. The librarians in the various centers are very enthusiastic over the program and report that the materials are in constant demand.

Another phase of public education, also supported by State grants, is the Museum's film production. The prize-winning film documentary, The Book and the Spade, showing in color and with expert narration the Museum's participation in archaeology in the Holy Land, has become a popular presentation at schools and library centers throughout the Commonwealth. Another Museum film -- The Alphabet; the Mark of Man -- is one more recent film production.

The University Museum's own library at 33rd and Spruce Streets is an invaluable resource for scholars and graduate students. Its 50,000 volumes comprise one of the best collections anywhere in the fields of archaeology and anthropology.

On a scholarly level with all these doings is the Museum's distinguished quarterly publication, Expedition. This handsome periodical, well illustrated, carries articles and papers largely written by the curators and specialists on the Museum's staff. They tell the story of current digs all over the world, new and dramatic finds, and the pursuit of scientific research in dating, translation, underwater exploration and the whole gamut of the Museum's activities.

More informal, but of great interest to the Museum membership, is a thrice-a-year Newsletter edited and published by the Museum's energetic Women's Committee, the fountainhead of many of the Museum's activities, cultural, social and in the encouragement of new funds to carry on the Museum program. A special fund-raising program was undertaken in 1967 to build a much-needed wing on the Museum to provide expansion for the collections, new classrooms, laboratories and storage facilities. Like an iceberg, much of a great museum's store of treasure is beneath the surface, yet scholarship and research demand its availability to staff, students and scientists.

An interesting side activity of the University Museum is the production of authentic items for other museums. Many requests are received for reproductions of fossil remains made from molds fitted to the originals.

As these reproductions yield a certain income to the Museum, so do authentic reproductions of more popular archaeological and anthropologic items -- from primitive masks to delicate jewelry -- on sale in the Museum shop beside its coffee shop. Each such reproduction bears the Museum's seal of authenticity and a description of the piece. The shop, which also offers an appropriate selection of books, postal cards and pamphlets, is open to the public and popular with Museum visitors.

The young people are not forgotten in the Museum's program and special films, recitals and puppet shows are a part of the overall program.

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One annual fixture in the Museum's planning for the last decade partakes of a private, that is to say membership, nature, but its continuing vitality is a tribute to the University Museum's solid stature in the Philadelphia community. This is the cruise organized each Spring to archaeological sites abroad. The latest scheduled for March/April,1968, entails a visit to southern Italy and adjacent islands and will take three weeks.

These tours are organized by the Women's Committee. By the preceding December some 50 members, husbands and friends have signed for reservations; there is always a waiting list. A Museum curator goes along as lecturer and guide; the sightseers fly over the sea by chartered plane to board their own cruise ship, their home throughout the tour. Evening lectures aboard ship review the day's activities and discuss the next day's schedule of ruins, tombs, museums and other archaeological points of interest. It is not an inexpensive holiday, but costs no more than a comparable cruise designed only for resort pleasure, and it offers an unusual dividend in purposeful travel with fellow members of similar interests.

Assuredly, the University Museum is an institution for everyone, even for the people who proverbially have everything. Few cultural institutions anywhere are so broadly based, so imaginatively directed to satisfy the scholar, the community and all sorts of people whose interests run from the merely curious to the specialist.

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The University Museum of the University of Pennsylvania is a name to conjure with at home and far afield. Many Philadelphians who daily pursue a westward course beyond the Schuylkill River know neither of its existence nor of the treasures it contains. Museum people think that's too bad but not surprising. The lucky ones have stopped by for a curious look, and have kept returning again and again. The Museum people think that's all to the good -- and they know it will keep on that way.

The Museum of the University of Pennsylvania
33rd and Spruce Streets
Philadelphia, Pa. 19104
David Crownover, Executive Secretary
EV 6-7400

January 1, 1968

Ban on Non-Greeks At Thera Dig Ends, With One Exception

Special to The New York Times

ATHENS, Jan. 12 — The Greek Archeological Service revoked its ban today on all foreign archeologists from the excavations of prehistoric remains on the Aegean island of Thera.

The ban was officially announced on Jan. 4. It was attributed to the fact that an American scientific team that took part in diggings last summer had made public its results before the director of excavations, Prof. Spyridon Marinatos, had made an official communication to the Greek Archeological Society.

Professor Marinatos, who is head of the service, said today that no foreign archeologists would be banned. He said the only undesirable person was Dr. James W. Mavor Jr. of the Woods Hole Oceanographic Institution of Massachusetts, who had been conducting a search for the lost continent of Atlantis. Dr. Mavor, he said, will be barred from the excavations at Thera. There is better known as Santorini.

Professor Marinatos said: "Dr. Mavor is an electrician and not an archaeologist. He has theories about Atlantis, which he is entittled to uphold and proclaim. However, he has no right to interfere with the Archeological Society's purely scientific work on Thera."

Professor Marinatos, whose excavations on the volcanic island of Thera revealed the remnants of a 4,000-year-old settlement, asserted that the ban on Dr. Mavor did not apply to Prof. Froelich Rainey and his assistant, Miss Elizabeth Ralph, of the Applied Science Center for Archeology of the University of Pennsylvania Museum, nor, he said, did it involve Mrs. Emily Vermeule, who cooperated with him at Thera last year. Mrs. Vermeule is a research fellow at the Boston Museum of Fine Arts.

19 Bodies Taken Off Peak

BATTLE MOUNTAIN, Nev., Jan. 12 (UPI)—Three helicopters carried the bodies of 19 servicemen today from a snow-covered Nevada mountainside where they perished in the crash of a Marine Corps transport plane Wednesday.

N.Y. Times
Sat. Jan. 13. 1968 p. 27.

St. Paul Dispatch
ST. PAUL, MINN.
D. 127,720
OCT 2 8 1965

CHRIS, LEIF BOTH COME-LATELIES—

Siberians First in New World?

PHILADELPHIA—(UPI)—You can forget the argument over whether the Norse or the Italians discovered the New World, a University of Pennsylvania professor said Wednesday.

The Japanese probably beat them both by about 7,000 years and Siberians were here thousands of years earlier, according to the Penn archeologist.

Froelich G. Rainey, director of the university's museum, said that excavations in Alaska during the summer uncovered tiny flint blades dating back to 6,000 B. C. He said the blades were similar to those uncovered previously in the Aleutian islands and the eastern coast of Japan.

"This would indicate the first settlers in this hemisphere migrated by foot from the eastern coast of Asia via the Aleutians, along the southern edge of a huge land mass that is now the Bering sea," he said.

Rainey said he and Brown university archeologists found the flints on the Kobuk river about 100 miles inland from the port city of Kotzebue at a crossing used by herds of migrating caribou for thousands of years.

He said the discovery "may revise our ideas about how people first came to this country for another reason."

"For while evidence of migration from Siberia was turned up in Alaska 15 years ago," he said, "it was thought that these crossings occurred in 15,000 to 20,000 B. C.

"These new findings indicate that the migrations lasted much longer than was previously believed. And they may have taken place along a different route—the Aleutians."

Rainey said eight distinct levels of activity were uncovered in the excavations and radio-carbon analysis showed they represented civilizations at 1,000-year intervals from 6,000 B. C. to the present.

Fort Worth Star-Telegram
FORT WORTH, TEXAS
D. 106,176 (EVENING)
OCT 2 8 1965



ADMIRAL RICKOVER

NOT NORSEMEN? — It may not have been Norsemen nor Christopher Columbus who discovered the New World after all, but the Japanese, says F. G. Rainey, a University of Pennsylvania archeologist. He said last night that excavations in Alaska last summer turned up tiny flint blades dating to 6000 B.C., and they appear to be the same type as ones uncovered on the east coast of Japan.

The Tulsa Tribune
TULSA, OKLA.
D. 77,420
OCT 2 8 1965

Were Japanese First to Reach The New World?

PHILADELPHIA (AP)—It may not have been Norsemen or Christopher Columbus who discovered the new world after all, but the Japanese, a University of Pennsylvania archaeologist has indicated.

Froelich G. Rainey, director of Peen's museum, said Wednesday night that excavations in Alaska last summer turned up tiny flint blades dating to 6000 B.C. They appear to be the same type as ones uncovered earlier in the Aleutian Islands and the east coast of Japan, he said.

"This would indicate that the first settlers in this hemisphere migrated by foot from the eastern coast of Asia," he said.

Rainey said the Asians may have migrated "across the southern edge of a huge land mass that is now the Bering Sea."

The theory that early Americans came from Asia is not new, but previous theories had them migrating from Siberia

Vineland Times Journal
VINELAND, N. J.
D. 13,063
OCT 2 8 1965

The Atlanta Journal
"COVERS DIXIE LIKE THE DEW"
D. 245,376
OCT 2 8 1965

Really Now, Japanese Got Here First

PHILADELPHIA (AP) — It may not have been Norsemen or Christopher Columbus who discovered the New World after all, but the Japanese, a University of Pennsylvania archaeologist has indicated.

Froelich G. Rainey, director of Penn's Museum, said Wednesday night that excavations in Alaska last summer turned up tiny flint blades dating to 6000 B.C. They appear to be the same type as ones uncovered earlier in the Aleutian Islands and the east coast of Japan, he said.

"This would indicate that the first settlers in this hemisphere migrated by foot from the eastern coast of Asia," he said.

The theory that early Americans came from Asia is not new, but previous theories had them migrating from Siberia, not Japan, and eastern Asia, he said.

Japanese Beat Norsemen to America

PHILADELPHIA (UPI) — You can forget the argument over whether the Norse or the Italians discovered the new world.

The Japanese probably beat them both by about 7,000 years and Siberians were here thousands of years earlier, according to a University of Pennsylvania archeologist.

Froelich G. Rainey, director of university's museum, said Wednesday that excavations in Alaska during the summer uncovered tiny flint blades dating back to 6,000 B.C. He said the blades were similar to those uncovered previously in the Aleutian Islands and the eastern coast of Japan.

"This would indicate that the first settlers in this hemisphere migrated by foot from the eastern coast of Asia via the Aleutians, along the southern edge of a huge land mass that is now the Bering Sea," he said.

Rainey said he and Brown University archeologists found the flints on the Kobuk River about 100 miles inland from the port city of Kotzebue at a crossing used by herds of migrating Caribou for thousands of years.

He said the discovery "may revise our ideas about how people first came to this country for another reason."

For while evidence of migration from Siberia was turned up in Alaska 15 years ago," he said, "it was thought that these crossings occurred in 15,000 to 20,000 B.C.

"These new findings indicate that the migrations lasted much longer than was previously believed. And they may have taken place along a different route—the Aleutians."

Rainey said eight distinct levels of activity were uncovered in the excavations and radio-carbon analysis showed they represented civilizations at 1,000 year intervals from 6,000 B.C. to the present.

Deseret News
SALT LAKE CITY, UTAH
D. 90,026
OCT 29 1965

Not Chris, Nor Eric, But The Japanese

PHILADELPHIA (UPI) — You can forget the argument over whether the Norse or the Italians discovered the new world, a University of Pennsylvania professor says.

The Japanese probably beat them both by about 7,000 years and Siberians were here thousands of years earlier, according to the Penn archeologist.

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EVENING TRIBUNE
SAN DIEGO, CALIFORNIA
D. 117,167
OCT 29 1965

Siberians Declared First in New World

PHILADELPHIA (UPI) — You can forget the argument over whether the Norse or the Italians discovered the New World, reports a University of Pennsylvania professor.

The Japanese probably beat them both by about 7,000 years and Siberians were here thousands of years earlier, according to the Penn archaeologist.

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"These new findings indicate that the migrations lasted much longer than was previously believed. And they may have taken place along a different route —the Aleutians."

The Times
CORPUS CHRISTI, TEXAS
D. 35,771
OCT 28 1965

NEW WORLD

Credit May Be Given To Japan

PHILADELPHIA. (AP) — It may not have been Norsemen or Christopher Columbus who discovered the new world after all, but the Japanese, a University of Pennsylvania archaeologist has indicated.

Froelich G. Rainey, director of Penn's Museum, said last night that excavations in Alaska last summer turned up tiny flint blades dating to 6000 B.C. They appear to be the same type as ones uncovered earlier in the Aleutian Islands and the east coast of Japan, he said.

"This would indicate that the first settlers in this hemisphere migrated by foot from the eastern coast of Asia." He said.

Rainey said the Asians may have migrated "across the southern edge of a huge land mass that is now the Bering Sea."

The theory that early Americans came from Asia is not new, but previous theories had them migrating from Siberia, not Japan, and Eastern Asia, he said.

New York Herald Tribune
D. 307,674 SUN. 385,268
OCT 29 1965

New World Discoverer: A Japanese?

PHILADELPHIA.

It may not have been Norsemen or Christopher Columbus who discovered the new world after all, but the Japanese, a University of Pennsylvania archeologist has indicated.

Froelich G. Rainey, director of the university's museum, said Wednesday night that his excavations in Alaska last summer, along with Brown University scientists, turned up tiny flint blades dating to 6000 B. C. They appear to be the same type as ones uncovered earlier in the Aleutian Islands and the east coast of Japan, he said.

"This would indicate that the first settlers in this hemisphere migrated by foot from the Eastern coast of Asia." He said.

Prof. Rainey said the Asians may have migrated "across the southern edge of a huge land mass that is now the Bering Sea."

The theory that early Americans came from Asia is not new, but previous theories had them migrating from Siberia, not Japan, and Eastern Asia, he said.

The Phoenix Gazette
ARIZONA'S PROGRESSIVE NEWSPAPER
D. 85,642
OCT 28 1965

A LONG WALK

Japanese Here First?

PHILADELPHIA (AP) — It may not have been Norsemen or Christopher Columbus who discovered the New World after all, but the Japanese, a University of Pennsylvania archeologist has indicated.

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Rainey said the Asians may have migrated "across the southern edge of a huge land mass that is now the Bering Sea."

Mexican Survey 1971 - winter

BETTY BELL

Archaeology Lectures Popular

by Carla Reiss



Almost 200 people attended the first lecture on "The Ancient Civilizations of Mexico" given by Dr. Betty Bell at the Mexican-Northamerican Cultural Institute last week, an overwhelming turnout by any standard. Dr. Bell, an adjunct professor of the University Museum of Southern Illinois University, will give three more lectures on archaeology in Mexico on March 18, March 25 and April 1.

Archaeology is of great interest to residents here. Mexico is full of unexplored regions where archaeological treasures are just waiting to be discovered.

Dr. Bell and her husband, Dr. William Winnie, a Fullbright professor of economics at the University of Guadalajara, will be living in Ajijic for at least two years and hope to eventually settle here. "Both of us are very interested in Mexico, having worked here on and off for the past 20 years," Dr. Bell said in a recent interview. "We would like to make Ajijic our permanent home where we can both concentrate fully on our different fields."

Both husband and wife were professors at Colorado State University in Ft. Collins before moving here. Dr. Winnie taught sociology and Dr. Bell taught anthropology.

Dr. Bell received her Ph. D. degree from U.C.L.A. She became interested in the archaeological sites in western Mexico under the guidance of her professor Dr. George Brainerd, a Maya specialist. Her thesis concerned the U.C.L.A. expedition in Amaya in the state of Nayarit where she spent much time. She also did some work with Dr. Brainerd in the Valley of Mexico.

After receiving her Ph. D. Dr. Bell worked with the Organization of American States (O.A.S.) in Washington, D. C. she evaluated health and education planning missions in Latin American countries and also served on the board which awarded O.A.S. fellowships. After four years, Dr. Bell returned to U.C.L.A. where she set up and administered a regional development training program that the University was sponsering in Brazil.

Last year Dr. Bell excavated Los Altos, a site near Teocaltichi in the eastern part of Jalisco near the Zacatecas border. The dig was sponsored by the American Philosophical Society and lasted two months.

"I had help from a student assistant who came from the States" Dr. Bell explained. "We hired a labor crew of ten Mexicans who did the heavy pick and shovel work. The laborers were very skillful and learned very fast what I needed to have done."

In order to do any kind of excavation, an archaeologist needs permission from the Mexican government. Anything that is found belongs automatically to Mexico.

From January 7 to February 7 of this year, Dr. Bell explored the shaft tombs in Etzatlan, 69 miles west of Guadalajara, in an area known as the Magdalina Lake Basin. This dig was sponsored by the Museum Applied Science Center for Archaeology.

"The big problem with shaft tombs is that most of them have been looted," Dr. Bell said. "The 'pot-hunters' or those local residents who loot the tombs, sell what they find to a middle man for a few hundred pesos a piece. The middle man then sneaks them illegally into the United States where he can receive $1,000 dollars or more for o piece. All this is terrible the sense that it robs the M xican government and the a chaeologists a chance to pie together some of Mexic past."

Dr. Bell feels that there a growing interest and app ciation of Mexican archaeol gy. Mexican artifacts a



Inquirer Photography by CHARLES W. JAMES

Chemist Mark Han (left) and Dr. Froelich Rainey work with equipment used to detect archeological forgeries

Fake Art Trade Booms

Tracing Forgeries Keeps Experts Busy

By MIKE LEARY
Of The Inquirer Staff

Froelich Rainey, director of the University of Pennsylvania Museum, motioned at an Olmec Indian figurine, smiling blandly through its glass display case.

"We know that's genuine," he said, puffing on his pipe. "We dug it up ourselves. But now, we're running into Olmec forgeries so good even experts can't tell if they're genuine or not just by looking at them."

What Rainey was talking about is a burgeoning business in counterfeit pre-Columbian antiquities — a business so big that Donald Collier, curator of Chicago's Field Museum of Natural History, estimates "Four out of every five pre-Columbian objects sold in Mexico are frauds."

And even though the chances of fakery are high — the best terra cotta frauds can be detected only by an esoteric process called "thermoluminescence," developed at Penn eight years ago — the demand for such objects is escalating.

"Only a decade ago, I could buy a whole basketful of Olmec figurines in Mexico for a few pesos — the Indians were digging them up all the time," Rainey recalls. "Today, jusht one figure may cost thousands of dollars."

And now that many Latin American countries have forbidden the export of their ancient treasures — a reaction against the plundering of archeological sites by professional bands of looters — the forgers have moved in to take up the slack.

The quality of their work is often extraordinary.

"I have been amazed ... astounded by the high degree of craftsmanship some of these people display," says Brown University anthropologist Dwight Heath, who has excavated sites in Costa Rica under a Fulbright grant.

Often, he says, forgers will use the same type of clay used in an original piece, sculpt it with genuine stone-age tools, then fire it in a wood-fed oven. But the real trick is aging.

"They'll smear a piece with whey," Heath says. "That gives it a mottled appearance. Then, they'll bury it in earth taken from an actual dig. The whey is really something, it encourages the growth of rootlets — so when they remove it from the dirt it has an ancient appearance."

Collier has come across "a family in Taxa (Mexico) that produces jade figurines that even surpass the originals in beauty. The work is exquisite." Indeed, these master forgers go so far as to import raw jade from Canada to insure the right shade of green now that local mines have fallen into disuse.

Even experts can be fooled by such polished fakery.

"We have no way of effectively dating gold or stonework," Rainey admits. "New gold looks pretty much like old gold, and a lot of our stone tablets come out of the ground in mint condition. If the craftsmanship is good enough, it can fool us."

But fraudulent terra cotta work — no matter how good — never slips past Penn's curators. At least not since museum researchers developed their thermoluminescence system eight years ago.

Basically, it measures the light emitted from microscopic pits burned into a piece by radiation after it was fired — and that yields the approximate date.

Only two other places in the world — Tokyo and Oxford Universities — have a similar systems, and Penn's was the first.

"We can tell within 100 years or so when an object was fired," says Mark Han, who helped develop the system. "If we have an Etruscan terra cotta that's supposed to be dated 400 or 500 B.C. and it's only 100 years old, we have a fraud."

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Man is in many ways more curious about his past than his future. The furious controversies that often arise over the dates of past events or the age of ancient cities and objects clearly indicate our determination to piece together the puzzle of history and disclose its meaning.

A new book, Dating Techniques for the Archaeologist (The MIT Press, $12.50), edited by two University of Pennsylvania scientists, Dr. Henry N. Michael and Elizabeth Ralph, offers the first comprehensive look at the modern dating techniques used by professional archaeologists which have so dramatically affected man's time perspective and his conception of human history. In his foreward, Dr. Froelich G. Rainey, Director of the University of Pennsylvania Museum, describes this impact and the changes it has brought in history, archaeology and anthropology.

"Probably future generations will look back upon this one," he notes, "as the one responsible for the adaptation of scientific technology and a new trend in archaeology."

(more)

The trend he refers to began more than 20 years ago when Dr. Willard F. Libby discovered that the ages of once-living things such as wood and bone could be measured by comparing the ratio of radioactive carbon 14 still present to the amount of stable carbon 12. Later, other techniques, including atomic-nuclear methods, were added to the list, and older methods such as tree-ring dating were refined. In the past few years, these techniques have been used in combination to provide a system of checks and balances, including "correction factors" for recently detected deviations in carbon 14 contents. Archeomagnetic analyses, for instance, contributed to more precise calibrations for carbon 14, whose atmospheric content increases and diminishes over the centuries in proportion to the varying intensities of the earth's geomagnetic field. Information obtained through tree-ring analysis of bristlecone pines has been used for similar purposes.

How all these techniques were developed, when and why they are used, how to employ them, and what their limitations are are all discussed in detail. Information is given on everything from collecting and packaging sample materials to testing and analyzing them in the laboratory. There are chapters on carbon-14 dating; tree-ring dating; archeomagnetic dating; thermoluminescent dating of pottery, fission track, potassium-argon, and obsidian hydration dating.

Contributors include both Michael and Ralph of the University Museum's Applied Science Center for Archaeology (MASCA); Henry Faul and Gunther A. Wagner of Pennsylvania's Geology Department; Vaclav Bucha of

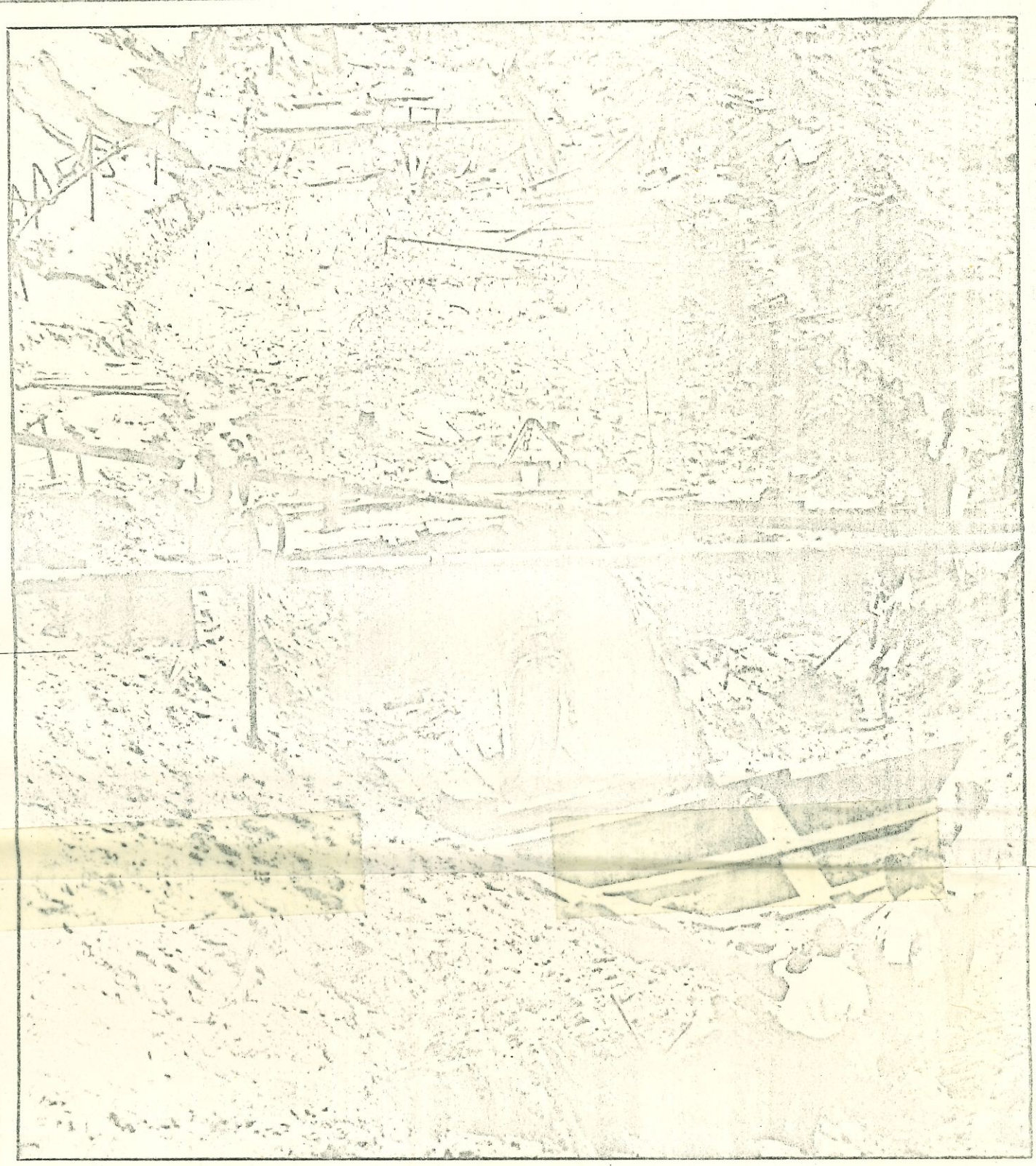
(more)

the Geophysical Institute of the Czechoslovakian Academy of Sciences; Joseph W. Michels and Carl A. Bebrich of the Department of Anthropology, The Pennsylvania State University; and John Winter, formerly with MASCA and now at the Freer Gallery, Smithsonian Institute, Washington, D.C.

The Indianapolis Star
D. 231,064 SUN. 379,299
DEC 5 1971

FILE: PUBLICITY

NEW TOOLS TO STUDY THE PAST



Science is providing new tools for archaeological exploration, especially for probing under water, where many treasures are buried. This vessel, unearthed in 1969, sank more than 100 years ago in an old channel of Missouri River in Iowa.

By KENNETH WITTY

THERE WAS a time when all an archaeologist required was a pick, a shovel, and a well-read volume of Homer or some other ancient author. Such simple tools unearthed the fabled cities of Troy, Mycenae, Knossos and Pompeii, to name just a few of the great finds of the past. The goals of archaeology, however, have become far more ambitious since the days a century ago when Heinrich Schliemann set out to prove that Troy was not a legend or some creation of Homer but historical fact.

Today, archaeologists want to know more than just the broad outlines of history. They are seeking to fill in the details of ancient cultures, the shadings and textures that will turn a sketch into a full-blown portrait of the past. To gain these insights they have been collaborating with physicists, chemists, electronics engineers and computer experts to develop new and sophisticated tools. The new technology that has resulted is helping archaeologists find, date, and analyze artifacts so that can tell the story of ancient man's daily life, his art, his migrations and his commerce.

One of the ways in which advanced technology is aiding archaeology is in the location of buried remains. For most of the last decade, one of the most important searches has been conducted by archaeologists and physicists from the University of Pennsylvania experimenting with new types of geophysical detection equipment in their search for the long-lost city of Sybaris, in southern Italy.

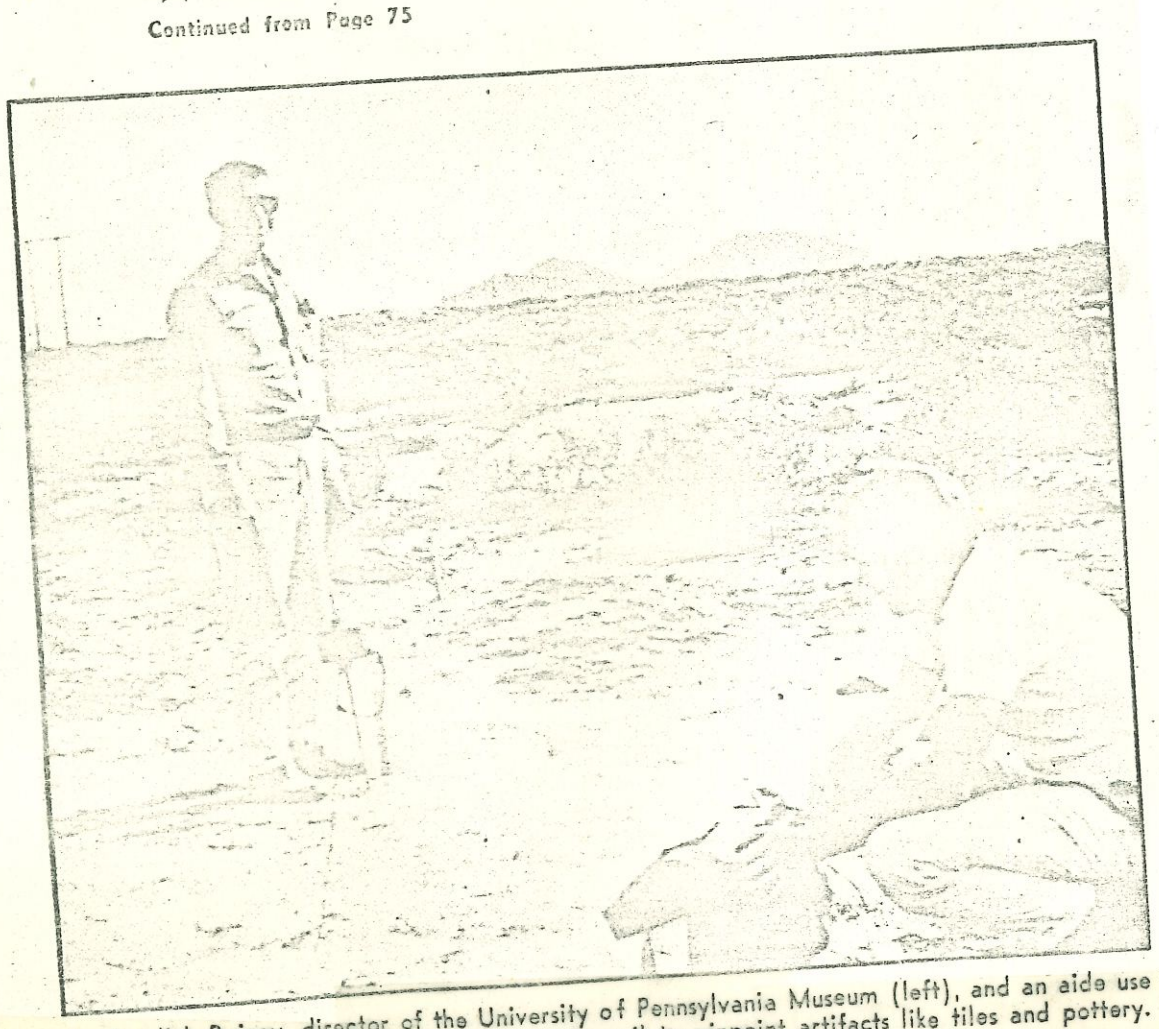
Sybaris was one of the largest and wealthiest cities of the Greek world in the 6th Century B.C. It had been founded, in approximately 720 B.C., on a fertile coastal plain by the Gulf of Taranto by colonists from mainland Greece. In little over a century, the city became so rich and powerful that it dominated a vast region and sent out colonies of its own as far away as the Italian west coast. Among the Greeks, the Sybarites earned a reputation for their opulent and pleasure-loving ways. In 510 B.C., defeated in battle by the neighboring city-state of Crotona, Sybaris was leveled and burned.

Although the city was abandoned 2,500 years ago, its fame as the pleasure capital of the ancient Greeks has survived and bequeathed the word "sybarite" to the English language. Although attempts were made to rebuild there in Greek and Roman times, the original Sybaris vanished from the face of the earth—to become one of modern archaeology's most intriguing enigmas.

Continued on Next Page

★ TOOLS

Continued from Page 75



Dr. Froelich Rainey, director of the University of Pennsylvania Museum (left), and an aide use a proton magnetometer, which is used to probe soil to pinpoint artifacts like tiles and pottery.

The University of Pennsylvania Museum and its director, Dr. Froelich Rainey, first became involved in the search for Sybaris in the early 1960s. The University Museum has been one of the pioneers in developing new instruments and techniques to aid archaeological research. Sybaris, Dr. Rainey felt, presented an ideal opportunity to test the effectiveness of electronic detection devices such as resistivity meters and magnetometers. His hope was that these highly sensitive instruments might succeed where more than a century of exploration with traditional methods had failed.

DR. RAINEY and his team began their search by probing the plain with magnetometers. These instruments can detect minute differences between the magnetic intensity of soils and any intrusions, such as buried stone foundations or ceramics. Objects of fired clay—bricks, roof tiles, pottery—register as more magnetic than the surrounding soil, while stone constructions register as less magnetic or nonmagnetic. Magnetometer results require very careful interpretation, but with experienced operators and the proper geophysical conditions large areas suspected of containing remains can be surveyed with relative speed.

The first instrument the expedition used was a proton magnetometer that had been employed on other searches, it soon became apparent, however that this tool was not sensitive enough to penetrate to the depths where Sybaris was thought to lie. Although no signs of the buried city were found, the archaeologists began to uncover Roman ruins from much later periods. These were not precisely what Dr. Rainey was looking for, but they did provide a clue: a Roman settlement was known to have been built close to the original site.

In 1967, Dr. Rainey brought along a new type of detection device, a cesium magnetometer originally designed for space research. A hundred times more sensitive than the proton magnetometer,

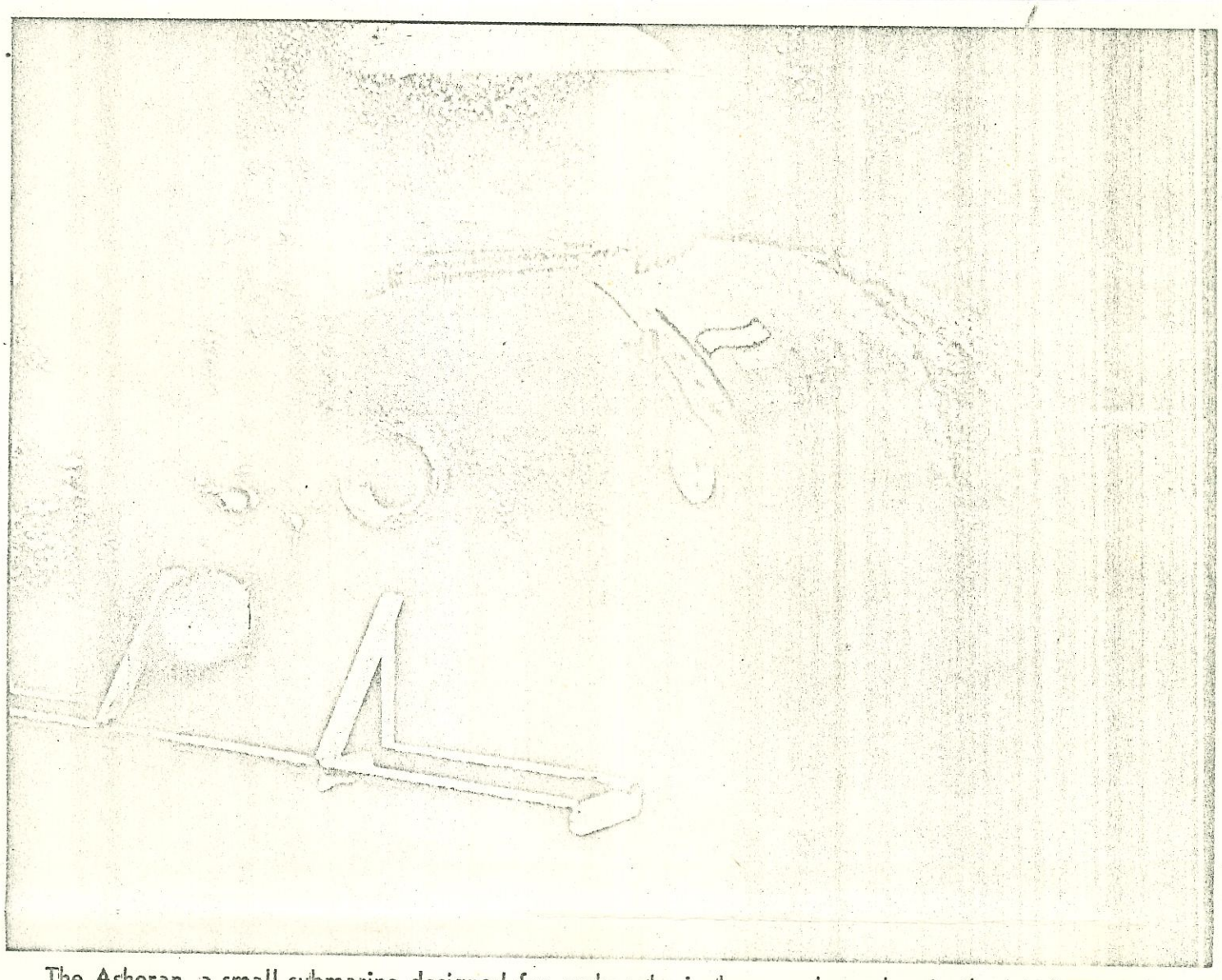
the portable cesium magnetometer can rapidly detect remains buried as deep as 20 feet. Surveying up to 10 acres a day with the instrument, the archaeologists began to pick up magnetic contrasts at depths where they calculated Sybaris to be. Test borings with power drills yielded bits of ceramic roof tile and pottery shards. A series of small trenches were dug, and the foundations of large buildings were revealed. To the north and south of these discoveries, the detector spotted ancient riverbeds, confirming accounts that the city had been built between two rivers.

Dr. Rainey's work at Sybaris was the first large-scale application of cesium magnetometers for archaeological exploration. Since then, these new instruments have been used to map entire sites, such as the Grecian city of Elis near Olympia. In Mexico last summer, Dr. Michael Coe of Yale University unearthed, with the aid of a magnetometer, the finest example of an Olmec head ever found.

Despite these successes, many archaeologists still look upon these new tools with reserve. "There is a resistance to the new techniques," says Dr. Rainey, "because archaeologists don't understand them. Only one in a hundred has any conception of modern physics and what it can do. It's really two worlds—the humanities and science." Ironically, even the most hardened traditionalists among archaeologists are relying increasingly on advanced technology in physics and chemistry to help them in one particular aspect of their research, the dating of artifacts.

The development that first brought about this collaboration between archaeologists and physical scientists was the discovery of radiocarbon dating by Willard F. Libby in 1949. Since its first application, thousands of radiocarbon dates have been established, changing profoundly our knowledge of early civilizations. We know now that the last Ice Age ended closer to 10,000 years ago than 20,000; that agriculture was practiced in Mexico by 5000 to 6000 B.C., almost as early as in the Near East; that men were constructing stone-walled towns in Palestine by 7000 B.C.

The ability of radiocarbon dating to tie down events to a particular century has revolutionized archaeology and given it a degree of precision it lacked previously. Prior to this, there had been no way of establishing the absolute age of an artifact and its related events. The radiocarbon technique is based on the fact that all living matter contains a small but virtually constant proportion of the radio-active isotope carbon 14. When an animal or plant dies, the radioactive carbon in the tissues is no longer replenished from the atmosphere and it starts to disintegrate at a constant rate—by one-half approximately every 5,730 years. By measuring the extent of carbon 14 disintegration in excavated organic remains, scientists can arrive at a fairly accurate determination of their age.



The Asheran, a small submarine designed for archaeological research, probes in the Mediterranean.

AS VALUABLE as radiocarbon dating has been, however, it is not infallible. Discrepancies in dating by radiocarbon methods have been noted, and one of the most effective means of cross-checking radiocarbon dates is through tree-ring dating. For example, radiocarbon dating established the age of Stonehenge at 3,670 years. Tree-ring dating proved that the site is actually some 500 to 700 years older. The shortcoming of carbon dating is that it can only pinpoint artifacts in time by association with organic material.

Suppose for example, an archaeologist uncovers a cache of farming tools and wants to know their age. He can only determine this if he is lucky enough to unearth some organic material at the same elevation. There may be no such material; or if there is a pinch of charcoal, for instance, it may well have found its way there centuries or even millennia later. In most cases, archaeologists, like good detectives, can arrive at conclusions by piecing together the circumstantial evidence. Still, as long as dating is done indirectly, there is always an element of doubt.

To eliminate such uncertainty, scientists and archaeologists have been looking into ways of dating the artifacts themselves. Today, there are at least seven direct dating methods, all based on atomic physics. One of the most promising of these is thermoluminescence, a technique used in conjunction with pottery and other clay products. Ceramics are among the most common relics of ancient civilizations. And scholars used to establish chronological periods for various cultures by analyzing stylistic changes in pottery. However, any pottery sequence can serve only to provide a system of relative dates, while thermoluminescence offers a way to pin down dates in absolute terms.

The method depends on the uranium and thorium content in clays. The older the pottery, the more these radioactive elements have decayed, leaving trapped electrons in the clay. When heated in a kiln, the pottery will release these electrons in the form of light. This light, or thermoluminescence, can then be measured by very sensitive instruments. Since old clay glows brighter than newer clay, the age of the object can be determined. However, the technique is still subject to a margin of error of about 5 per cent, which is too great to satisfy

Continued on Next Page

★ TOOLS

Continued from Page 77

the needs of many archaeologists. In the past few years, though, it has scored some notable successes.

Chemists at the University Museum have spotted several forgeries that had been passing as valuable Etruscan statues. One of the Museum's own treasures, the Etruscan Lady, turned out to be no more than 100 years old. Testing a second Etruscan figure, Diana the Huntress, owned by the City Art Museum of St. Louis, scientists discovered that it too was of 19th Century origin—possibly a creation of the same Italian forger.

Typically such new atomic-age technologies as thermoluminescence, neutron activation analysis, X-ray fluorescence, and mass spectrometry are used as laboratory aids in archaeology, either for dating or for chemical comparison of artifacts. Recently, however, these techniques also have been used to map the world's mineral deposits and correlate them with artifacts dug up in different parts of the world. With such "fingerprinting," chemists and archaeologists have been able to learn a great deal about prehistoric trade routes and migrations.

DR. CURT Beck of Vassar College has been using an infrared spectrometer to map deposits of European amber. Although still in its initial stages, his research has already shown that, as far back as 1500 B.C., Greeks were using Baltic amber that was probably mined in Denmark. These findings bear out various ancient legends of trade between Aegean sailors and peoples of northern Europe.

At the Atomic Energy Commission's Brookhaven National Laboratory, Dr. Edward V. Sayre, a chemist, has been working with Dr. Ray W. Smith, an archaeological expert on ancient glass, to classify glassware spanning 2,700 years. Sayre puts glass samples that Smith has collected all over the world into a nuclear reactor. Neutrons produced in the reactor form radioactive isotopes, which emit radiation at different energy levels for each of the elements contained in the glass. By measuring the radiation intensities peculiar to each element, Dr. Sayre can identify the unique characteristics of each type of glassware without harming the valuable treasures in any way. The technique is called neutron activation analysis, and it has enabled archaeologists to learn what kinds of materials ancient peoples used for manufacture. In Dr. Smith's work, the technique has often helped to pinpoint where and when a particular piece of glass was made. He once traced a priceless vase found in Afghanistan to its origin in Syria around A.D. 300.

While innovations such as the computer and atomic-dating processes are helping traditional archaeology, recent technology has also created a whole new field of study under the sea. Marine archaeology owes its existence to the invention of SCUBA diving equipment after World War II. Two decades ago, Jacques-Yves Cousteau and other professional divers began to explore and salvage shipwrecks and their cargoes from the ocean floor. Despite the valuable contribution of these divers, however, underwater archaeology did not begin to make scientific headway until the early 1960s, when archaeologists themselves first donned SCUBA gear.

One of the pioneers among this new breed of archaeologist has been Dr. George Bass of the University Museum. Bass, whose specialty was Bronze Age Greece, had had considerable experience in land excavations in Greece and Turkey before making his first dive a decade ago. Since that time, he has devoted all his attention to the problems of underwater archaeology. Working with various types of engineers, Bass has developed a broad range of new tools that are making underwater excavations as exact as any on land.

The ability to do systematic archaeological work undersea is no mere novelty. Excavations of ships in the Mediterranean, Caribbean and Baltic have added whole chapters to history by providing information on ship construction, navigation techniques and trade routes of many periods.

"Even more important," says Dr. Bass, "when we find artifacts under water, they are usually much better preserved than those found on land. And almost everything that was made in ancient times was carried on ships at one time or another."

FURTHERMORE, shipwrecks serve as buried time capsules whose contents can be very accurately dated. The only comparable situation found on land is that of a city such as Pompeii, which was destroyed by a sudden catastrophe—an archaeological rarity.

P78

At first, Dr. Bass did his reconstruction survey work by sending down teams of divers to draw and photograph ship remains. He used a scaled grid system to diagram their observations. After several years of working out this procedure in the study of wrecks off the coast of Turkey, charting could be done with great accuracy. But the process was slow and costly, since divers can work for only short periods of time under water and must go through hours of decompression after working at any great depth. To locate the site of an 8th Century Byzantine cargo ship at a depth of 90 feet, for example, took Bass and 12 divers more than a month.

To speed up underwater surveying, Bass and the University Museum commissioned the construction of a small, highly maneuverable submarine, specifically built for archaeological mapping and exploration. Christened the *Asherah* after a Phoenician sea goddess, the pressurized craft can carry two men to a depth of 600 feet. It can stay down for as long as eight hours, travels at speeds as high as four knots, and is equipped with powerful searchlights for undersea exploration and a pair of stereophotographic aerial-survey cameras designed to take pictures that can be translated into a three-dimensional plan of a wreck site.

According to Dr. Bass, the *Asherah* functioned far beyond her designers' original dreams. When she was first used in 1967, it took only a half-hour to locate the wreck of a Roman ship—a tiny fraction of the time previously required.

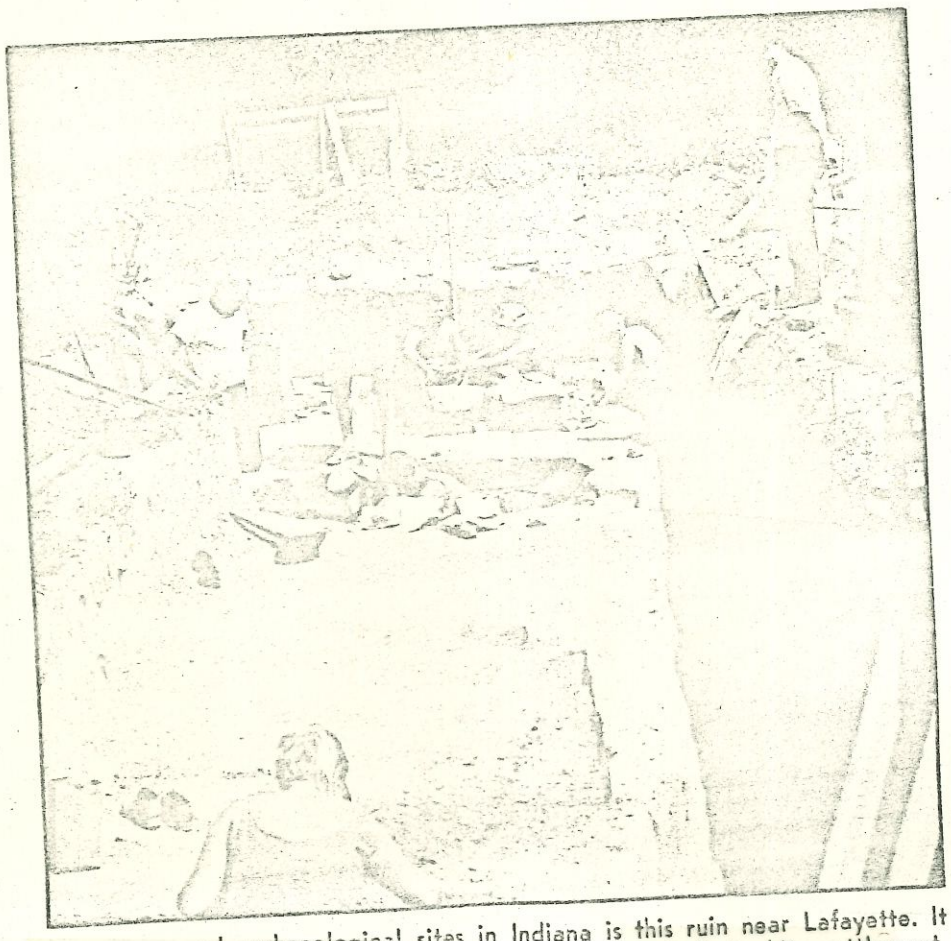
Increasingly, Dr. Bass has turned his attention to finding new ways of locating wrecks, particularly those buried in deep water. His interest in finding effective search techniques, is not purely academic. One summer, while Bass was working in Turkey a sponge fisherman netted a beautiful bronze statue of a boy with negroid features wearing a toga. The statue was found some 300 feet below the surface. A few years earlier, the fisherman's uncle had hauled up another bronze, in this case a sculpture of Demeter, from the same depth a number of miles away. Dr. Bass knew from experience that, when one statue is found, there are likely to be others from the same wreck.

"To those of us interested in classical sculpture, shipwrecks are the only source of bronze statuary," he explains. "Bronzes that

Continued on Next Page

★ TOOLS

Continued from Page 79



Among several archaeological sites in Indiana is this ruin near Lafayette. It is believed to be a French fort which was the state's first white settlement.

were not lost at sea were melted down in later times for the metal." Thus Bass suspected that the Demeter and the boy might have been part of a priceless cargo of classical art treasures.

BASS BEGAN a search, experimenting with television cameras, magnetometers, and a manned capsule known as the "Tow-Vane," which can dive to depths of more than 300 feet for visual observation while being towed behind a surface ship. After a season of searching with these various methods, no wrecks had been located. Bass concluded that the magnetometer and visual-exploration techniques were too limited in range for the vast areas involved. Still intent on finding a possible treasure ship, he turned the next year to a sonar detector, which can scan a path more than 1,000 feet wide by bouncing sound waves off the ocean floor.

With this new tool, it took only two days of runs across the suspected area to reveal a promising clue. The *Asherah* was sent down to investigate and at 285 feet settled directly on top of a cargo of ancient lamps, pottery and amphoras. Bass had discovered a reliable search technique as well as one of the largest ancient wrecks ever found, a Hellenistic vessel from the 3d or 4th Century B.C. Unfortunately, there were no signs of other bronze statues, although the next summer some of Bass' students did observe broken pieces of bronze around the wreck.

"The problem is that looters have been getting to these treasures faster than the archaeologists," Bass laments. "One of the biggest dangers facing underwater archaeology in the future is that historically valuable wrecks are being badly destroyed by looters and sports divers before trained professionals can get a chance to excavate them properly." But archaeology's new electronic devices may still help the scholars win this race against time.

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Reprinted from RCA Electronic Age

Colorado College
72

Book Reviews

By Richard M. Pearl

KARST. J. N. Jennings. The M.I.T. Press, Building 19, Room 714, 50 Ames Street, Cambridge, Massachusetts 02142. 1971. 252 pages, photographs, drawings, maps, tables, bibliography. $8.95.

Volume 7 of the series "An Introduction to Systematic Geomorphology" covers the interesting subject of cavern features. Not merely caves and their manifold aspects, which have been treated in greater charm and lovelier pictures than this, on a number of occasions. This most useful and well-illustrated book, however, is more comprehensive than just caves and caverns and treats in enough detail the whole subject of underground geology. In fact, the entire series, imported from Australia, should be in the library of everyone interested in landforms.

GLOSSARY OF MINERAL SPECIES 1971. Michael Fleischer. Mineralogical Record, Inc., P.O. Box 783, Bowie, Maryland 20715. 1971. 120 pages. $1.00 paperbound.

The names and chemical formulas of hundreds of mineral names are given in this handy publication. Synonyms and discarded names are not included for commonly used names. In an appendex John S. White, Jr. has written out the chemical equivalents in word form, such as zinc arsenate hydroxide for adamite. For quick reference and especially for proper labeling of museum and show exhibits this is a most useful item to have.

THE CHANGING EARTH. An Introductory Geology. Brainerd Mears, Jr. Van Nostrand-Reinhold Company, 458 West 33d Street, New York 10001. 1970. 429 pages, photographs, drawings, maps, glossary. $11.95.

This is a fine book on general geology for the beginning student at college level. Many of the standard things are here, as well as up-to-date information on all subjects. This text is substantially better than many others.

DATING TECHNIQUES FOR THE ARCHAEOLOGIST. Henry W. Michael and Elizabeth K. Ralph, coeditors. The MIT Press, Cambridge, Massachussetts 02142. 1971. 227 pages, photographs, drawings, tables, bibliographies. $12.50.

The methods presently available for dating the sites and artifacts of early man are explained in this book. Carbon-14 dating is discussed first. Tree rings follow, then the magnetic dating of ceramic objects, and then the thermoluminescent dating of pottery. Earth scientists will also be interested in dating by the hydration of obsidian, as well as with fossil bones. The treatment is not overly simple, but not too difficult either.

COLORFUL MINERAL IDENTIFIER. Anthony C. Tennissen. Photographs by Werner Lieber. Sterling Publishing Company, Inc., 419 Park Avenue South, New York, New York 10016. 1972. 224 pages, color plates, drawings. $3.50.

Based on a German book of 1969 by Werner Lieber, whose pictures are retained, this translated and adapted book is most attractive because of its pocket size and its fine color photographs of 120 specimens. The outlined information has a paragraph about each mineral, similar in style to my own "How to Know the Minerals and Rocks." The arrangement is by chemical group, like Frederick Pough's well-known book, hence this is not really a field guide, for nobody can tell an oxide from a silicate by anything he can do outside a good laboratory. The very low price (for these days) reflects its Hong Kong manufacture.

GUIDEBOOK TO THE SAN JACINTO MOUNTAINS OF SOUTHERN CALIFORNIA. GUIDEBOOK TO THE MOUNTAINS OF SAN DIEGO AND ORANGE COUNTIES. Russ Leadabrand. The Ward Ritchie Press, 3044 Riverside Drive, Los Angeles, California 90039. 1971. $1.95 paperbound.

These are two of a series of colorful books on the mountains of California, which will be useful to traveling students of earth science as well as others. In addition to general tourist information, a more than average coverage is given to geology, rocks, and minerals. The maps and photographs are very fine. Here are guidebooks that are much above average.

Geotimes July '72



the geologic column

by Robert L. Bates

Sometimes it seems as though most of the bright ideas that I set forth here get slapped down as irreverent or immaterial. It is thus a pleasure to record that the term *dedolomitization*—akin to *dedolomite,* which I deplored in May—got a going-over in a scholarly paper by Smit and Swett in the *Jour. sed. pet.* for March 1969. As these authors point out, the term is inconsistent, ambiguous, and geochemically misleading. So there!

Those fellows who excavate ruins and dig up old pots are more bashful than I'd realized. A recent book, entitled *Dating techniques for the archeologist,* is by two authors, whose names are Henry and Elizabeth. Well, I suppose you *do* get sort of dried-up and anti-social, out there in the desert. . . . A new dam is described in the Los Angeles *Times* as being protected with 'heavy riffraff'. It's in Bill Easton's community and he says their riffraff is second to none. . . . In the foothills southwest of Denver there's a mountain named Long Scraggy. R.H. Butcher reports that near its base is an outfit called Long Scraggy Girls Camp. My advice to the counselors is, watch it. Nowadays a lot of what appear to be long scraggy girls actually turn out to be boys.

Form 1A of Florida's Dept. of air and water pollution control is headed 'Application for permit to construct water pollution sources.' . . . W.D. Brueckner forwards an issue of the *Gazette* of the Memorial U of Newfoundland, with a headline referring to their 'synchronized swimming coach.' . . . A meeting that I overlooked in May was the 'Spring joint computer conference.' I'm with Jennifer Savage in wondering about computers with spring joints. Somehow I'd always thought of them as hard and unyielding.

According to *Oilweek,* one solution to problems of pipelines in permafrost is known as the chilled gas concept. . . . W. Maresch has received a reprint of a paper by 3 Italian colleagues, inscribed to him 'with the best author's compliments.' . . . D.J. Duncan notes a headline, 'Successful underwater meet held', and suggests that it was an in-depth study. . . . Hafner has published a book entitled *Bibliography of congressional geology.*

Up to the moment of writing, 12 persons have sent in 74 entries in the 'I could have been' game, and more arrive daily. I'll wait another month, by which time I fervently hope I will have all the entries in hand.

The AEC operates a Contaminated Soil Removal Facility, and a Radioactive Solid Waste Reduction Facility. Obviously they also have a Contaminated English Installation Naming Facility.

It's been some time since I awarded a People's Prize for Purple Prose. How about this, from the U.S. Dept. of Labor: 'The occupational incidence of the demand change is unlikely to coincide with the occupational profile of those registered at the employment office.' Translation: The jobs may not fit the people. A P_2P_2 to that bureaucrat!

products & services

Edmund Scientific Co. is offering a new **stereoscopic microscope.** It has paired 10x eyepieces with rubber eyeguards and paired 3x color-corrected objectives for 30x over-all viewing. The left side focuses independently and the interpupillary adjustment is 50-80mm. The instrument weighs 3½ pounds. For more information, write to Edmund Scientific Co., 380 Edscorp Bldg., Barrington, N.J., 08007.

AMF Inc. is offering a vector-averaging **current meter.** The meter samples currents and water temperature continuously at a given location for up to 1 year, without recovery, tape changing, and battery replacement. The coördinate vectors are computed, summed, and recorded in digital form on a cassette digital magnetic-tape recorder. Current speed and direction are sampled every ⅛th turn of the rotor; the number of vector computations is proportional to the number of rotor turns. Water temperature is measured by a thermistor and is averaged and recorded on the cassette tape. The meter operates at depths of as much as 20,000 ft. For more information, write to AMF Inc., 1025 North Royal St., Alexandria, Va., 22314.

A 2-channel time-share minigraph **analog recorder** is available from Esterline Corp. The recorder has 2 independent measuring systems that record side-by-side on identically calibrated chart areas. 2 independent traces on the full chart width are produced; for identification, one trace is broken, the other solid. For more information, write to Esterline Corp., Box 24000, Indianapolis, 46224.

Hubbard Scientific Co. has published **catalogs** of visual aids and materials for earth-science and social-studies teaching. Film-loop listings, 3-D models, overhead transparencies, slides, investigation labs, maps, charts and study prints are listed in the catalogs for earth sciences, environmental studies, geography and general science. For free copies and more information, write to Hubbard Scientific Co., Box 105, Northbrook, Ill., 60062.

A **micro-ion milling** device for preparation of electron microscope samples is made by Technics Inc. Ions are created in dual sources, diametrically opposed, in order to remove material from both sides. The process is monitored with a stereozoom microscope. The device consists of a vacuum diffusion-pump system, vacuum instrumentation, gas-supply system, specimen chamber, twin ion guns, and stereozoom microscope. For more information, write to Technics Inc., 80 North Gordon St., Alexandria, Va., 22304.

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TOOLS FOR UNRAVELING THE PAST

BY BARBARA FORD

On a hot, dusty day last summer, four people slowly moved up and down a field of newly cut wheat near Gravina di Puglia in southern Italy. Ropes tied to stakes divided the field into rows. One woman in the group carried an aluminum tube with a can-like apparatus attached to each end. Beside her, a man held a cable that ran from the tube to a box strung around the neck of another man. A woman with a notebook completed the quartet. The group halted every few steps, and each time the man with the box peered into a view finder and called out the numerals he saw. The woman with the notebook wrote them down.

Prospectors? Yes. But instead of looking for oil or minerals, the group in the Gravina wheat field was seeking a buried Neolithic site. The tube, cable, and box are parts of an instrument called the cesium magnetometer, which can detect variations in magnetism as far as twenty feet below the soil. A similar, less sensitive instrument is used by many United States airlines to detect metal objects on passengers. The magnetometer was developed for industry, but the device used at Gravina was modified by Varian Associates for the use of the Museum Applied Science Center for Archeology (MASCA) of the University of Pennsylvania.

Elizabeth Ralph, the associate director of MASCA, was the woman with the notebook. She had brought the magnetometer (one of two owned by MASCA) to Gravina at the request of Dr. George Bass, a professor of archeology at the University of Pennsylvania. He and Dr. Peter Vinson of the University of Alberta (Canada), the codirectors of the Gravina excavation, were convinced that there was a Neolithic settlement somewhere below the field, a belief based largely on Vinson's discovery of Neolithic potsherds in the field the summer before. A small sinkhole excavated in the field by Bass and Vinson yielded promising finds.

Before Miss Ralph arrived with the magnetometer, the two archeologists spaded up a 30-meter-long trench without results. Digging trenches across the entire 240-meter by 220-meter field would have taken years. With the magnetometer, however, the survey of the field took a week. When it was completed, Miss Ralph pasted the magnetometer readings in her notebook onto a grid representing the entire field,



The terra-cotta head above, fired in the fourth century B.C., was taken from Thurii, an ancient Greek city built on the site of Sybaris. The site was found with a cesium magnetometer.

then circled figures indicating the position of magnetic features. Here, archeological objects were likely to be found. She staked out five spots, and Bass and Vinson began a trial excavation. Before long, they uncovered Neolithic and Bronze Age tools, pottery, and animal bones. In the first layers, the bones were of domesticated beasts; below, the bones belonged to deer and rabbit. The pottery also varied in the upper and lower layers.

Chemists at MASCA's laboratory on the University of Pennsylvania's Philadelphia campus are now busy dating the pottery uncovered by the archeologists. The results are still uncertain, but Bass thinks the stratification of the finds may help clarify the chronology of prehistoric ages in southern Italy.

It is a typical success story for MASCA, one of two large world centers (the other is at Oxford University in England) engaged in the development of technology for archeologists and anthropologists. MASCA started out in 1951 as a laboratory devoted to the carbon-14 dating technique, but in the last decade it has expanded its research to include other dating techniques and the development of archeological prospecting tools. Its services now are available to other institutions and even foreign governments. Half of its staff is composed of anthropologists, including its director, Dr. Froelich Rainey, who also is director of the University Museum; the others are physical scientists. Miss Ralph, a physicist, had never set foot on an archeological site before she joined MASCA in 1951. "In fact," she admits cheerfully, "I never even knew the University Museum existed when I studied physics on the University of Pennsylvania campus."

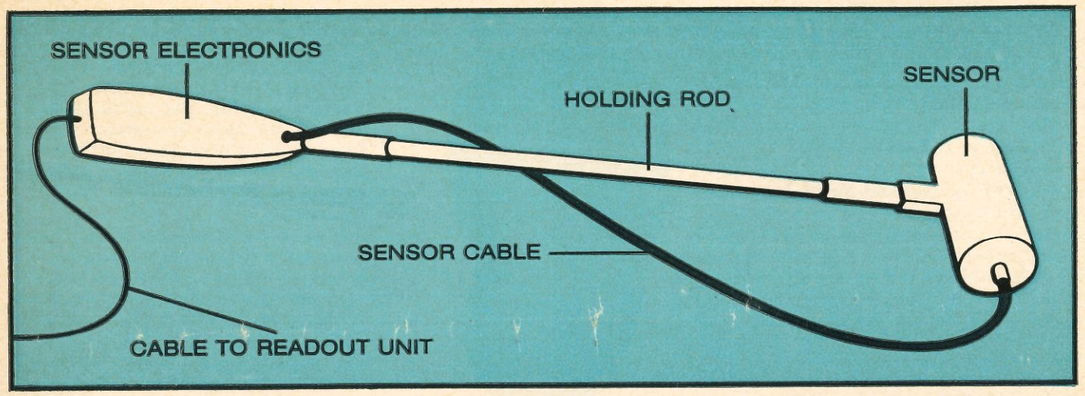
Most of the techniques MASCA employs are based on the application of atomic or nuclear phenomena discovered during and after World War II, explained Miss Ralph as she conducted an informal tour of the MASCA facilities in the basement of the University Museum. The principle behind the cesium magnetometer is the "Zeeman effect," which states that the electron levels of atoms split when the atoms are placed in a strong magnetic field. To detect this splitting, the magnetometer excites the electrons by various means. So sensitive is the device that not only can it detect objects twenty feet below the surface but it can indicate whether they are rocks or objects such as roof tiles and pottery. The magnetometer has been used at more than forty sites in a dozen countries during the past decade.

"This is a cesium magnetometer," said Miss Ralph, lifting a long metal rod lying on a laboratory table. "I can't show you how it works, because there's too much metal here." If the area surrounding an object is strongly magnetic, she explained, the background will show more magnetism than the object the archeologist is trying to find.

When she visited the rocky island of Thera in Greece with the cesium magnetometer not long ago, Miss Ralph found the soil so magnetic that the instrument was virtually useless. At the Greek site of Elis, on the other hand, conditions were so perfect that she located a buried city within a few days. Archeologists were able to uncover the ruins as she proceeded ahead of them with the magnetometer. To date, however, the big triumph for the cesium magnetometer is the discovery of what is thought to be the Greek city of Sybaris in southern Italy. Around the sixth century B.C., Sybaris was the home of a wealthy, luxury-loving population, from which we derived the term "sybarite." The city was razed around 510 B.C. in a war with a neighboring city.

Archeologists had been searching for Sybaris for 100 years without success;

New dating techniques can place objects within 100 years of their correct age.



The portable cesium magnetometer depicted in the drawing above is carried over archeological sites to locate magnetic features. The sensor, which contains a cesium lamp and a cesium vapor cell, is located in the can-shaped apparatus at right; the electronic components are in the box at left. Under proper conditions, the device can distinguish between rocks and tiles or pottery at depths of up to twenty feet.

in 1961, however, an expedition headed by Rainey began what may turn out to be the final hunt for the buried city. All the group knew about the location of Sybaris was that it was said by ancient historians to lie in the arch of the Italian boot near the sea and between two rivers. For the first few summers the party turned up nothing but a few uninteresting Roman structures. Rainey had brought along MASCA's proton magnetometer, but Sybaris was thought to lie about twenty feet below the surface, and the proton device can locate magnetic features only to a depth of about six feet.

By 1965, however, Varian Associates, working with MASCA, had produced the cesium magnetometer, which not only is capable of sensing objects at a depth of twenty feet but also works much faster than earlier instruments. Miss Ralph brought one of the devices to the supposed site of Sybaris. The first buildings it detected turned out to be Roman, but the following year it picked up strong anomalies—areas of unusual magnetism—at the level of Sybaris. Drills soon indicated the remains of structures and numerous fragments of pottery and large roof tiles. Excavations by the Italian Department of Antiquities, now in progress, should provide final proof whether, after 2,500 years, Sybaris has indeed been found.

For sites where a magnetometer is not feasible, MASCA employs older prospecting tools: seismographs, metal detectors, resistivity instruments, aerial photography. The resistivity apparatus, a little black box with a galvanometer and four cables leading to four steel probes, has turned out to be the second most useful piece of equipment in the MASCA toolbox. When the probes are placed in a line and an alternating current is sent through the two outer probes, the resistance of the ground between the inner two probes can be measured, even in the presence of magnetic "clutter" that would throw off a magnetometer. Best prospects for the apparatus are shallow historical sites, particularly in built-up areas.

Metal objects that do not lie deep in the soil can be uncovered with a simple metal detector, the "treasure probe," which sends out magnetic waves that become distorted when they meet metal. "Dr. James Pritchard, the associate director of the museum, took a metal detector to Lebanon last summer to find unexploded shells in his excavation," said Miss Ralph. "He didn't find any shells but he did locate several hordes of Roman coins."

One prospecting technique that may one day prove more helpful in locating archeological sites is aerial photography, according to Bruce Bevan, a geology student with a background in electrical engineering. Bevan is handling MASCA's aerial photography section. "This is a site in the Thames Valley in England," he said, holding up photographs of a barley field with a distinct pattern of lines across it. "All these lines are buried Roman walls. The walls have caused the soil in that area to be drier, making the crops grow differently." By making repeated flights over the Thames Valley site, MASCA has shown that these variations are visible only at certain times of the year, often early in the germination season.

Bevan added that MASCA has hopes of obtaining usable data from the Earth Resources Technology Satellite (ERTS) being launched by the U.S. in the spring or summer of 1972. "The smallest thing we can see on a big satellite photograph is about one hundred feet long, but that would include ancient roads and other long, linear objects," he said.

Finding archeological sites is only half of MASCA's job; the other half is dating them. The core of the dating operation is the carbon-14 laboratory headed by chemist Barbara Lawn in the basement of the University of Pennsylvania's physics building. In the past two decades the laboratory has published more than 2,000 carbon-14 dates. It is one of the few laboratories devoted exclusively to carbon-14 dating for archeology. The technique is based on the fact that all plants and animals ingest small amounts of radioactive carbon 14. When they die, the ingestion stops, and decay begins at the average rate of thirteen disintegrations per minute per gram of carbon. The rate decreases as the dead organic material ages.

After a sample of the ancient organic material is reduced to pure carbon dioxide in an elaborate chemical setup, the carbon-14 disintegrations can be measured in a proportional counter. The rate of disintegration determines the age of the sample to within 100 years.

Of course, it isn't quite that simple. In recent years the burning of fossil fuels and thermonuclear explosions have affected the carbon-14 decay in organisms. Furthermore, a few years ago archeologists began discovering embarrassing discrepancies between the carbon-14 dates of Egyptian events and the dates suggested by ancient astronomical observations. The carbon-14 technique placed some of these events several centuries too late. Now, however, Miss Ralph and MASCA anthropologist Henry M. Michael have worked out a correction table for carbon-14 dates based on information obtained by tree-ring-dating long-lived bristlecone pine trees. Using the correction table, an archeologist can now come up with a carbon-14 date accurate to within a century.

What causes the discrepancies in carbon-14 dating is a controversial subject, but it now looks as though a number of factors play a part in increasing or decreasing the amount of radioactive carbon in the atmosphere that organic material then ingests. A variation in the intensity of cosmic rays is one possibility. The intensity has been shown to rise when solar flares occur, and some astrophysicists believe this rise leads to an increase of carbon 14 in the atmosphere. Documented changes in the magnetic fields surrounding the earth also may affect the cosmic ray intensity. The changes do occur—the earth's magnetic field was about 50 per cent stronger in Roman times, for example—but the question is: Have the changes affected the amount of carbon 14 in the atmosphere?

Elizabeth Ralph thinks the changes in magnetic fields do play a part in the amount of atmospheric carbon 14, but she also ascribes some of the variation to changes in the equilibrium between the atmosphere and the ocean. She admits, however, that it is extremely difficult to assess the magnitude of the equilibrium effect on a worldwide basis.

In spite of these problems, the carbon-14 technique has proved to be invaluable to archeologists, but Miss Ralph believes that a newer method of atomic dating, one that she and chemist Mark Han of MASCA helped to develop, will prove almost as useful. The method is called thermoluminescence.

The basic principle of thermoluminescence, which was first noted in 1663 by the English scientist Robert Boyle, is that energy stored in inorganic material can be stimulated by heat and released as light. The big advantage of using thermoluminescence for dating archeological finds is that, unlike the carbon-14 technique, it can be used on the inorganic, fired-clay material found in many archeological sites. Until the new method was developed, the only way the age of clay objects could be determined was by dating the organic material with which they were associated in the excavation. With thermoluminescence the clay itself can be dated.

When clay is in its natural state, it contains radioactive elements that bombard other elements, raising some of their electrons to unstable levels. When the clay is heated in firing, the unstable elements return to a stable position, giving off light. At this point the thermoluminescent clock of the newly fired object is at zero. But as the years pass, the fired object again accumulates radioactive damage. When fragments from the object are heated a second time, they release an amount of light that corresponds to the amount of radioactive damage suffered by the object since it was originally fired. In general, the older the pottery, the greater the glow that can be observed.

As with carbon 14, though, there are problems. "Unless you do a complete analysis of the object, thermoluminescence is risky," cautioned Mark Han. A complete analysis includes not only measuring the light an object emits when heated but also measuring both its inherent radioactivity and its susceptibility to radioactivity. To check all three factors, a chunk of material about an inch square and a quarter-inch deep is needed.

As might be expected, MASCA is often reluctant to take that much material from a work of art. A few years ago the University Museum received what was purportedly a beautiful Etruscan terra-cotta figurine on which it decided to use a short-cut version of thermoluminescence. Only two factors were checked, the amount of light emitted and the susceptibility to radioactivity. The results indicated the statue had been created between 780 B.C. and A.D. 300. Shortly thereafter, a similar "Etruscan" statue in the Metropolitan Museum of Art was checked for inherent radioactivity and proved to have an extremely high level. The glow it would emit would be due largely to this inherent radioactivity, not to its great age. The statue had to be modern. Dismayed, MASCA sacrificed a few more grams of their statue's arm to continue their own check. The level of inherent radioactivity was shown to be so high that the statue's age was reduced to one-tenth of that indicated by the light it emitted. Instead of being 2,000 years old, it was only 200.

Thus far, MASCA has published only twenty-five thermoluminescence dates, but Miss Ralph feels the new technique will someday be as popular as the carbon-14 method, at least for periods dating back to the beginnings of pottery-making (around 9000 B.C.). Even now, the age deviation for some kinds of pottery is roughly the same as that for objects dated with carbon 14—about 100 years. In fact, thermoluminescence dates may be more reliable in some instances. Thermoluminescence dates for pottery found aboard a ship wrecked off Jamaica have been accepted as more credible than carbon-14 dates, because the wreck is thought to have occurred around the time of Columbus's voyages to the New World, one of the periods for which carbon-14 dates are in doubt.

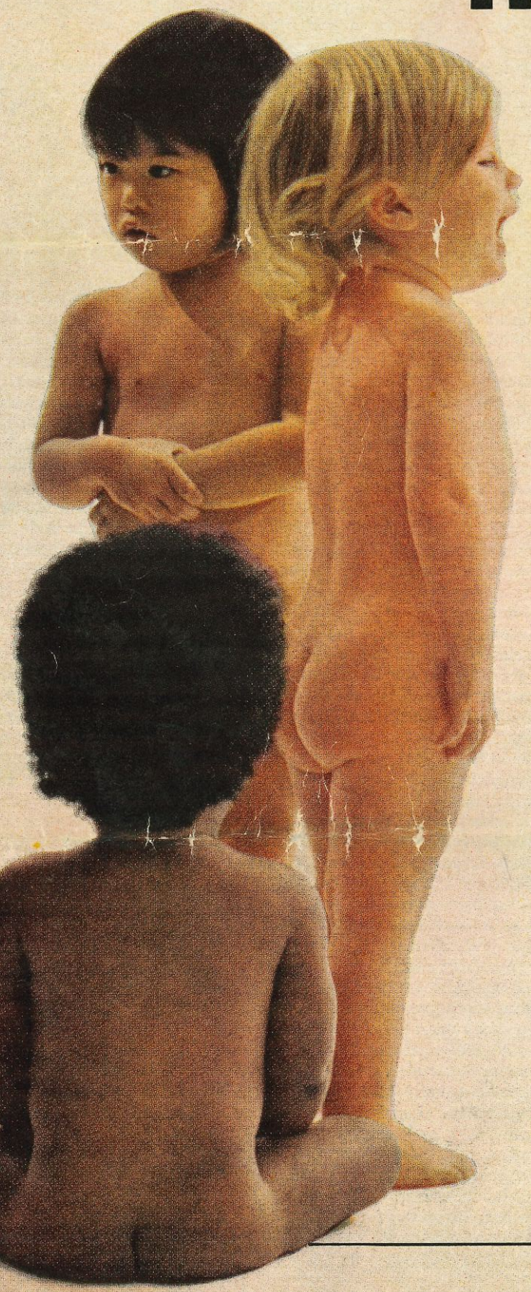
Significant as MASCA's achievements have been in the past twenty years, not all archeologists, even at the University of Pennsylvania, are eager to accept its technical help. "There is resistance to the new techniques because archeologists don't understand them," said Rainey. "Only one in a hundred has any conception of modern physics and what it can do." Dr. Bass, who depends heavily on such technological aids as sonar and television in his own specialty, underwater archeology, has suggested why the new methods are avoided by some archeologists schooled in the classical tradition: "They accuse underwater archeologists of being gadgeteers."

According to Bass, "Many archeologists get involved in the subject through its more romantic aspects, as I did, and the use of these techniques takes something away from this. I was talking once with a noted archeologist —not from this university, by the way —and I said, 'Wouldn't it be great if there was a machine that could dig through a mound, test the sherds, and give us a reading?' He said that would take all the fun out of it." □

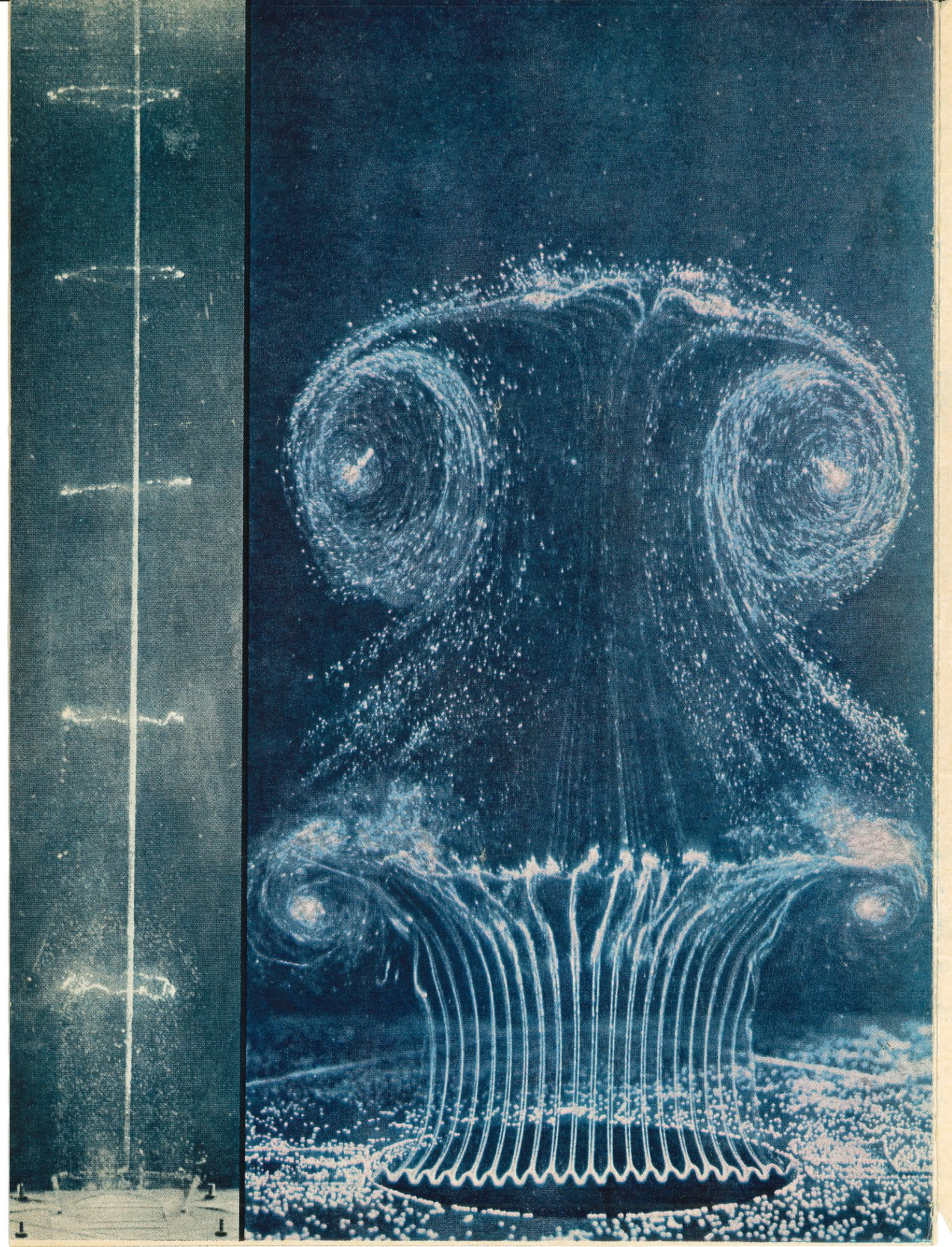
THE INNATE

The speech of infants may provide a clue to the evolution of language.

BY EDMUND BLAIR BOLLES



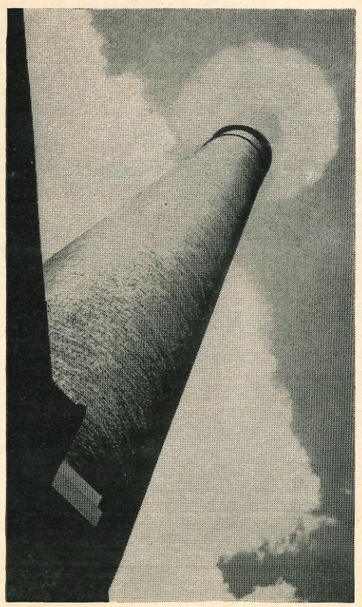


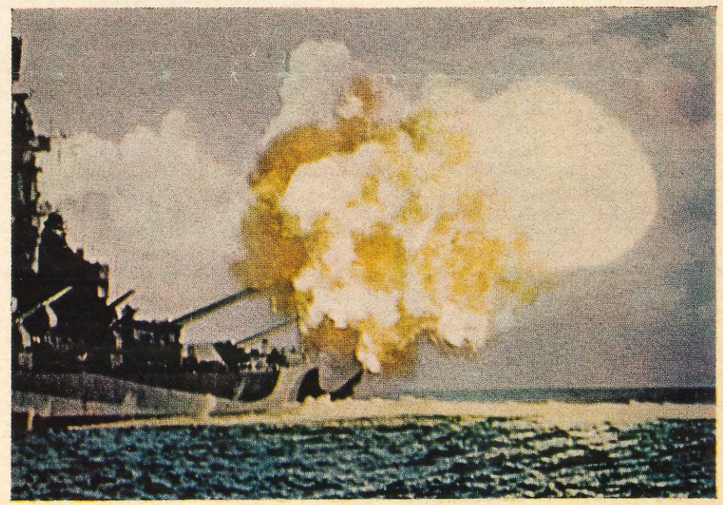


Vortex rings might make the skies around our major airports considerably safer spaces in which to fly.

A multiple exposure (far left) captures a vortex ring as it rises in a tank of water, propelled by its own internal energy. The lyre-shaped figure at left consists of two vortex rings, fired one after the other. The lower ring, as shown by the streams of bubbles, will soon be pulled through the hole of the upper ring in leapfrog fashion. The mushroom cloud (right) of an atomic blast is an example of a vortex ring, as is the burst of smoke emanating from a naval gun (lower right). The photograph below is a simulation of how smoke rings may be used to fight pollution.







Vortex rings may some day carry silver iodide crystals into clouds for artificial rainmaking.

break up or defuse the thermal inversion itself. When the ring penetrates the inversion layer, it might agitate the air to such an extent that the inversion would dissipate. Furthermore, Mattingly speculates that elliptical or egg-shaped vortex rings might do an even better job. The elliptical rings he has produced in the laboratory display an erratic wobbly motion that might add to the agitation of the inversion layer and thereby speed up its dissipation.

Similarly, vortex rings fired downward in water some day might be used to defuse or destroy thermoclines (boundary layers in water where the temperature changes sharply) thus promoting circulation and oxygenation. Anyone who has dived into the waters of an abandoned quarry and suddenly come upon a layer of icy water at about ten feet below the surface has experienced a thermocline.

Mattingly has been studying the behavior of vortex rings at the Lewis F. Moody Hydraulics Laboratory of Princeton's engineering school. Because of the ease of generation and control of test conditions, his experiments have centered on the behavior of vortex rings in liquids, primarily water. His findings, however, are applicable to vortex rings in air, for the laws of vortex behavior are the same in any fluid.

Mattingly produces vortex rings by forcing water through a circular aperture, or by abruptly moving a heavy metal plate with a circular hole in a tank of water. In both cases, the ring is formed as the water passes through the hole. It meets the calm waters on the other side, and rolls up into a doughnut-shaped ring of whirling fluid.

To facilitate study of the rings, Mattingly employs what is called the hydrogen bubble flow visualization technique. The technique is based on the fact that when electrical terminals are placed in water and electrically energized, the water breaks down into its component parts: Oxygen is given off at the anode; hydrogen at the cathode. For his vortex-ring experiments, Mattingly stretches a thin platinum cathode wire across the aperture where the ring is formed. Tiny hydrogen bubbles are produced along the wire and are captured by the vortex ring as it is generated. The bubble patterns allow the ring to be easily seen and photographed.

Another possible application of vortex rings is being studied by George E. Shepard, a Princeton senior working under Mattingly's direction. Shepard and Mattingly are investigating the possibility of applying vortex rings to the serious turbulence problem now plaguing major airports. Large aircraft such as the 707 and the 747 trail powerful line vortices that linger long enough to endanger small planes. According to Mattingly, a vortex ring of air fired from the ground might intercept and dissipate the so-called tip vortices left by large planes, thus making the skies around our major airports considerably safer spaces in which to fly.

To examine this possible application of vortex rings, Shepard and Mattingly have constructed a model in which a wing is towed through a tank of water. When the wing reaches a certain point, a vortex ring is fired from the bottom of the tank. The ring rises through the water and clearly destroys the vortex pattern left by the wing.

The success of his vortex-ring experiments has led Mattingly to consider other applications. Vortex rings, for example, might be used to aerate the deep waters behind large dams. "There's a serious water-resources problem involved here," he says. "Water discharged from the base of a dam is often so low in oxygen that it can hinder plant and animal life when it enters a stream. A vortex ring composed of aerated surface water fired downward might provide a useful way to oxygenate deep water before it is discharged into a stream. Of course, you could install a hose and accomplish the same thing, but the vortex ring might not require such continuous activity, and probably wouldn't be nearly as turbulent. Princeton's water-resources program is now considering further research on this use of vortex rings." Mattingly also suggests that vortex rings might prove an efficient means to carry silver iodide crystals into clouds for artificial rainmaking.

The study of vortex rings also may yield valuable information to architects and designers. High winds striking tall buildings often form violent flow patterns, resulting—as many urbanites can testify—in broken windows and other damage. These flow patterns are functions of the shape of the building, and knowledge of their behavior may lead to safer designs and construction techniques.

Mattingly began to study vortex rings soon after he joined the Princeton faculty in 1969. In June of 1971 he received a grant from the National Science Foundation to continue his research. Whatever his future findings, it is already evident that his work on the vortex ring will amount to more than just a puff of smoke. □

Meetings

Progress in Luminescence Dosimetry

After two highly successful previous conferences on this subject in 1965 (*1*) and 1968 (*2*), a third international conference on luminescence dosimetry took place at the Research Establishment of the Danish Atomic Energy Commission (AEC) in Risö, near Copenhagen, from 11 to 14 October 1971. It was cosponsored by the Danish AEC and the International Atomic Energy Agency (IAEA). The increasing worldwide interest in integrating solid-state radiation measurements and their many applications was reflected in the attendance of scientists from 27 nations and 3 international organizations; 75 papers were presented.

The first two sessions were devoted to the progress made during the last 3 years in understanding the mechanism of thermoluminescence (TL). Among many interesting investigations are some studies on the TL peaks in LiF: Mg,Ti (TLD-100) in the temperature range 100° to 660°K, which revealed an increase in "supralinearity" (more than proportional radiation response) with increasing peak temperature as well as an anomalous breadth of some low-temperature peaks (E. B. Podgorsâk *et al.*, University of Wisconsin, Madison, and C. M. Sunta *et al.*, Bhabha Atomic Research Center, Trombay, India). The properties of high-temperature glow-peaks in this material have also been studied by a group from the United Kingdom (E. W. Mason and G. S. Linsley, National Radiation Protection Board, Glasgow). The hydroxide anion was shown to have a strong effect on the TL properties of LiF (L. A. DeWerd and T. G. Stoebe, University of Washington, Seattle) and CaF_2, but not on phosphors containing oxygen, such as $CaSO_4$, BeO, or Mg_2SiO_4 (T. Nakajima, National Institute of Radiation Sciences, Chiba, Japan). The effects of a large number of other impurities and their potential use as activators in LiF were studied by M. E. A. Robertson *et al.* (United Kingdom) and by M. J. Rossiter (National Physical Laboratory, Teddington, U.K.). The latter made a strong case in support of Ti (approximately 10 parts per million) as the only important coactivator for Mg (approximately 80 parts per million) in TL-grade LiF.

Abnormally rapid fading, probably due to nonradiative electron leakage from the traps, has been observed in a wide variety of TL phosphors (Z. Spurny and J. Novotny, Technical University, Prague) and geologic materials (A. G. Wintle *et al.*, Oxford University, U.K.). This complicates TL dating. Various new or modified TL models were suggested, for example, the possibility of a Gaussian trap-depth distribution instead of a single trap depth (R. Abedin-Zadeh, IAEA, and S. Watanabe and P. S. Morato, Institute for Atomic Energy, São Paulo, Brazil). In particular, the TL kinetics of CaF_2 : Mn have been studied (G. Adam, Beer-Sheva, Israel). Electron spin resonance studies helped to clarify the TL mechanism in lithium borate glasses (D. R. Shearer, St. Williams Hospital, Rochester, U.K.) and in natural CaF_2 (K. S. V. Nambi and T. Higashimura, University of Kyoto, Kyoto, Japan).

Closely related to some of the more basic studies were reports given during two sessions on new or modified TL materials. A particularly important development is the emergence of BeO as a TL material of low atomic number, with properties equal or superior to those of LiF : Mg,Ti. Toxicity problems have been solved either by sealing BeO : Na in special glass capillaries (Y. Yasuno and T. Yamashita, Matsushita Co., Osaka), or by using extremely hard and chemically resistant sintered disks (G. Scarpa *et al.*, Comitato Nazionale Energia Nucleare, Rome), which are also becoming very popular for use in thermally stimulated exoelectron emission (TSEE) dosimetry (R. B. Gammage *et al.*, Oak Ridge National Laboratory). Two approaches designed to avoid the time-consuming, complicated post-irradiation annealing procedure for the widely used LiF : Mg,Ti have been successful. It can be done either by a special preparation of the phosphor (K. Naba, Vienna, and G. Portal *et al.*, Comité Energie Atomique, Paris), or by a special short annealing added to the reading cycle (G. A. M. Webb and H. P. Phykitt, Teledyne Isotopes, Westwood, N.J.).

Natural fluorites (CaF_2) from India (C. M. Sunta, BARC, Trombay) and Brazil have also been used for ultraviolet dosimetry (E. Okuno and S. Watanabe, University of São Paulo). Quartz can be used for measuring high "accident" doses (D. J. McDougall, Loyola College, Montreal), and even naturally occurring Kapis shells exhibit TL (N. T. Bustamente *et al.*, Philippine AEC, Manila). Other studies were devoted to TL enamels (M. Mihailović, Ljubljana, Yugoslavia), sintered TL materials (T. Niewiadomski *et al.*, Institute for Nuclear Physics, Cracow, Poland, and D. Uran *et al.*, Ljubljana), and $Li_2B_4O_7$ activated with Ag, Fe, Co, and Mo (A. Moreno, University of Mexico, Mexico City).

In a session on TL instrumentation, it was pointed out that a-c heater currents can, in some readers, produce substantial changes of the TL readings (J. E. Saunders, Ontario Cancer Foundation). A better knowledge of the emission spectra of TL materials permits optimal reader design (K. Konschak *et al.*, Technical University, Dresden). Photon counting can improve the sensitivity (T. Schlesinger *et al.*, Israel AEC, Yavne), and heating of the dosimeters with a hot air stream in a new commercial instrument reduces the disturbing infrared emission (H. Onishi *et al.*, Matsushita Co.). Automatic or semiautomatic TL readers for routine personnel dosimetry have been developed in Chalk River, Canada (A. R. Jones) and in Risö (L. Bøtter-Jensen and P. Christensen).

A fresh look has been taken of numerous dosimetric properties of TL materials. The effect of dosimeter size on the response was studied for CaF_2 : Mn (M. Ehrlich, National Bureau of Standards, Washington, D.C.) and granulated LiF incorporated in silicone (P. Bassi *et al.*, CNEN, Bologna). Closely related is the problem of measuring steep dose gradients at interfaces (G. A. Carlsson and C. A. Carlsson, University of Linköping, Sweden). Very fine TL powders were used for preparing extremely thin TL foils (G. A. M. Webb and G. Badin, Teledyne Isotopes). Like natural CaF_2, $CaSO_4$: Tm and $CaSO_4$: Dy can be used for ultraviolet dosimetry (K. S. V. Nambi and T. Higashimura, Kyoto University). The linear energy transfer response and the parameters that affect it,

in particular in LiF : Mg,Ti, have been the subject of several studies (C. A. Carlsson and P. Spanne, University of Linköping; J. R. Harvey and S. Townsend, Berkeley, U.K.; T. Nakajima, Chiba; and B. Jähnert, Hahn-Meitner Institute, Berlin). The dependence of various detector materials on dose and energy was studied by two Belgian groups (G. Eggermont *et al.*, University of Ghent, and S. K. Dua *et al.*, Mol, Belgium). The consistency of the properties of LiF-Teflon disks over repeated use cycles can be remarkably good (T. O. Marshall and K. B. Shaw, National Radiation Protection Board, Belmont, U.K.). Thermoluminescence measurements at very low temperatures were reported by R. D. Jarrett *et al.* (Natick, Massachusetts), and M. R. Mayhugh *et al.* (University of São Paulo) described the dosimetry of thermal neutrons by "self-dosing" of the phosphor due to its activation.

Concerning practical applications of TL, it has been pointed out that within a few years about half of the world's personnel dosimeters will consist of, or be supplemented by, TL (F. H. Attix, Naval Research Laboratories, Washington, D.C.). Since TL personnel dosimetry is already routine, most of the reports focused on other applications. Thermoluminescence dosimetry is also widely used on a routine basis in clinical dosimetry (B. I. Rudén, Radiumhemmet, Stockholm; D. S. Gooden and T. J. Brickner, Jr., St. Francis Hospital, Tulsa, Oklahoma; and N. Suntharalingam and C. M. Mansfield, University Hospital, Philadelphia). Among the special applications are precise area monitoring (measurement of the background dose), which became possible with the development of more sensitive phosphors such as $CaSO_4$: Dy, $CaSO_4$: Tm (K. Becker *et al.*, ORNL and Hsinchu, Taiwan), and CaF_2 : Dy (D. E. Jones *et al.*, Livermore), and archeological dating, with accuracy increased by the use of more sophisticated techniques (S. J. Fleming and D. Stoneham, Oxford University; V. Mejdahl, Risö; M. C. Han and E. K. Ralph, University Museum, Philadelphia).

Almost one-quarter of the papers were devoted to phenomena other than TL, in particular to the related process of exoelectron emission. In two studies, a comparison was made between the TL and TSEE characteristics of various phosphors, including CaF_2 and LiF : Mg,Ti (K. J. Puite, Wageningen, Netherlands, and A. E. Nash *et al.*, NRL, Washington, D.C.). It was concluded that different centers are frequently involved in the two processes. Instrumentation for TSEE, in particular the use of proportional counters, was the subject of other investigations (L. D. Brown, London Polytechnic, and T. Niewiadomski, Cracow). Optical instead of thermal stimulation offers advantages in the use of organic emitters or carriers, such as paper (J. Kramer, Physik.-Techn. Bundesanstalt, Braunschweig). When heated to very high temperatures, Al_2O_3 becomes quite sensitive (G. Holzapfel and E. Chryssou, PTB, Berlin and Athens). However, most of the work was devoted to the use of certain ceramic beryllium oxides first studied at Oak Ridge. Silicon was identified as activator in these materials, but the characteristics might be modified by activation with Li or by particle irradiation (R. B. Gammage *et al.*, ORNL); Li activation was also studied by D. F. Regulla and G. Drexler (Neuherberg). E. Rotondi (CNEN, Rome) further investigated the effect of the detector's environment on its photon response, and M. Euler *et al.* (University of Giessen, Giessen, West Germany) added other oxides such as ZnO to the BeO/SiO_2 system in attempts to further increase its sensitivity.

Another main topic of the conference was radiophotoluminescence (RPL) in glasses. E. W. Claffy *et al.* (NRL, Washington, D.C.) used RPL and optical absorption changes in LiF for measurements at high doses. L. Westerholm and G. Hettinger (University of Umeå, Umeå, Sweden) studied the response of commerical dosimeter glasses to 10- to 30-Mev electrons, and laser pulse excitation, first suggested by J. Kastner, helps to reduce the background effect called "predose" (R. Yokota *et al.*, Toshiba, and F. Hillenkamp and D. F. Regulla, Neuherberg). Most important, new systems have been developed for routine personnel dosimetry by means of RPL glasses in Finland (M. Toivonen, Institute of Radiation Physics, Helsinki) and Germany (M. Dade *et al.*, Berthold-Friesecke, Karlsruhe). The latter permits an energy-independent measurement down to about 15 kev as well as an effective energy reading from the same small glass plate.

Another, more exotic technique of potential interest for high-level fast neutron dosimetry, based on triplet exciton annihilation changes induced in anthracene, was described by D. Pearson *et al.* (University of Wisconsin).

From the papers, the final panel discussion (with K. Becker as moderator and F. H. Attix, C. Carlsson, J. F. Fowler, R. Maushart, and A. Scharmann as participants), and many informal discussions, the following conclusions can be drawn:

1) Thermoluminescence dosimetry, which was still generally considered an experimental technique a few years ago, is now firmly established in routine personnel and clinical dosimetry as well as in archeological dating.

2) The theory of TL, even for such highly complex materials as LiF : Mg,Ti and natural CaF_2, is finally better understood, but there are substantial gaps in our knowledge of the mechanism of TSEE and its relations to TL.

3) Other TLD phosphors that combine either higher sensitivity ($CaSO_4$: Tm,Dy) or better energy response (BeO: Na), or both, with simpler dosimetric and annealing properties offer attractive alternatives to the widely used LiF : Mg,Ti. Also, the complicated annealing of conventional LiF can be simplified by different preparations of the material, or by a modified heating cycle.

4) Thermally stimulated exoelectron emission emerged as an important research tool and potentially interesting dosimetric technique, with some materials such as BeO : Si combining very high sensitivity and stability with an extremely thin sensitive layer (solid-state "microdosimetry").

5) With the development of more sophisticated dosimeters and readers, RPL (glass) dosimetry has also matured so that its use in large-scale personnel dosimetry as a replacement of the usually insufficient film badge can be considered.

At the suggestion of J. H. Schulman (Washington, D.C.), a standing committee has been formed to decide on the location and date of a possible fourth conference, perhaps in 1974. The proceedings of the third conference have been published in three volumes as Risö Report 249 and are available on exchange from the library of the Danish AEC, Risö, Roskilde. The sales distributor is J. Gjellerup, 87 Solvgade, Copenhagen, Denmark.

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The material in the "History," in conjunction with the information on inter-tribal contacts, trade routes, and hostilities that is imbedded in the travel narratives, have provided generations of ethnologists with a base perspective on the ethnohistory of western boreal Canada.

The volume under review presents not only the materials contained in *Voyages*, but also letters and Mackenzie's note on Arrowsmith's map of his "tracks"—all of Mackenzie's extant writings. The maps for the 1801 first edition of *Voyages* are reproduced in large scale, and two modern maps of his routes to the Arctic and the Pacific Oceans are included. A welcome surprise is "a portion of a map of north-western America prepared by Peter Pond for presentation to the Empress of Russia, July, 1787," which illustrates the compression of the distance to the seas beyond that the hope of an easy Northwest Passage inspired in the man who established the Athabasca base. The editor, W. Kaye Lamb, provides a useful introduction that reviews Mackenzie's role in the fur trade.

This edition is all the more welcome because previous publications of the full *Voyages* (the last two were in 1922 and 1927) lack editorial annotation. This lack can be maddening, as, for example, the reader is left to answer for himself, "Where is he now?"! Lamb is remarkably explicit as to the particular locations reached at each stage of the journeys. (For those interested only in the 1789 expedition, the well-annotated McDonald [1966] edition is a "Best Buy" at $4.95).

For the account of the first voyage, Lamb has chosen to substitute a copyists' manuscript of Mackenzie's original journal for the polished version of the expedition presented in the published *Voyages*. Although additional phrases and sentences found in the 1801 edition are indicated, not all small alterations are. "Purchased a Couple of large original skins from them . . ." (p. 193) is left without comment by the editor. Only the informed reader can guess that *orignal*, French for "moose," is meant. This is made clear in the 1801 edition.

For the anthropologist, the index of the Lamb edition is lamentable. I checked the index entries for three Indian groups named by Mackenzie—Hare, Dogrib, and "Quarrellers"—and found all to be incomplete or in error.

For Mackenzie's "Quarrellers" or "Diguthe Dinees" there is no entry in the index. I then looked for "Kutchin"; no luck. "Loucheux Indians" in the index yielded pages 195, 198-199, and 211. The "Quarrellers" named on page 195 are correctly identified in a footnote as Kutchin or Loucheux. Fine. But pages 198-199 say nothing of "Quarrellers," etc. Rather, they describe two abandoned camps in the delta of the Mackenzie River that evidence, among other items, whale bones, sledge runners, train oil, a "stone kettle," and "very thick leather that we thot the covering of a Canoe"! Loucheux are treated on page 210, but not by that page in the index. Page 211 has nothing about Loucheux in it; it begins a passage about Hare Indians and a Dogrib. Finally, a careful reading of pages 192-195 reveals that the description therein is of the Loucheux, but the index says it is about the Hare.

In short, the research ethnologist will have to prepare his own index on entries pertaining to Indians.

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Reviewed by CHARLES C. KOLB
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Two paperbound volumes comprising the contributions of the 38th International Congress of Americanists, 1968, have been issued, *Band III*, containing papers from the urbanization symposium and remaining contributions, is scheduled for late 1971. The excellence of these volumes is due in large part to the Kongress Generalsekertär Hans Rhotert, Director of the Linden-Museum, Stuttgart, and his administration.

There are 119 contributions: half (sixty) in English, one-fourth (twenty-eight) in Spanish, and the remainder in German (seventeen), French (twelve), Italian (one) and Portuguese (one). Seventy percent are archaeological/ethnohistorical in nature, with the Mesoamerican and Andean areas predominant. This review will be primarily concerned with these articles.

Band I accommodates an introductory forty pages enumerating I.C.A. statutes and organization; lists of delegates, members, resolutions, and programs. The residual 456 pages embody fifty-eight archaeological papers, categorically including: General (one), North American (five), Mesoamerican (twenty), Intermediate/Caribbean (eight), Andean (nineteen), and Amazonian (one).

Taylor, Swain, and Berger note recent developments in ceramic artifact chronometric dating by radiocarbon, thermoluminescence (TL), and electron spin resonance (ESR). More recent articles in *Archaeometry*, *MASCA Newsletter*, and *Science in Archaeology* (Brothwell and Higgs 1969) supersede their report. Konitzsky's German-language "The Archaeology of the Upper Allegheny River" (Pennsylvania) is a brief, unpretentious, and speculative summary of pre-1955 data, presumably substantiated by his own yet unpublished material.

von Winning summarizes his results of a study of thirty-six ceramic house models from Nayarit, and discerns five types according to architectural characteristics. The chronological range is estimated between the first and seventh centuries A.D., and "outside sources" are suggested for the origin of these grave offerings. Hilda Delgado's keen interest in archaeological-ethnological Mayan textile production is seen in two interrelated, descriptive articles, one in each volume. Harrison's investigation of the Central Acropolis of Tikal, employing five lines of evidence (middens, structure plan and modification, stratigraphy, human traffic control, and facade ornamentation), is exploratory at best. He concludes that structure function is not yet discernible.

Smith and Willey continue the preliminary reports from Seibal, Guatemala, begun in earlier I.C.A. volumes (thirty-sixth and thirty-seventh for the 1964 and 1965-1966 seasons respectively). This 1968 summary reports that the Late Preclassic ceremonial center was abandoned following Cantutse Chicanel, possibly reflecting the expansive power of Classic Teotihuacán. Stelae associated with Late Classic pyramid Str. A-3 depict personages accoutred in Maya fashion who are not characteristically Maya in appearance. Other stelae incorporate non-Maya features (speech scrolls, Ehecatl masks), and a round temple platform and carved stela platform (dated 10.2.0.0.0 or A.D. 870), plus jaguar representations, suggest a Toltec-Maya connection as early as the middle of the ninth century A.D.

Mesoamericanists concerned with the literature (Bronson, Puleston, U. Cowgill, etc.) on Yucatecan Maya subsistence problems and demographic estimates, should read Wagner's provocative article in which he concludes that the fifteenth century population was twice the present (40.1 persons per square kilometer). In a contribution in French, Baudez and Becquelin discern four local ceramic complexes at Los Naranjos, northwestern Honduras. An excellent article by Haberline summarizes and reevaluates early ceramic phases and complexes of Panama and southern Costa Rica, and relates the inability to correlate Greater Nicoya and Greater Chiriqui without a sequence for central Costa Rica. Bischof contributes valuable information and interpretations regarding Colombian Tairona Culture.

Of interest to Peruvianists is Nachtigall's criticism of new classification patterns and unsatisfactorally defined terms for Central Andean cultures. Attempts at classification are traced from 1910-1966, and divided chronologically into five periods. Early attempts were confined to data on sites, techniques or styles, while recent ones are evolutionary and socio-political. There is no consideration of Lanning's recent system (1967). Cerulli's preliminary report in Italian relates that excavations of the Missione Archeologica Italiana in Perù at Cajamarquilla indicate a blending of Mochica and Nazca ceramic art styles in the "Nievería style," ca. A.D. 790-850. King's "Some New Paracas Textile Techniques from Ocucaje, Peru" details five new or rare methods. The Hacienda Ocucaje collection relates closely to Paracas Cavernas textiles, and she concludes that techniques may have been introduced into the South Coast during the time of Chavin influence. Middle Paracas Period was a time of "experimentation on a solid base of technical excellence" (p. 377). In addition, Ballesteros-Gaibros and Alican Franch review the initial results of La Misión Española en Chinchero (Perú).

Included in the Mesoamerican papers is an admirable symposium, "Some External Relations of Aboriginal Honduras" (Doris Stone, organizer). These contributions contain an extensively researched and meticulous synthesis of the Pre-Columbian Ballgame by the late Stephan F. de Borhegyi, in which he discerns five main types and relates chronology (from Middle Preclassic), as well as areal distribution. Rand's scholarly comparison of Copán monumental lithic sculpture with that from other lowland Maya sites is notable, as is Longyear III's discussion of Olmec influence in western Honduran pottery from Plata de los Muertos (Late Pre-Classic). Gordon Willey's commentary on this paper (he holds for Middle Pre-Classic) and the others is must reading.

Band II contains three symposia (220 pages) and thirty-five ethnographic reports (281 pages). Symposia and organizers include: (1) "Nahuat and Maya Traditions in the Fine Arts" (Doris Stone), seven papers, ranging in scope from linguistics to ceramic and mural styles; (2) "Tecnicas de conservación y restauración de estructuras arqueologicas" (Henri Lehman), with three papers concerned with restoration at Mixco Viejo, Tikal, and Iximché, Guatemala; (3) "Schrift und Kalenderwesen Altamerikas," including sixteen papers. The ethnographic presentations embrace eleven concerning North America (primarily on band-level societies), fifteen for Mesoamerica (generally about religious and socio-cultural phenomena), and nine for South America (six Andean).

From the first symposium, Durbin's paper on linguistics and writing systems, Phelps' article on "Mesoamerican Glyph Motifs on Southeastern Pottery," and Robertson's study of Tulum murals merit special attention. Phelps suggests the introduction of Late Formative Mesoamerican religious symbolism by Maya-speakers into the Southeastern Santa Rosa-Swift Creek Phase, and a second period of influence spreading north and east from the Texas-Oklahoma-Arkansas region, correlating temporally with the Toltec expansion (Nahuat tradition). Robertson compares Tulum murals with Bonampak murals, a Uaxactun bowl, Dresden Codex, Laud Codex, and Santa Rita (Belice) murals. Relationships to the latter are strong, and he concludes: "The Tulum murals then stem from the Mixtec artistic traditions of South Central Mexico and not from the Maya traditions of the Classic Period nor from the Maya-Toltec traditions of Chichen Itza" (p. 86).

Fourteen papers from the third symposium deal with Mesoamerican topics, two with Andean. Simons' "The City of Cholula and its Ancient Barrios" contributes data from the original version of the Cholula Codex. He presents a diagram of buildings and lands near the large pyramid, evaluates place-names, and describes the reverse and uncopied side of the manuscript. Locations and place-names are concluded to be largely reliable and supported by other historical sources, and the reader is enlightened as to ethnic affiliations of the prehispanic population. Prem summarizes that the Aztec hieroglyphic writing system was used as a mnemonic device, lacked systematization, and cannot be categorized by formulae and rules. Berger reports that three radiocarbon dates from Lintel 3 of Temple IV at Tikal correlate with the G.T.M. classification, and that the sapote wood used came from a tree cut toward the end of the seventh century A.D. He has taken into account secular variations in the radiocarbon content of the wood and specific location of the original tree.

Among the stimulating ethnographic papers are those by Freeman, on Netsilik Eskimo infanticide; Stenzel, on Mesoamerican sacred bundles; Piho, concerning symbolism in Aztec attire; Colajanni, considering the "trickster" in South America; and Seiler-Baldinger, on South American net-making. Of special interest to statis-

tically-minded anthropologists is Brudner's presentation on social/behavioral paradigms, which might benefit from a consideration of various works by G. Cowgill and by Pelto (1970). Mesoamerican ecological anthropologists will find West's definition and analysis of *melepantli* cultivation techniques particularly rewarding. Carrasco's archival researches on Aztec social organization complements and expands his earlier excellent presentations.

These paperbound volumes (glued, unsewn) are printed on high-quality gloss paper. Illustrations are admirably reproduced (except *II*:140, 147, which are dark), and typographical errors are infrequent. Both spelling and pagination errors occur in the "Table of Contents," but do not detract from the quality of these publications by Klaus Renner. Mesoamerican contributions are abundant, indicating intensive research in that area, while the American Southwest and Amazonia are two large areas grossly underrepresented. Recent I.C.A. volumes have been heavily archaeological in content, and these are no exception. Latin American specialists will certainly want to read, and should own, these fine publications.

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historians of physics (including Hermann) began as physicists, it is especially interesting to read his account of Haas, who is probably the only one to have made the inverse transformation.

Despite its merits Hermann's book is not adequate as history. It does not begin to reconstruct the science of the early 20th century in the kind of depth and detail that we need in order to understand what happened in the crucial first decade of the quantum revolution.

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Archeometry

Dating Techniques for the Archaeologist. HENRY N. MICHAEL and ELIZABETH K. RALPH, Eds. M.I.T. Press, Cambridge, Mass., 1971. xii, 228 pp., illus. $12.50.

This collection of papers, which inaugurates a series of handbooks to be produced under the auspices of the University of Pennsylvania Museum Applied Science Center for Archaeology, joins a collection of volumes that have appeared over the last three years dealing with the various technical and analytical specialties that can be grouped together under the heading archeometry. The other recent works include *Radiocarbon Variations and Absolute Chronology*, edited by Olsson; *Science and Archaeology*, edited by Brill; *The Impact of the Natural Sciences on Archaeology*, edited by Allibone; *Scientific Methods in Medieval Archaeology*, edited by Berger; and the second edition of *Science in Archaeology*, edited by Brothwell and Higgs. With the appearance of these works, archeometry can be said to have come of age, although the actual number of people engaged in it is relatively small. It has been, and presumably will continue to be, a contributory factor in nudging archeological research in the direction of more rigorously built strategies and methodologies modeled on those of the physical sciences. Although the so-called "new archeology" has a number of tangled roots, certainly the advent and increasing precision and accuracy of chronometric—"dating"—methods now in use must not be overlooked in any explanation of its origins.

The volume under review brings together contributions by eight authors, with four of the seven chapters—on dating by means of radiocarbon (Ralph), archeomagnetics (Bucha), thermoluminescence (Winter), and obsidian hydration (Michels and Bebrich)—providing extended discussions that include outlines of laboratory procedures. The other chapters—on dendrochronology (Michael), fission-track dating (Faul and Wagner), and potassium-argon dating (Faul)—although brief and selective, are valuable for those who wish to understand or review the basic elements of these techniques. The chapters on the two techniques with which most archeologists have had the most contact—radiocarbon and obsidian hydration—should be commented on specifically.

The chapter on radiocarbon is one of the most complete summaries of the technique available. Especially pertinent is the discussion of sample types suitable for radiocarbon work and of problems connected with their utilization. Very valuable also is a concise outline of the laboratory procedures, including the specific basis of statistical manipulations of counting data and the significance of $^{13}C/^{12}C$ ratios in fractionation determinations. Some, however, may be puzzled to find that a discussion of the basic assumptions of radiocarbon dating has been alloted only about twice the space of a section devoted to the McBee edge-punched retrieval cards for radiocarbon dates, especially in view of the fact that a project to provide a computer-based data-retrieval system is now well under way. Ralph's discussion of the relation of radiocarbon years to calendar or "true" years, in other words the secular variation or De Vries effect, apparently does not completely utilize the data published by Suess, and Ralph specifically notes some concern about the use of some radiocarbon data in magnetic intensity studies in Bucha's chapter in the volume. Ralph accepts the validity, *on the average*, of the long-term cycles identified by Suess, but does not agree on the existence of short-term oscillations. The occurrence of at least some of these short-term perturbations has been supported by carbon-14 data from European medieval samples (see the Berger volume). Those concerned with the problem of correcting carbon-14 data for secular variation may wish to use the "MASCA Correction Factors" in conjunction with the Suess values published in *Radiocarbon Variations and Absolute Chronology*.

The chapter on obsidian hydration provides a complete historical survey of the development of the technique, noting the lack of immediate acceptance of it as a time-placement method. Although the grounds are not specifically stated, the reluctance to accept the technique can be attributed to the simple fact that, on the average, 60 to 70 percent of the early obsidian hydration "dates" did not agree with the age of the obsidian sample as determined by other criteria. It was not until about five years ago that other workers began to investigate the chemical and physical nature of the hydration phenomena and the effect of compositional variability on hydration rates. Although the chapter notes the chemical problems in obsidian hydration work, it does not bring into clear focus the trends of the current research, in particular the realization that all hydration rates cannot be assumed to follow a simple diffusion formula. Evidence available by 1968 called into question, at least for one area, the use of a simple diffusion formula, and subsequent geochemical evidence confirms the extremely complex nature of obsidian hydration chemistry.

One trusts that, as the editors intend, this handbook will be regularly updated.

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Metropolitan Expansion

Suburban Land Conversion in the United States. An Economic and Governmental Process. MARION CLAWSON. Published for Resources for the Future by Johns Hopkins Press, Baltimore, 1971. xviii, 406 pp., illus. $12.50.

This comprehensive and careful study characterizes the broad results of America's century-long process of urbanization and illuminates the subtle and complex mechanisms that produce those results. Although the primary focus is on the land conversion process as it operates at the growing suburban fringe of our cities, its scope reaches into the slums and city halls of the metropolitan centers and the vast remaining rural areas of the nation. Based primarily on the last two decades, this study tells as much about our future as an urban nation as it does about our past.

The principal contribution of Clawson's book, in my view, is provided by the well-documented, analytic overview of the process of urban expansion in the United States in the period since World

War II. The general findings are not novel. For at least a full century, on a national scale the concentration of population in metropolitan areas has been increasing while at the same time the population within the metropolitan areas has been moving outward toward the suburban fringes. Three-quarters of the American population now reside within a land area representing only 1½ percent of the total. In the last generation, a centrifugal process of resettlement has created sharp divisions of age, race, and income among the 150 million metropolitan Americans as the young, white, affluent segments have moved out to the suburbs.

Who builds the metropolis? Sam B. Warner, Jr., asked that question in *Streetcar Suburbs* (1962), a study of the process of growth in Boston in the 19th century. Warner's answer, "The . . . metropolis is the product of hundreds of thousands of separate decisions," is echoed and elaborated by Clawson and his colleagues at Resources for the Future. As they put it, "The decision-making process in urban expansion is highly complex and diverse. It is incredibly fragmented and diffused among a wide variety and large number of private individuals and organizations and among many public agencies at each of the major levels of government." What follows is a rich description and analysis, constituting one-third of the book, of the characteristics of the decision-making process, the chief actors in it, the market for suburban land, and the role of public agencies and services.

Clawson's concise appraisal offers a balanced view: The process has great vitality and has produced a lot of good housing and pleasant neighborhoods. Although diffuse decisions sometimes produce inconsistent results, the process avoids massive errors. On the other hand, housing costs appear to have been higher than was perhaps necessary. Land has been consumed lavishly, with undistinguished esthetic results. Most distressing is the fact that fully half the population—the poorer half—is not served at all by high-cost suburban growth. The strengths and weaknesses of the process are shown to be consequences of the diffuseness of decision-making and the inexorable force of the land market.

A "case study" of the Northeastern Urban Complex provides a more detailed example of the forces at work in urban expansion. Ideas that are treated generally and within a national scope elsewhere in the study are quantified and made particular in this part. A detailed analysis of the region, at a much finer grain than is usually found in such work, reinforces the general note of caution to the effect that the real story of urban America lies in the variegated unfolding of local action, that sweeping generalizations about urban trends on a national scale may mislead as much as they inform.

The book concludes with a look at the future. Not surprisingly, Clawson finds that the future of the American city will greatly resemble its past if there is no major effort to change the process of development. How might that be done? The concluding chapter cites some possibilities for change, such as improving the land market, reforming local government, providing housing for the poor. It is no criticism of this book to say that these ideas are insufficient to induce great confidence in the nation's ability to alter the flow of a process so integral to the lives and interests of the broadest segment of our population.

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Environmental Physiology

The Temperature and Water Relations of Reptiles. J. L. CLOUDSLEY-THOMPSON. Merrow, Watford, Herts., England, 1971 (U.S. distributor, Bonn Industries, Metuchen, N.J.). vi, 160 pp. + plates. $8. Merrow Technical Library, Zoology.

The ancestral amphibians and reptiles were the earliest terrestrial tetrapods; they invaded the land and gradually shifted from the shores of lakes and swamps to occupy the interior of the continents. Invasion required specialization to resist the effect of gravity, the unbuffered incidence of solar radiation and celestial cooling, and the more limited availability of water. Water was required for maintenance of the internal milieu, removal of waste products, and conditioning of exchange surfaces. All the true invaders of the land have long since become extinct, and the surviving amphibians have adapted for a quite different mode of life history. Hence one must look to reptiles for clues to the diverse solutions that ultimately made terrestriality successful.

There was a long time before physiologists realized that interesting answers might indeed be obtained from studying reptiles, and even longer before it was seen that reptiles might incorporate basically different solutions from those seen in most mammals and birds. The last three decades have led to an explosion of information regarding these animals. The diversity of thermoregulatory patterns, the different solutions arrived at by different species and in different environments, and the critical importance of the behavioral state of the animal have been documented multiple times; we stand at the beginning of a true comparative physiology. This small book addressed to the informed undergraduate deals with problems of thermal (*not* temperature as in the title) and water relations, the latter topic occupying less than 20 percent of the whole. The treatment is by examples and is more ecologically than physiologically oriented. Though much literature, particularly some later references, has been omitted, the text gives an excellent conception of the diversity of solutions developed by reptiles and the diversity of approaches used by ecologists and physiological ecologists studying them.

The volume does show a certain lack of synthesis (for a more synthetic approach see J. R. Templeton's chapter in G. C. Whittow's *The Comparative Physiology of Thermoregulation*, Academic Press, 1970). When two species are stated to differ one is left with the question whether the difference is due to experimental approach, to interspecies variation, or to ecological adaptation. There might also be a more critical approach to questionable data or to methods that should not be used; a small addendum pointing out approaches to further study and cautions needed in experimentation might well have been desirable. The proofreading, particularly of Latin names, leaves a bit to be desired, as does the subject index, which is much shorter than those of author and species names. Perhaps the greatest strength of this volume is in its extensive use of examples, particularly from tropical (mainly African) situations. Here the author is closest to his own research, and this competence definitely shows through. This view makes the volume a reference that may be as useful for specialists as for the audience to whom it is addressed.

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wish to do so. As such this book can be recommended without qualification.

ANDREW TRAVERS

Elihu Thomson

Selections from the Scientific Correspondence of Elihu Thomson. Edited by Harold J. Abrahams and Marion B. Savin. Pp. xiv+569. (MIT Press: Cambridge, Massachusetts, and London, 1971.) $17.50.

THIS book contains a remarkable collection of letters written and received by an American engineer and scientist of great distinction. Elihu Thomson died in 1937 at the age of 84, and during his lifetime made a major contribution to the science and practical application of electricity as well as to a lesser though significant effect in other fields as evidenced in his patents numbering over 700. During his early years he formed a close friendship with a teaching colleague, Edward Houston, an association which later developed into the world-famous electrical concern, the Thomson–Houston Company.

The greater part of the correspondence is of course devoted to scientific work, and rarely has a man based his whole life philosophy more on the Latin motto *"Rerum cognoscere causas"*. On January 29, 1930, in a dramatic reply to a former student requesting information on the history of his discovery of the Maxwellian wave, he recounts in a letter of a length equivalent to about three columns of *The Times* how, at the age of 22, "for the first time in the world's history that one circuit was tuned to correspond in its constants with another by making the minute changes in its capacity by hanging bits of foil on a wire". He admits that Houston was with him in these experiments, but says, "I do say the ideas were mine." In any case when he raced to the top of the building to find the waves had travelled a hundred feet Houston was not there, "he weighed 186 pounds stripped". The outcome of all these exciting events was of course that Elihu Thomson in 1875 anticipated Marconi by three years in the production of electro-magnetic waves.

An impressive side of Elihu Thomson's character emerges from the wide variety of subjects in which he took a keen interest and carried out pioneer work. From the correspondence between 1899 and 1916 with Hewitt, a distinguished architect and gifted amateur astronomer, and a longer one of 46 letters between 1902 and 1935 with Hale, the one-time Director of the Mount Wilson observatory, it is evident that the production of special glass and of large mirrors of fused quartz occupied much of his time. The step-by-step progress of the work at Lynn makes a sensational story but one which seems, however, to have come to an end with the courageous prediction of a mirror 200 inches in diameter, 30 inches thick and weighing between 25 and 30 tons!

In the longest of the series covered by this book, sixty letters in all, Elihu Thomson and his favourite pen-friend Crompton had much in common. First of all they shared a keen sense of humour: Elihu's specific treatment against influenza was " . . . to get into contact with it as often as possible . . . an attack limits itself by immunity . . . if another attack can be obtained at the earliest possible time it will be but a light one". Crompton's ideas on health were rather different: "My invention is to apply radiant heat on the front side of the leg up to the knee. I find that keeping the head cool one does far better brain work." And in his last letter on December 11, 1935, he finds in his 91st year that, though his memory is to some extent reduced, his mental faculties are not much impaired.

One of the striking aspects of this collection of letters is the number of instances which anticipate future significant developments in science and invention. Throughout the correspondence much light is thrown on the personal character of Elihu Thomson which appears in so many of his letters and can be confirmed by me when I had the pleasure of meeting him in his laboratories at Lynn, Massachusetts, in 1926. He was a lovable man impressing all by his modesty and by the deep careful thought which he gave to any complex matter before declaring an opinion. This book is a wonderful tribute to a great man.

PERCY DUNSHEATH

Schneirla's Ants

Army Ants: A Study in Social Organization. By T. C. Schneirla. Edited by H. R. Topoff. Pp. xx+349+8 plates. (W. H. Freeman: San Francisco, 1971.) $12.

THE nomadic Dorylines have become widely known, from works of fiction, as invading armies of ants destroying everything in their path. In fact each colony of African driver ants (*Anomma wilverthi*) has been estimated to consist of more than 10,000,000 ants, but their destructive powers have frequently been exaggerated. *Eciton* colonies, normally numbering at least 1,000,000 ants, fail to take half of the potential victims in the area raided and active vertebrates usually escape.

At the time of his death in 1968 Schneirla had been studying these phenomenal insects for nearly 40 years and eleven chapters of this book had already been written by him, leaving three to be completed by Topoff. As expected from the author's justly famous earlier publications the central theme of the book is the control of cyclic periods of activity especially in genus *Eciton*. Each colony normally has one queen which lays eggs in batches separated by a month without laying and the colony is not nomadic while the queen's gaster is swollen with eggs. While each batch of larvae is growing the colony moves each night, but forms temporary "bivouac" nest sites each day and the queen is fully mobile with a reduced gaster. When the larvae cease growing and spin cocoons the colony ceases to be nomadic, the food intake is switched to the queen and the cycle starts again. Schneirla concludes that the cycle is brood determined and each nomadic phase is initiated by the hatching of a new batch of callow workers.

As well as the detailed account of *Eciton* cycles there is a chapter on colony division and much interesting comparison with other Dorylines, especially the much simpler *Aenictus*.

Unfortunately the book has faults which reduce its readability. Repetition of information and ideas soon becomes irritating and it was also unnecessary to repeat the colour illustrations in black-and-white or to repeat quotations such as that from Belt appearing on pages 7 and 43. Although the style is claimed to be semipopular it resembles that of scientific papers and in the later chapters there is a fashionable but deplorable tendency to state the obvious in complicated language. The space could better have been used to compare Dorylines with other ants as it is possible for readers to assume that some of the features described are special to Dorylines when they are actually more widespread.

One of the main impressions left on the reader is the high proportion of untested hypotheses presented and it would be appropriate if this book stimulated further field experiments on these fascinating ants—an approach particularly advocated by Schneirla.

A. J. PONTIN

Dating Samples

Dating Techniques for the Archeologist. Edited by Henry N. Micheal and Elizabeth K. Ralph. Pp. xi+227. (MIT: Cambridge, Massachusetts, and London, November 1971.) $12.50.

ACCORDING to the blurb, this book has been written on the premise that many archaeologists need to be better informed on modern methods of dating, and it attempts to remedy this situation by discussing the technicalities of the various methods so that the archaeologist will

gain enough information to enable him to collect and prepare his samples properly.

The space allocated to the various techniques varies widely, and by no means in direct proportion to their relative importance to archaeology; archaeomagnetic dating (60 pp) is the longest chapter, and fission track (5 pp) the shortest, with carbon-14 (48 pp) running third. Undoubtedly the differences in lengths of chapters partly reflect the extent to which the various authors have considered it necessary to discuss the technical details of their subjects, and one finds here some examples of the way in which the specialist's enthusiasm for his subject can lead him into dealing with some aspects of it in more than necessary detail. For example, the chapter on carbon-14 dating achieves a good balance between brevity and detail in describing the basis of the method, samples and sampling, interpretation of results, and radiocarbon age discrepancies, but deals with laboratory techniques and particularly that of proportional gas counting in what may seem to be unnecessary detail to the archaeologist. Technical detail also tends to obscure the section on archaeomagnetic dating from the layman's point of view, although this is admittedly a very complex subject and one appreciates the author's difficulties. In contrast one can agree that the wealth of detail in the section on obsidian dating is fully justified because this is a technique which by virtue of its low cost and relative simplicity should be within the technical competence of a small archaeological unit to set up and operate, and the chapter provides enough practical detail to make this possible.

Finally, in commenting on a book aimed at enabling the archaeologist to collect and prepare his samples properly, one must make the point that some chapters could have devoted more space to the practical aspects of sampling, or alternatively specifically warned the archaeologist against attempting it in those cases where, as in archaeomagnetic dating, the technique is highly specialized.

HAROLD BARKER

Sociology of Science

The Social Process of Innovation. By M. J. Mulkay. Pp. 64. (Macmillan: London and Basingstoke, April 1972.) 60p.

IN this well-constructed essay, the author addresses himself primarily to the question: what sorts of scientists are the most likely to produce innovations? For this, he distinguishes between "migration" to nascent specialities and "radical innovation" that challenges existing paradigms. His description of the social process of control of research makes effective use of the concepts of "cognitive and technical norms" and also the (unstable) "research network" which enforces these on workers in each problem area. Partly by a relatively formal argument using these concepts, and partly by commonsense argument at crucial points, he arrives at a tentative conclusion: high-status men will tend to migrate, and young men to innovate radically.

Always maintaining an admirable clarity concerning his assumptions and methods, the author articulates a model of *Homo scientificus.* He is a direct descendant of *Homo economicus,* an entrepreneur operating on a market whose currency is prestige, and as always concerned only to get the highest price for the product of his labours. The author explicitly defends this model: "It is sometimes argued that the scientist's main reward is neither money nor recognition but rather the pleasure derived from completing a successful piece of research. However, this argument is inconsistent with the regular occurrence of priority disputes and the prevalence of anxiety over anticipation."

In accordance with this model, the psychology of the young scientist prone to radical innovation is simply that of a gambler with little to lose and much to gain. An important part of his motivation is his ignorance that he is playing with a stacked deck: "Furthermore, it seems probable that young scientists will believe more firmly than their elders in the myth of scientific impartiality. If this is so, they will be less likely to conceive that revolutionary contributions might be rejected." The author's chosen case study of innovation is the work of Pasteur on fermentation; and so he apparently believes that the great scientists of the past, who endured hardships of many sorts during their struggles for acceptance of their ideas, were all silly little opportunists who struck it lucky.

It is to be regretted that the author's useful bibliography did not include N. Storer, *The Social System of Science* (1966), which in spite of its naiveté is valuable as the prime source of the "exchange" model of scientific activity: Two more recent studies indicate problems that could well be worth considering in connexion with such models of *Homo scientificus.* I would be interested to see if the maintenance of quality-control in science can be explained on such Hobbesian assumptions. And to this model of scientific activity, even more than to Kuhn's, there can be applied the Feyerabend paradox: is there anything in this analysis that does not apply equally well to gangsterism; and if not, why not?

J. R. RAVETZ

Simple Liquids

Physical Chemistry: An Advanced Treatise. Vol. 8. *Liquid State.* Vol. 8A, Pp. xix+1–412+14; Vol. 8B, Pp. xix+413–892. Edited by D. Henderson. (Academic: New York and London, December 1971.) Vol. 8A: $23; £10.75. Vol. 8B: $25; £11.65.

THIS treatise on the theory of molecularly simple liquids has fifteen authors, most of whom have concentrated on the developments of the last five years. Some of their material is in other books but there is here much which can be found elsewhere only in research and review papers.

Scott opens with a summary of our knowledge of intermolecular potentials; Chen and Baxter in separate but overlapping chapters discuss the determination of the structure of a liquid and its representation in terms of the distribution functions; Ree describes the computer simulation of model systems; Jhon and Eyring return to the latter's "significant structures"; and Henderson and Barker bring part A to a close with a welcome account of the perturbation theories with which they have enriched the armoury of equilibrium statistical mechanics. In part B, Henderson and Leonard apply these and other theories to liquid mixtures; ter Haar disposes of liquid helium in twenty-five pages; Berne gives us nearly two hundred on time-dependent properties, a valuable chapter which could usefully have been developed into a book in its own right; and Stephenson, Stanley, Paul and Milosevic close with two chapters on the equilibrium and dynamic properties of fluids at their critical points.

The editor has brought together some first-class players who have performed admirably. He has not, however, welded them into a team, for there is too much repetition and too little evidence that any author knew what the others were saying, except in the two chapters written by the editor himself. Thus one example of this lack of cooperation is that the important function usually written h(r) is called the total, the net and the indirect correlation function in different chapters. The indexing inevitably suffers where there are such discrepancies. No doubt the editor, like others who have undertaken similar tasks, was only too glad to receive the final contribution not too many years behind the original schedule to want to spend more time correlating the material. Certainly the rich meal he has assembled would have been spoilt by keeping. The penalty of concentrating on recent developments is that this book will lose its usefulness more quickly than might be expected from a treatise. It is really a group of timely monographs.

J. S. ROWLINSON

PRINCIPLES AND APPLICATIONS OF PALEOMAGNETISM, by D. H. Tarling. Barnes & Noble Inc. ($5.50). DATING TECHNIQUES FOR THE ARCHAEOLOGIST, coedited by Henry N. Michael and Elizabeth K. Ralph. The MIT Press ($12.50).

Locked in the rocks like so many frozen compass needles are oriented domains of magnetic material, which remember the earth's magnetic forces in that remote epoch when the rock itself formed, from fire or from water. Only within the past two decades, largely due to the researches of Louis Néel, have we had sufficient cunning to read the record. The record is written mainly in small grains of magnetite and hematite, dark minerals often present not as the pure iron oxides of those names but as complex solid solutions of iron-titanium oxides. A rock physically corresponds to a dilute dispersion of fine ferromagnetic particles within a nonmagnetic matrix. These minerals are not strict ferromagnets like metallic iron, which is an ordered array of identical atoms with all spins aligned and intensely magnetic. They are nonetheless seats of long-range magnetic order. Their crystal lattices consist of two opposing sublattices, in each of which all the iron ions are spin-aligned. In some of these ferrimagnetic crystals the two lattices cancel neatly to hide all outside signs of magnetic order, even though it is fully present on the atomic level. In the mineral grains, however, there is a definite imbalance between the two opposed sublattices, so that the grain is magnetized overall, less so than metallic iron but much more so than the rock matrix.

A good rock sample—a four-inch drilled core—is likely to have a magnetization a million times smaller than that of a pocket compass. How this is measured, how the original direction of the sample is marked out on the cliff face, how the data are to be treated statistically and what geologists have made of this subtle lore are the topics of *Principles and Applications of Paleomagnetism,* a lively but somewhat detailed paperback meant for undergraduate students in geology or physics but good reading for anyone with some training in these disciplines. How to fix direction in the field? If you collect rocks in sunny climates, the fastest, most accurate and lightest equipment is a hand-sized plate with a vertical shadow pin! Mark the shadow, note the time, date, place and tilt and compute the angles back home. With a good watch you can expect one-degree accuracy except near noon or in the Tropics. Tests "in igneous terrain" show that the gyrocompass, sights on mapped landmarks and the sun compass all agree to within about 1.5 degrees. "Watch out for lightning" is a useful warning. The danger is not from present lightning but from fossil flashes. The fast-pulsed currents close to where a bolt strikes amount to tens or hundreds of kiloamperes. The magnetic effects penetrate in depth only 20 meters or so, although they extend farther on the surface.

Time is the key. What one seeks is the old original magnetism. It is there, preserved by the guaranty of the highest

second. A quite similar grain with only five times the volume will hold its internal field against the insistent atomic motions for as long as the age of the earth! That is the basis of the science.

The clever paleomagnetician studies his sample under varying temperature and field strength. Watching carefully how the tiny magnets respond, he can remove most of the effects of secondary magnetization (because it is less long-lasting) without modifying the few larger telltale grains that bear magnetic witness to the dim past. Given that understanding, he has mapped the drift of continents and the earth's magnetic poles of the past, and he has established the repeatedly changing strength and alternating direction of the earth's magnetic dipole. In one graph you can see the paleolatitudes of ancient reefs, of coal, oil, dry lakes and more, mapped by the dip of the compass grain within. All these phenomena, wherever they are found today, were as one might expect tropical or nearly so when they were made, save only those coal deposits of the greatest age, which seem to have been laid down in polar climates.

This is altogether an unusual book. It sets out a new field to the depth needed for real use without barring the less specialized reader. Quantum mechanics, for example, appears only by invocation on one page, without equations. Magnetism is quantal, all right, but we can use it forcefully at the level of old Newton and Maxwell. All we need from Bohr is the magneton itself!

Dating Techniques for the Archaeologist is a valuable, concise, pointed set of summary pieces each explaining the how of one physical dating technique "for the use of professional archaeologists." A good many readers not in that trade may expect to use it with real profit, both for reading as a whole and as an accessible and authoritative source for specific points and for guidance to methods and

slower growth with time, close enough to the theory.

Both of these books convey the dual growth of science. Its growing depth makes it more and more powerful at explaining the most diverse phenomena. The growing diversity of its reach then brings remote disciplines together, here aiding the recovery of man's past by close understanding of ferrimagnetism and of diffusion theory. For the users downstream, so to speak, these are timely books; for the physicist-reader, who sees them from upstream, they form a fresh guide to his own discipline in a novel context of relevance and wonder.

MAIN PRODUCTS □ Telephone Exchange Equipment □ Carrier Transmissi
Computers & Peripheral Equipment (FACOM) □ Telegraph & Data Commun
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SCIENTIFIC AMERICAN
NEW YORK, N.Y.
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Microchemical Journal v.17, #5 Oct. 1972

placed since most university and industrial chemical laboratories now employ the more convenient single pan balance. The principles of titrimetric measurements (Section IV) are treated in great detail with copious literature references (albeit few from the last decade). The concept of gravimetric titrations employing small polyethylene wash bottles for dispensing titrant is novel and probably deserves greater popularity than it now enjoys. The fifth and last section treats electrical and optical methods. There are far too few experiments included here and notably absent are discussions of ion-selective electrodes and atomic absorption analysis.

The authors are quite thorough where it counts but the organization of material is confusing to the reader. The reviewer would have preferred seeing the procedures and experiments collected in one section of the book rather than distributing them throughout the text. A laboratory manual containing *only* procedures and experiments (with a sturdy vinyl cover to withstand laboratory conditions) might have been an even better approach.

Despite the diligent and rather detailed treatment given to principles and theory of gravimetric and titrimetric analysis, the student has at times been forgotten. There is a paucity of worked numerical examples and a lack of illustrative diagrams for gas chromatography, liquid–liquid extraction, and ion-exchange separations. In summary the book has shortcomings which detract from its overall appeal and which prevent its recommendation by the reviewer.

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Dating Techniques for the Archeologist. By H. N. MICHAEL AND E. K. RALPH. M.I.T. Press, Cambridge, MA, 1971. XI + 227 pp. $12.50.

The reader may well ask the question as to why a review of a book of the above title occurs in a microchemical journal. This question is answered readily by the simple fact that archeological dating may be done by microanalytical techniques and these are referred to in the text.

The text is written by eight contributors each discussing his field of specialization. The first section goes promptly into the technique of ^{14}C dating. The format of this section is followed subsequently in each of the sections. This comprises an explanation of the principle of the technique followed by the mechanical and chemical procedures for obtaining and preparing the sample. These techniques are described in detail, the text being directed to workers in the field. The final measurement is then described in detail, including the application of statistics in arriving at the age of estimation. Estimation of the validity of the results obtained are then discussed. Under the heading "Laboratory Methods" detailed setups are shown by drawings and halftones for carrying out the procedures. Finally, a list of references is cited.

Other topics discussed in a similar manner are dendrochronology (tree ring counting), archaeomagnetic dating, thermoluminescence dating of pottery, fission track dating, potassium argon dating, and obsidian hydration.

The tree ring dating makes use, at least at present, of no particular chemical techniques. It is well known that since the weather varies from year to year changes occur in the width of the tree rings. A particular sequential arrangement of wide and narrow rings becomes a recognizable pattern in structural lumber permitting the correlation of the dates between different sites.

When clay is heated to a high temperature it is demagnetized. As it cools it is remagnetized along the lines of the earths magnetic field at that time. Thus the declination, inclination and total field intensity of the earth's magnetic field can be obtained provided the clay is in its original position. This permits the changes in the earth's magnetic intensity to be plotted for several thousands of years. Subsequently this information may be used for dating newly found specimens. This technique is called "Archaeomagnetic Dating." This is explored in depth in the text.

When an X-ray beam strikes a piece of glass it turns brown, a KCl crystal turns purple. This is due to dislocation of electrons and storage of some of the irradiated energy. If heated, this energy will be given off as "thermoluminescence" along with the normal incandescent light. On cooling and reheating the extra energy will not be present. Thus, if a fired piece of ceramic is buried it will absorb energy year by year due to radioactive materials in the ceramic and its surroundings. The amount of glow obtainable on heating is a measure, then, of the time elapsed between firing and the present. This assumes that one can estimate the rate of energy absorbed per year. How this is done is given in the chapter with the title "Thermoluminescent Dating of Pottery."

If a mineral contains uranium, then spontaneous fission will take place of ^{238}U. As the atom splits, the fragments plow through the material at high speed, leaving tracks. These tracks can be brought out in a substance like obsidian by etching with HF. By counting the number of tracks, one may estimate how long ago it was that the volcanic glass was formed. This is a new technique and is still being developed. For this reason the chapter on "Fission Track Dating" is short.

The so called "potassium–argon clock" is based on the accumulation of radiogenic ^{40}Ar produced in the radioactive decay of ^{40}K. Most often it is applied to date lava flows. At that time the rock is completely degassed setting the clock to zero. This subject is discussed in a chapter on "Potassium–Argon Dating."

The last chapter is an extensive one on obsidian hydration dating. This is also a relatively new technique. When obsidian is formed it is heated to a high temperature and dehydrated. As it ages it becomes hydrated, water diffusing into the obsidian at a fairly continuous and determinable rate. One then cuts the specimen and after polishing may then measure and photograph the hydration rim.

It is of interest to the analytical chemist that by X-ray spectrometry, neutron activation and conventional analytical techniques, volcanic glasses from different parts of the world have been analyzed and characterized by their trace metal components. In this manner specimens which have been moved in prehistoric times in order to make artifacts can be traced back to their point of origin.

The text is intended as a workbook for those engaged in acheological dating and is written with this in mind. However, it is of general informational interest to the analytical chemist and may serve as a source book for the microanalyst suggesting applications of new techniques developed to archaeological problems.

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sented on the analysis of key alloys and commercially available compounds. Surprisingly, this excellent arrangement is not followed for lead, and the only cross references provided are to lead azide and lead styphnate (considered under Explosives). This reviewer holds the assessment of lead compounds and pigments as important. Is it possible that some author missed the deadline and the information will appear in a latter volume? "Plumbic and Plumbous Compounds" would be a reasonable title!

For the practice of microchemistry and microanalysis many articles in this volume, as in previous volumes, provide salient information that is applicable directly to *real* samples. For inorganic practice, the articles for key metals can be recommended. The 31-page article on Isocyanic Acid Esters summarizes most effectively, and especially through the use of tables and spectral curves, their properties, reactions, determination, and analysis. Organic isocyanates have become of commercial importance only since World War II with their extensive application in the polymer industry. The 24-page article on Mercaptans delineates the determination of the thiol function, including the presentation of gas chromatographic and amperometric titrimetric procedures.

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Quantitative Measurements and Chemical Equilibria. By Ernest H. Swift and Eliot A. Butler. Freeman, San Francisco, 1972. XVII + 719 pp. $14.50.

It is surprising that the choice of subject matter for a modern freshman and sophomore quantitative analysis text has changed so little over the past decade. This book represents yet another entry to an already saturated textbook market. Unfortunately the entry is flawed by several drawbacks. Some material incorporated by the authors probably belongs in a general chemistry or introductory chemistry text. In addition the authors have an annoying tendency to change voice and address the reader/student directly. The book is organized into five sections and includes 30 procedures and experiments as well as seven useful appendices.

The first section discusses the general principles of quantitative measurements over the space of nine chapters but contains superfluous material, such as the historical background of quantitative analysis (Chapter 1). In the discussion of terms and units (Chapter 2)—also superfluous in a text of this nature—the authors err in defining atomic and molecular weights in terms of gram-atomic and gram-molecular weights and confuse the reader concerning the exact number of equivalents per mole in a substance like phosphoric acid. A clear and well-written section dealing with evaluation of experimental data follows in Chapter 3. The remaining material in Section I lays the foundation for gravimetry and titrimetry.

Section II treats equipment and techniques in detail, but contains some unnecessary material. For instance, stirring rods and dropping pipettes are available commercially, and time in the freshman chemistry is usually too valuable to spend making these items by hand. Perhaps it is a sign of the times that the reader/student is warned against coming into the chemical laboratory in sandals (Hippie-type professors, take note!)

In Gravimetric Measurements and Methods—Section III—the lengthy discussion of the principles of operation of the analytical equal-arm balance seems mis-

Choice
Chicago, Ill.
OCT 1972

MICHAEL, Henry N. and Elizabeth K. Ralph, eds. Dating techniques for the archaeologist. M.I.T., 1972 (c1971). 227p il tab 79-153296. 12.50. ISBN 0-262-13074-2

Collection of original papers describing some of the latest developments in dating techniques used in archaeology. The techniques include dating by carbon 14, tree rings, archaeomagnetism, thermoluminescence (pottery dating), fission track (for dating glass), potassium-argon, and obsidian hydration. The papers describe the history of each method, explain how it works, what samples can be dated, how to collect and package them, how the laboratory processes them, how it calculates the age, what are the possible sources of error in the samples or method, and how to evaluate the dates. The highly authoritative papers are written by scientists who have helped develop these techniques. Described as primarily a handbook for the professional archaeologist, the book is also clearly enough written that even the more difficult parts can be followed by those with a knowledge of high school chemistry and physics. It ought to have a sizable audience among readers who are curious how scientists, through applying atomic physics, have learned to date our world. Detailed bibliography provides a complete listing of earlier research reports on dating methods. Recommended for college libraries.

'WHATDUNIT' BOOK

Lodestone Points to Ancient Mysteries

By GENE LINDBERG

The lodestone — ancient man's first compass needle — is now pointing out magnetic answers to one of earth's oldest detective mysteries:

"Which way was north when the oldest rocks were new?"

TWO BOOKS

Told in understandable language, this "whatdunit" story unfolded in a new book, "Principles and Applications of Paleomagnetism" by D. H. Tarling; Barnes & Noble, Inc. ($5.50). Another book, "Dating Techniques for the Archaeologist," includes the same topic in a collection describing the many methods scientists use for clocking and dating Mother Earth's life history. This volume was coedited by Henry N. Michael and Elizabeth K. Ralph; MIT Press ($12.50). Both books were reviewed in the September issue of Scientific American magazine.

Locked in the rocks, "like so many frozen compass needles," are dark grains of a magnetic material which "remembers" how the earth's magnetic poles were lined up when the rocks were formed. The oldest stones, such as granite, are igneous (fireformed). Newer rocks, the sedimentaries, started as loose sediments (sand, silt, gravel and coarser rubble) which weathering and stream flow had deposited in lakes and seas.

Push a horseshoe magnet into the sand of a mountain stream and it comes up bristling with needles of magnetite.

This is magnetic oxide of iron. The ancients called it lodestone (or loadstone) because it can pick up a magnetic

Such is the black sand found with gold dust in the prospector's pan. Weathering and stream flow have freed it from its native rocks.

LOCKED IN PLACE

But in large rock samples core-drilled from a cliff face, those grains remain locked in place just as they were millions or billions of years ago when the earth's magnetic field lined them up.

Only withing the past 20 years, says Tarling, have men gained sufficient cunning to read these records — thanks largely to the research of one Louis Neel. The tiny grains of magnetite (and hematite) are not pure iron oxides. They're complex solid solutions of iron-titanium minerals within a non-magnetic matrix.

The alignment isn't nearly as complete as is the orderly arrangement of atoms in an iron magnet. It may, in fact, be a million times as weak as the magnetic strength of a pocket compass. Yet a ferro-magnetic reading is there if scientists know how to take it.

WORD OF WARNING

Here the book sounds a pertinent warning to the would-be "paleomagnetician." (Now there's a word, meaning student of ancient magnetism.) Greenhorns in this field are warned to "watch out for lightning" — fossil lightning, that is. Sounds weird, but it's as natural as the dinosaur tracks, adult and young, found on the east face of the hogback formation west of Denver. Surrounding those tracks was dimpled proof of raindrops on an ancient beach, now hardened into sandstone.

Had lightning struck during that rain squall, the magnetic field surrounding the flash would have twisted loose magnetite grains into fossil patterns all its own. Such electric surges can penetrate more than 50 feet. They spread even farther on the surface, obliterating the original compass readings.

Time is the key. What scientists look for is the old, original magnetism, directionally preserved despite its struggle with random movements that sought to pull it askew. At room temperature, the author reports, a tiny grain of magnetite only 4 millionths of an inch across can follow magnetic changes in a split second. But a similar grain of five times its bulk can stay put for as long as the age of the earth!

Stay put it does, with trillions of grains like it. Imagine long trowel marks on an ancient concrete sidewalk. So long as everything remains intact, those scratch lines show the actual compass direction along which the trowel moved. An earthquake may crack the concrete, tilt it, twist it out of line, yet the lines stay.

In the case of old sedimentary rocks that hardened from a mix of sand and natural cement, the magnetite streaks running through it were made by the compass pull of the earth's poles.

Years pass, the continents drift apart and twist out of line. The earth's magnetic poles may shift position as milleniums and eons come and go. But so long as the rocks hold together the original record remains.

Geologists have found that certain rocks on the east coast of South America have magnetic "trowel marks" identical with those in rock layers on the west coast of Africa. They take this as proof that these rocks, now an ocean apart, originally were together as one formation that split apart when the continents separated.

Scientists who hold with the continental drift say it's no coincidence that the east bulge of South America would fit like a jigsaw piece into the concave curve of the African shore as shown on any global map.

The magnetic lineups no longer point north and south, but they'd match if the two continents could be swung back together.

"This is altogether an unusual book," states the Scientific American review. "It sets out a new field in the depth needed for real use without barring the less specialized reader. Quantum mechanics, for example, appears only on one page, without equations.

"Magnetism is quantal, all right, but we can use it as forcefully at the level of old Newton and Maxwell. All we need from Bohr is the magneton itself!".

UNIT TERM

Magneton is a quantum unit term like photon. It pertains to the smallest possible unit of magnetism.

The companion book, "Dating Techniques for the Archaeologist" is a "valuable, concise, pointed set of summary pieces," each explaining a physical dating technique intended for the use of archaeologists interested in determining the age of fossils, artifacts, etc.

Interested nonprofessionals should find the book valuable in understanding tree ring and carbon-14 dating, paleomagnetism, fission-track dating, thermo-luminescence of pottery, potassium-argon dating and estimating age by judging the thickness of the "visible rind" formed on natural glasses (obsidians) as water diffuses into them. This is roughly a micron of thickness per century, so it would take water 2500 years to penetrate a thousandth of an inch.

As these new tools of science increase and develop, the non-technical reader finds it harder to understand their use by professionals. How can they tell that one pottery shard from an Indian dig is older than another?

Perhaps by pottery-luminescence. As time passes, the radioactive minerals in clay build up atomic lattice defects which give off light when the broken pot is heated.

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OCT 5 1972

languages, p. 194). They also perpetuate a substantial mistake in the drawing of the northeast Queensland coastline. Both the main text and especially these maps seem to omit some revisions of O'Grady-Voegelin that would have been possible in 1969. For example, Mrs Hercus's work on Victorian languages is referred to but her linguistic groupings are not adopted.

Holmer's treatment of Bandjalang is apparently intended to be of interest and use to the non-linguist, as it is mostly written in paragraphs of prose and utilizes few of the technicalities that linguistics has evolved in the last twenty years. The morphophonemics of case-marking suffixes are stated in traditional paradigms, an exercise which takes 99 lines. The same amount of information is presented in only 13 lines by M. C. Cunningham, using a simple technical device, in her *Description of the Yugumbir Dialect of Bandjalang* (St Lucia, 1969).

Bearing in mind that analyses of dying languages are mostly going to be read by linguists, a concentrated and easily scannable treatment is preferable to a prosy one cluttered with examples.

The collection of papers by Blake and others, like many previous collections, sets a high standard of concentration and scannability. But there is, as before, little that is adventurous or new in scale or technique. Works of a theoretical orientation are rare in the Australian field, and the variety of possible technical approaches has been under-utilized. The tagmemic method is still the one most commonly used, and there is a concentration on the brief presentation of semi-raw data.

Blake's interesting paper 'Jalanga and Kalkatungu: some comparisons' demonstrates how comparative studies may go ahead even where the data are distinctly limited.

The *Vocabulary* by Aubrey Hall (1871-1963) is a highly curious book. It is a list of about 900 words in Ngarluma (W.A.) by a white man who knew the language well. His layman's orthography is very reliable and his ear good. The editor has provided a 'concordance' which contains the same vocabulary in his own scientific orthography.

Where any morphemes begin with stops von Brandenstein uses the 'voiceless' symbols (p, t, k etc.), and uses the 'voiced' ones (b, d, g etc.) whenever the same stops occur elsewhere. This is apparently to provide a visual guide to morphology, but is presented (p. 78) as if it were a statement about Ngarluma phonology, and most readers will find this confusing.

PETER J. SUTTON
97 Hargrave St, Paddington, N.S.W.

Dating Techniques for the Archaeologist. Edited by Henry N. Michael and Elizabeth K. Ralph. M.I.T. Press, Cambridge, Mass., 1971. Pp. xii +227, 50 figs, 30 tables. $US12.50

This comprehensive handbook describes the Carbon 14, Tree Ring, Archaeomagnetic, Thermoluminescence, Fission Track, Potassium/Argon and Obsidian Hydration methods for dating archaeological remains. The laboratory techniques and age calculation procedures, together with some of the limitations of each method, are listed.

For the professional archaeologist appraising a dating programme or teaching graduate students this would provide a useful reference. For fieldworkers, the sections on sample requirements and information to be supplied to the dating laboratory could be expanded and more lucidly set out. The book should indicate that close co-operation between the sample collector and the dating laboratory is essential if realistic interpretations are to be placed upon any age estimation.

RICHARD GILLESPIE
Radiocarbon Laboratory, University of Sydney

The Aborigine Today. Edited by B. Leach. Paul Hamlyn, Sydney, 1971. Pp. 160, 3 black and white, 115 coloured illustrations, 1 map. $6.95

This is an attractive book for the general reader. Unlike some similar popular books the text as well as the photographs is stimulating. A pleasing feature is the inclusion of contributions from Aborigines Kath Walker and Joe McGuinness. Essays appear on important topics: traditional life, languages, land rights, education, employment, and voluntary agencies, Aboriginal attitudes and identity. Contributors include journalists (Hardy, O'Brien), anthropologists (Barwick, Capell, Peterson), an economist (Stevens), and a researcher (Lippmann).

Most of Hulsbergen's coloured photographs are superb, but an 'arty' double-image treatment of some seems inappropriate.

The editor's neglect of photo captions in the final essay section is regrettable as is her inconsistency in the use of terms for Aborigines. She could well have avoided the use of 'half-blood'!

ALAN WEST
National Museum of Victoria

ment that between World War I and World War II "the value system was reasonably stable for much of the middle class." Pettigrew and Riley report an exploratory use of path analysis, coupling census and attitudinal data. Their data speak to some of the issues raised by Abelson and point out the need for interpreting attitude results within meaningful social contexts. The final chapter, by White, is a brief analysis of how some very simple attitude survey data could and should play an important role in foreign policy decisions.

With the above four exceptions, the remainder of the book suffers from all the ills of edited symposium reports—poor organization, jarring changes in writing style, irrelevant contributions, and contributions which misrepresent the state of knowledge in the field—*Russell A. Jones, Behavioral Science, University of Kentucky College of Medicine*

MENYUK, Paula. *Sentences Children Use.* 165 pp. M.I.T. Press, 1972. $1.95 paper.

The present monograph, first published in 1969, is one outcome of a renewed interest in how children acquire language. In it, the author tries to explore the kinds of syntactic knowledge that the child might have about his language at different stages in development, e.g. whether the child considers a sentence like "Him got ball" grammatical, or whether he uses forms like "went" and "goed" in alternation with each other. This study is not concerned with phonology (the sound system) or with semantics (the meaning system of language). The bulk of the monograph contains an analysis of samples of spontaneous speech and of repetition data collected from 154 children between the ages of 2 and 7 years. The aim of the analyses is to illustrate the syntactic rules that could be attributed to children at particular stages in development. The author assumes that these syntactic rules specify psychological operations performed by the child learning language.

The reader is faced with several problems in this study: for example, the author does not spell out her reasons or criteria for assigning a particular base structure to a particular utterance, so the analysis has to be taken on trust. Moreover, there is no systematic reporting of quantitative data, e.g. the percentage of ungrammatical forms or of alternations, or the number of children contributing to the means that are given. In addition, few psycholinguists today share Menyuk's assumption that the rules specify psychological operations.

More generally, this study illustrates some of the many problems faced by the developmental psycholinguist who has no contextual information to accompany the spontaneous speech samples nor any independent check on the child's knowledge, e.g. from a comprehension test. Successful repetition of an utterance, of course, cannot be equated with comprehension of the syntactic rules used to describe that utterance. This type of study has made it more and more obvious that detailed information about the child's comprehension is needed in addition to data on production, in order to assess his knowledge about syntactic structure.

While Menyuk does raise a number of problems connected with acquisition research, she does not seem to have applied her discussion to the present work. Nonetheless, her monograph contains many interesting examples of children's speech, and she also suggests one promising new technique, that of using the child's own spontaneous "corrections" of (adult) ungrammatical sentences in a repetition task.—*Eve V. Clark, Committee on Linguistics, Stanford University*

MICHAEL, Henry N., and Elizabeth K. Ralph, eds. *Dating Techniques for the Archaeologist.* 227 pp. M.I.T. Press, 1971. $12.50.

During the past decade archaeologists have slowly come to the realization that it is necessary for them to acquire extensive technical knowledge about the laboratory techniques employed by physical scientists in analyzing archaeological materials. For the archaeologist who takes such a statement seriously, this book is an absolute must. It contains seven papers on the most common dating techniques, including carbon 14 (Ralph), dendrochronology (Michael), archaeomagnetism (V. Bucha), thermoluminescence (J. Winter), fission tracks (H. Faul and G. Wagner), potassium-argon (Faul), and obsidian hydration (J. Michels and C. Bebrich). With the exception of Bucha, Michels, and Bebrich, the authors are from the University of Pennsylvania. While the quality of the papers vary, the overall result is an excellent introduction for fieldworkers to the mysteries of the laboratory.

Ralph's treatment of C-14 dating is first-rate and deserves special mention. She provides simple but accurate explanations of the glassware jungle and blinking lights of a C-14 laboratory, as well as a rundown on the latest bristlecone pine calibrations. A handy table for the calibration of C-14 dates is provided, although it is based only on Pennsylvania's measurements (about 25 percent of the total). Sample requirements are also based on Penn's oversize 8-liter CO_2 counter and are therefore maximal.

Field sampling techniques are glossed over with an apology for the presumptuousness of a physical scientist mentioning the subject at all. The reviewer finds, however, that when training archaeologists in such techniques, one must proceed like the man who trained the mule: first hit him on the head with a two-by-four to get his undivided attention.

Winter's account of thermoluminescent dating of pottery is the best to date. The quoted levels of error are in the 15–20 percent range, proving to this reader's satisfaction that the method is only useful for museum authentications. Michels and Bebrich provide enough information on obsidian hydration work for any budding obsidian grinder to start his own laboratory. Michael on dendrochronology is disappointingly brief and uninformative, while Bucha's paper is rather heavily technical and lacking in description of field collecting techniques. The papers on fission tracks and potassium-argon, however, are short, sweet, and to the point.—*Nikolaas J. van der Merwe, Anthropology, State University of New York at Binghamton*

SOKOLOV, A. N. *Inner Speech and Thought.* G. T. Onischenko, trans. D. B. Lindsley, ed. 283 pp. Plenum Press, 1972. $22.50.

This book is a frontal attack on the ancient problem of the relationship between thought and speech. Placing his emphasis on the inner speech that develops out of external speech, Sokolov's approach is representative of the prominent physiological-cognitive zeitgeist which seeks to explicate "the higher mental processes" by psychophysiological techniques. Objective records of inner (soundless) speech are obtained in the form of minute electromyographic reactions of the speech musculature. The conclusion is that covert motor speech activity occurs in all subjects during thought and is a necessary component of that thought activity.

As for the function of speech muscle activity, Sokolov, following Pavlov, holds that speech proprioception is the basal component of man's second (verbal) signal system. Afferent impulses generated by the covert speech reactions relate the first (visual, nonverbal) and the second (verbal) signal systems. Sokolov established that covert speech reactions occur in both verbal and nonverbal thinking. Hence, thought is always associated with language, though in nonverbal thought covert speech reactions do not always occur since there is no need to verbalize everything that is perceived. The function, then, of covert speech reactions is to generate proprioceptive impulses that become an abstract signal (code) that synthesizes connections with impulses of other modalities. These impulses, proceeding from the speech musculature, initiate speech activation in the cortex that regulates the stream of cortical associations during intellectual activity. In this way "inner speech and the concealed articulation associated with it is . . . the principal mechanism of thought" (p. 263–4).

Sokolov has written a most engaging and valuable book. While it is principally for those with psychophysiological interests, others will be interested in his historical development of the problem starting with the ancient Greeks, in his summary of relevant clinical work on aphasia, in the research that employs the strategy of interfering with the speech mechanism, and in his making available valuable discussions of

not infants and all other circumstances are balanced, the sons should remain with their fathers (p. 354)."

The book also has a number of weaknesses which should not be taken lightly. The methodological inadequacies of the experimental study of a group of 100 delinquent and 100 nondelinquent males, on which most of the results in the first half of the book are based, are glaring. Although matched on age, body build, and delinquency records, the delinquents had significantly lower IQs and lower social-class backgrounds than the nondelinquents, who attended a private Catholic school and had a mean IQ of about 120.

Not only is such poor matching inexcusable, it is especially so in this case, since Conger and Miller (1966. *Personality, Social Class and Delinquency.* New York: Wiley) have demonstrated that "personality factors may be differentially related to delinquency, depending on the social class and IQ status of the child" (p. 71). Moreover, a delinquent sample that is 76 percent Catholic and 9 percent black and a nondelinquent group which is 100 percent Catholic and 0 percent black is hardly representative. The disproportionate percentage of Catholics is crucial, since religiosity is postulated as a major preventative factor. Numerous other methodological flaws—e.g., a Catholic priest administered all of the interview inventories—render the empirical results less than convincing.

Another major weakness lies in the authors' advocating truly untenable suggestions, given the current state of knowledge in the social sciences. For example, they advocate psychological testing to detect children apt to become antisocial and the establishment of special camps for retraining them and the placement of infants from "hard core" families in residential "schools." These suggestions are made in spite of the poor predictive validity of most psychological tests and the vast evidence against institutionalization.

This book is full of extremes, some thoughtful, others outrageous, most provocative. It should be read by serious students of crime and delinquency, but with an extremely critical eye.—*N. Dickon Reppucci, Psychology, Yale University*

CUNNINGHAM, Michael. *Intelligence: Its Organization and Development.* 173 pp. Academic Press, 1972. $8.95.

Developmental psychology has been especially plagued or blessed (choose one) with prodigious giants who have blown gigantic bubbles, awing and encapsulating their disciples with ontogenetic concepts such as "reciprocal interweaving," "syncretism," "schemas," "fixation," "modes," and "phase sequences." The trouble is that the Gesells, Werners, Piagets, Freuds, Eriksons, and Hebbs are too astute in observation and formulation to be dismissed. One wishes it were possible, however, to conceptualize development among and across their theories, rather than solely within each theory. Theoretical comparison and integration has been almost impossible among theories of such widely differing syntax and semantics.

In my mind, Cunningham's book is an initial attempt at such bridge building. Working within a relatively neutral framework, an information processing-computer simulation model, Cunningham seeks to reduce the data and concepts of Hebb and Piaget to their essence and tries to construct from this a clear, programmable model of the early development of human intelligence. While I'm not entirely convinced that the first two years of mental development are sufficiently specified and programmed within Cunningham's framework, his inductive-analytic integration of the two theories should lead the reader to recognize that Hebb and Piaget are most compatible and complementary in advancing intelligence from reflex to thought.

Cunningham supplements the intelligence of Piaget and Hebb with the attention of Sokolov in order to allow the model to perceive selectively, as well as to learn and to know. Also included are extensions and speculations from his model into such diverse areas of infancy as memory, motivation, neurophysiology, language, concept formation, and imagery. An initial attempt at the computer implementation of the system is also made.

Cunningham deals knowledgeably with Hebb, Piaget, and Sokolov, and they are a sound, compatible trio for his purposes. Extensions of this volume, however, should pay more attention to the reams of empirical studies in the field of infancy not included in this book. In places, e.g. vision, the auditory and vocal systems, and conditioning, too large a superstructure is built on too few observations. But the book is an engaging first bridge and he has selected his data judiciously.—*Philip Salapatek, Institute of Child Development, University of Minnesota.*

KIESLER, Charles A. *The Psychology of Commitment: Experiments Linking Behavior to Belief.* 190 pp. Academic Press, 1971. $9.95.

How do you get someone to act in accordance with his attitudes? Common sense tells us it would be foolhardy to expose him to persuasive arguments that contradict his attitude prior to requesting action. Indeed, one of the six new experiments reported in this monograph supports common sense, but only when people have not previously been behaviorally committed to their attitudes. For the committed, however, encountering an attack on their attitudes serves to sharply increase (from 10 to 41 percent) the percentage of individuals willing to take attitude-consistent action.

Kiesler has written a personal narrative that organizes his thoughts and research on the effects of becoming committed to attitude-related behaviors. Through an interlacing of published and unpublished experiments, ingenuous glimpses of his research philosophy, and borrowings from more developed attitude theories, he emerges with some helpful empirical generalizations. For example, the committed person does not become more extreme in his attitude, but rather he becomes more resistant to subsequent counter-additudinal influences. Further, he becomes more open to subsequent attitude-congruent influences. Other variables examined in relation to commitment were forewarning of persuasive messages, learning and retention of attitude-linked materials, and future interaction with others.

There are several issues that were not adequately dealt with in this otherwise comprehensive social psychological analysis of behavioral commitment. The work deals almost exclusively with the consequences of commitment and leaves us relatively uninformed regarding its antecedents. Unlike most research on attitudes, we are offered an analysis of effects rather than determinants. This makes it difficult to assess the degree to which a person is committed to a behavior and what conditions serve to increase that commitment.

To study this problem, it would be helpful to have a more direct measure of commitment. Kiesler sometimes refers to the "feeling of commitment" as if commitment manifested itself at the affective or cognitive level. If this be the case, a measure of these feelings should be devised and used as a manipulation check in research on the effects of commitment and as the primary dependent measure in the recommended research on its antecedents.—*Thomas M. Ostrom, Psychology, Ohio State University*

KING, Bert T., and Elliot McGinnies, eds. *Attitudes, Conflict, and Social Change.* 234 pp. Academic Press, 1972. $10.50.

This book is a compendium of papers given at a symposium of the same title at the University of Maryland in May 1970. In addition to the editors' overview and introductory remarks for each section, there are chapters by Abelson, Helmreich, Orne, Zimbardo, Likert, Bowers, Triandis, Weiss, Pettigrew, Riley, Guthrie, and White.

Four of the chapters are well worth reading and almost—but not quite—worth the price of the book. Abelson's chapter is a thoughtful and intriguing essay on the apparent discrepancy between attitudes and behavior coupled with some novel suggestions about why this discrepancy may be more apparent than real. Orne and McGinnies offer a well-reasoned analysis of some possible causes of student dissatisfaction. By taking a fairly broad perspective on student demonstrations they cast considerable doubt on the most popular "explanations," i.e. moral revulsion over the war. Their chapter is marred only by a number of unsubstantiated generalizations. For example, on page 66 one finds the bald state-

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HESTER, THOMAS ROY,"Chronological ofering of Great Basin prehistory",Contributions of the University of California Archaeological Research Facility, # 17, Feb. 1973. p. 7

CHAPTER II

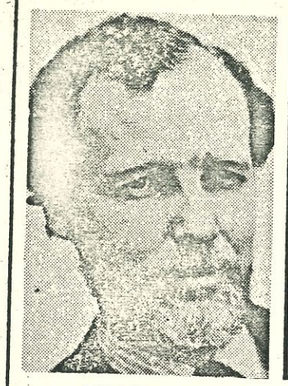
CHRONOLOGICAL METHODS IN GREAT BASIN ARCHAEOLOGICAL RESEARCH

Most discussions of chronological methods center around "relative" versus "absolute" techniques. Relative or indirect chronological methods are those which provide some basis for the sequential placement of cultural entities. Using such methods, we can pronounce something to be "older than" or "younger than" something else. Stratigraphy is without doubt the most widely applied technique for deriving relative chronology, though there are a variety of other methods, such as artifact seriation, the use of "horizon markers," cross-dating, geochronology, paleontology, and the application of fluorine and nitrogen tests to determine if bones are of similar ages. All of these techniques are described in detail in introductory archaeology texts, although especially good discussions can be found in Hole and Heizer (1969) and Rouse (1972).

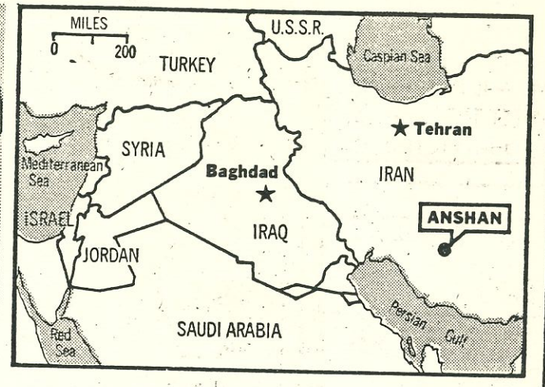
Absolute or chronometric dating is used by the archaeologist to learn the precise time in prehistory when an event occurred. There are numerous chronometric techniques being applied today, ranging from the interpretation of ancient calendric systems to highly complex and sophisticated physico-chemical methods such as potassium-argon dating, thermoluminescence, paleomagnetic dating and fission-track dating (for a review of these techniques, see Michael and Ralph 1971). The most widely used chronometric technique in archaeological research today is, of course, radiocarbon-dating. Because it can be used to date a variety of organic materials, the method can be applied in most areas of prehistoric research; refinements in the process in recent years have provided prehistorians with highly accurate chronometric assays. An even more precise dating technique, developed in the early part of this century, is dendrochronology (tree-ring dating). But it is quite limited in its application and at present is used primarily in the American Southwest. Obsidian hydration is a chronometric device developed in recent years; however, it, too, has limited potential and its full value has not been clearly ascertained.

In the following pages, I will review the major dating techniques, both relative and absolute, which have seen wide application (or which have the potential for wide application) in Great Basin archaeological research. I do not think it necessary to devote space to an explication of stratigraphic methods, since not only is such a method clearly understood, but it also has quite limited use, producing relative chronologic data usually pertinent to a single site. Another technique used for the relative ordering of archaeological materials is seriation. In the Great Basin, it has been used by Meighan (1959c) in arranging a sherd sequence at Paragonah, a Sevier Fremont site in Utah, and by Weide (1968:197) in research with obsidian scrapers from Warner Valley, Oregon. Here I am more concerned with those techniques which can and have been used in developing a broad chronological ordering of the regional prehistory. Therefore, in this section I will present discussions of geochronological, paleontological

PHILADELPHIA INQUIRER 03/23/73



ROBERT DYSON
. . . lucky hit



When Anshan was found

Lost City Found in Iran

Penn Team Unearths Ancient Capital

By JOEL N. SHURKIN
Inquirer Science Writer

An expedition from the University Museum has uncovered an important ancient lost city in Iran, archeologists said Thursday in Washington.

The city is Anshan, one of the capitals of the kingdom of Elam. It was inhabited from before 4,000 B.C. to about 1,000 B.C. and was a major commercial and political capital. The discovery may mean cities were more widespread in the Mideast at an earlier age than had been thought, according to Dr. William M. Sumner of Ohio State University, who participated in the expedition.

Dr. Sumner and Dr. Robert H. Dyson of the University Museum, University of Pennsylvania, told the American Oriental Society that the excavation at Anshan—in southwestern Iran near the present village of Tall-I-Malyan—began almost two years ago.

"Excavations have shown that Anshan was a great city fully justifying its ancient reputation," Dr. Sumner said.

Anshan was apparently as important to the area as the legendary city of Susa.

An archeologist at the University of Chicago unlocked the mystery of Anshan's location by deciphering bricks inscribed with an ancient form of writing called cuneiform.

Archeologists found a group of seven tablets dated about 3,000 B.C. in a large building made of sun-dried mud bricks. The building was probably a warehouse.

No one can read the writing on the tablets yet, the archeologists said. It is in a written language called Proto-Elamite. The tablets appear to be business records.

Objects from a later period also were found, including small clay figurines of women clasping their hands or holding their breasts.

The latest Elamite habitation was found by Pennsylvania's Dr. Elizabeth Ralph, using a magnetometer. She located what turned out to be one room of a very large building that had been destroyed by fire.

The Metropolitan Museum, Ford Foundation, Ohio State and the University Museum are sponsoring further excavations at Anshan.

Aug
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WEEKLY READER NEWS REPORT 4/4/1973

Science Feature

Tools Help Uncover the



TV is linked to computer for study.

• A man walks across a field in Italy. He carries a tool made up of a metal rod with instruments at each end. He is using a magnetometer (mag-nuh-TOM-uh-ter) to try to find a town of long ago.

• A plane flies over fields of grain in England. A camera on the plane takes pictures of the field. An archeologist is using this way of trying to find the sites of Roman settlements.

How Sites Are Located. How can the magnetometer and aerial photos help locate sites? In two different ways they show that walls or buildings may be underground.

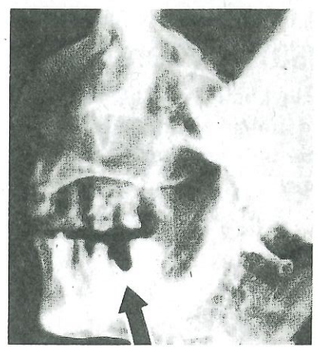
The magnetometer was made by the University of Pennsylvania Museum. It is a special kind for the use of archeologists; others are used for locating metals underground. The magnetometer



Archeologist uses magnetometer to search for old city underground. Note stakes set up to map the area.

X rays were taken of the teeth of Pharaoh Rameses II. They showed that the ruler suffered from absent and abscessed teeth.





Past

neasures magnetism under-ground. Where the magnetism is ow, scientists think they may ind the walls or buildings of an old city or old pottery. They then lig at such spots.

The magnetometer helped cientists find a famous Greek ity, Sybaris, in southern Italy. Archeologists had been searching or it for 100 years. The tool also elped to find a late Stone Age ettlement in Italy.

Photos taken from the air show he crops may differ a little in olor. Crops growing above the valls of an old town have a slight-y different color from those in the est of the field.

Use of X Rays. To learn more bout ancient times in Egypt, X rays have been taken of mum-nies. The X rays give a picture of he health problems the Egyp-ians had.

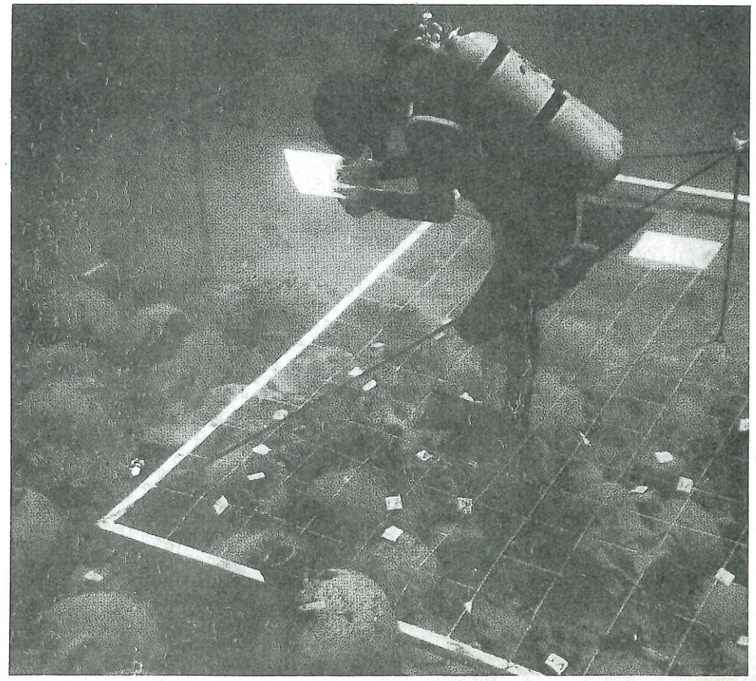
X rays of Pharaoh Rameses II, who lived 3,000 years ago, showed hat he had missing and ab-cessed teeth. He was also found o have had a joint disease in a ip. Such X rays, scientists say, dd much to our knowledge of life n ancient Egypt.

Underwater Equipment. At he eastern end of the Mediter-anean Sea lie the wrecks of ships hat sank more than 2,000 years ago. Scientists put on wet suits and scuba tanks to study them and to recover objects from the ships. They have also used a two-man sub to look for wrecks.

Study of the wrecks adds to man's knowledge of the life of the times. It also adds to knowledge of shipbuilding in the past.

Help from Computers. A TV and a computer are used together to study objects from the past. A museum worker etches the design of an object on the screen of a TV that is linked to a computer. This gives the computer information about the object. The computer then shows where the same or a similar design has been used.

New tools are being used to help uncover the past. Their use is, however, still only a beginning. Tools may be used much more widely in the future.



Scientist sketches on plastic the objects lying in wreckage of old ship.

Phila., March 1970

Phila. Inquirer

Scientists Believe Nevada Mountain Holds Oldest Tree

ELKO, Nev. (UPI) — The oldest living thing on earth may be a pine tree high on a remote mountain in northeastern Nevada.

A stand of bristlecone pines on Pearl Peak in the Ruby Mountains south of here has captured the fancy of scientists, some of whom believe it may include a specimen up to 7,000 years old.

Bristlecones at Wheeler Peak, along the Nevada-Utah border 150 miles away, have been growing for 5,000 years and rank as the oldest known living thing in the world. Experts have determined that still-standing dead bristlecones were young trees 7,000 years ago—50 centuries before Jesus was born.

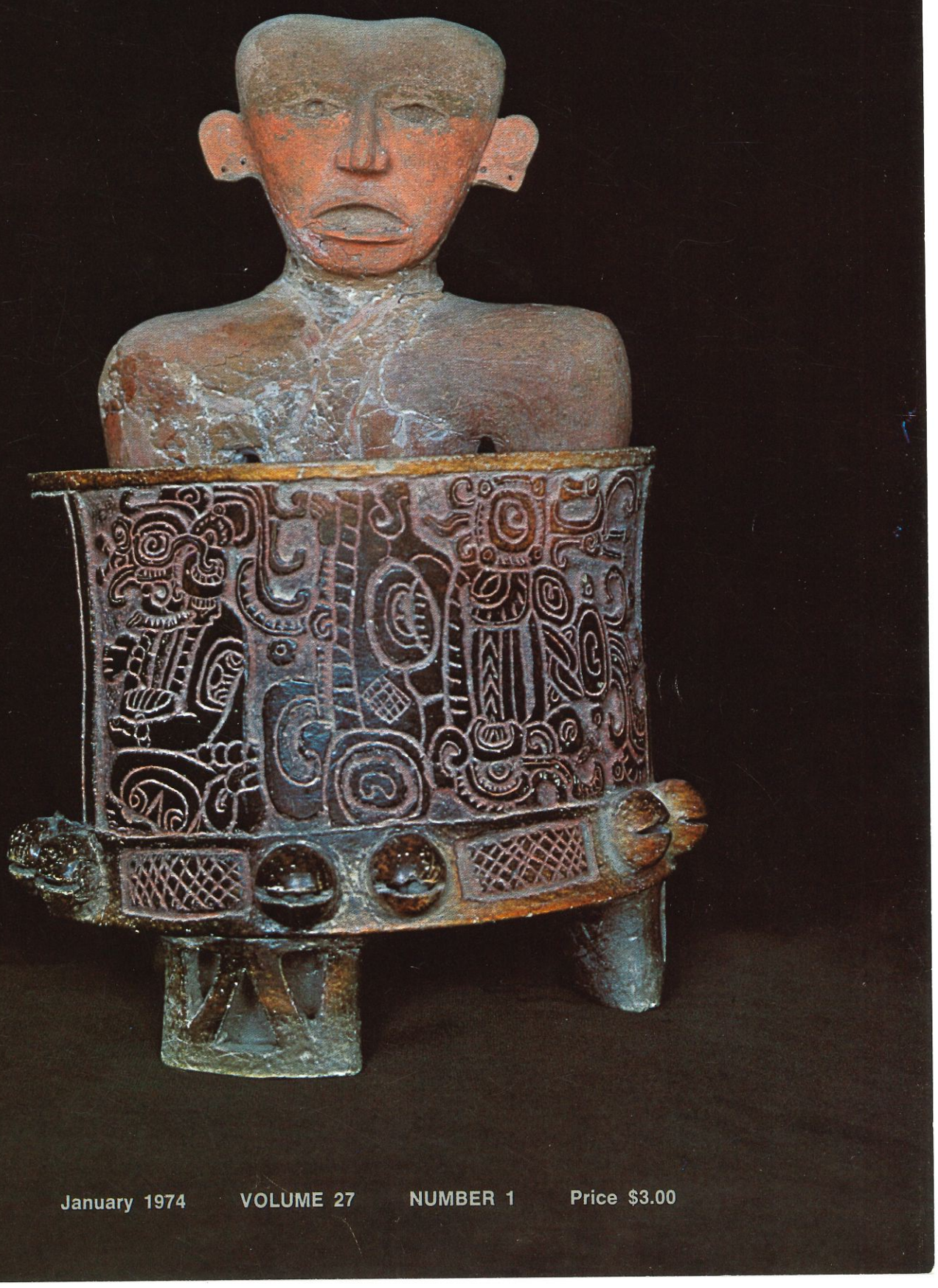
Began Fight Long Ago

Somewhere, one of these battlers for survival may still be growing, and it could be on Pearl Peak. Battered by wind, snow and cold, the trees cling to a rocky slope at an elevation of between 8,000 and 10,000 feet. They began their fight for life at a time when a long-vanished lake covered much of what is now the Nevada Desert.

Only the hardiest of forest rangers and sheepherders have ventured into the stand, which now covers several thousand acres. The Forest Service asked Dr. C. W. Fergeson, dendrochronologist from the University of Arizona, to study it and determine the age of the trees. Dr. Fergeson, who previously had established the age of the Wheeler Peak stand, said that the Pearl Peak trees might be the most significant yet located.

Scientists have been able to chart climates of the past by studying the annual growth rings of trees. The age of bristlecones provides a new dimension to the study. A core sample taken by drilling into a live tree is laid alongside a core sample from a dead one. The two cores are compared until the common ring pattern is found. Then the dead sample is counted back. The most ancient rings are used to calibrate the carbon dating process, which archeologists use to determine the age of materials found at sites occupied by early man.

ARCHAEOLOGY



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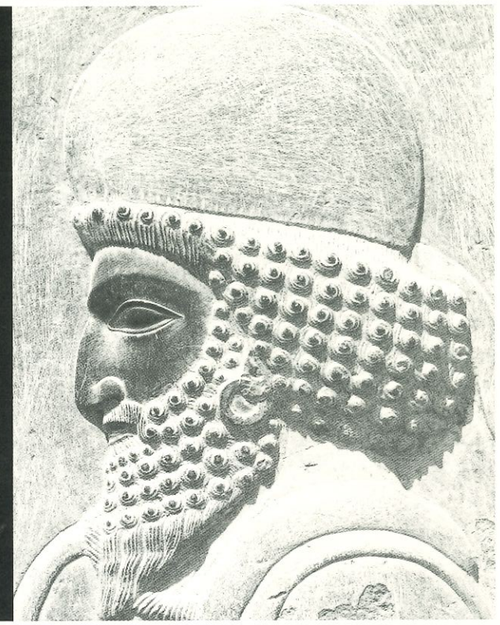
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Science and Archaeology

By Froelich Rainey

In the past few years archaeologists have more and more turned to the discoveries of the natural scientists to help them gain a better understanding of the past. No one has been more active in encouraging the use and development of science for archaeology than Froelich Rainey, director of Philadelphia's University Museum. Here he presents an account of some of his own work in this field.

One of the most attractive aspects of the search for new scientific techniques in archaeology is the constant element of surprise. Recently in *Earth and Planetary Science Letters* 15 (1972) 223-231, an article by Jeffrey Bada was entitled "The Dating of Fossil Bones Using the Racemization of Isoleucine." Most archaeologists have been thinking about new dating techniques in terms of atomic or nuclear phenomena, not in terms of biochemistry. But now the study of amino acids, which has brought about a wholly new understanding of biology and genetics, suddenly suggests the possibility of quite another field in archaeological dating.

Some years ago, while some archaeologists and physicists were trying to devise a more efficient method for probing beneath the surface of the ground in the search for the remains of the ancient Greek city of Sybaris, then thought to lie about six meters deep on the plain of the Crati, a river in Italy, we found that a magnetometer designed for a satellite could be adapted to archaeology and give enough magnetic sensitivity to locate remains at that depth. The United States Defense Department heard of it, requested that we experiment with them at one of the military proving grounds, and, as a result, they utilized the new cesium magnetometer in Viet Nam for the location of buried munitions. For the first time, to my knowledge, archaeology contributed to the military, rather than the other way around.

Such surprising developments in science and archaeology are, of course, similar to what is happening in most fields of research. When at a meeting of the Planning Board for the 21st Century Exhibition the members were debating the world of the future, they were all impressed with the startling impact of new technology, rather than "pure" science, upon daily life. It is not so much the gadgetry affecting man's way of living as it is the technical tools for research that open up new ways of probing into the environment and thus change man's attitudes and ideas about the world. The electron microscope and the radio telescope are the classic examples, but revolutionary chemistry, solid-state physics and a new order of electronics in general cut into the very core of the nineteenth century conceptions about the nature of man and the universe.

The following comments on the application of new scientific techniques in archaeology certainly are not intended as a summary of all the extraordinary applications now being made, but rather as reminiscences of my own involvement over the past 25 years. With the establishment of the Museum Applied Science Center for Archaeology (MASCA) at the University Museum in Philadelphia in 1961, the development of such techniques became my major professional concern.

Most archaeologists first became aware of the possibilities of applying scientific technology to archaeology with the discovery of radiocarbon dating after the Second World War. In my own case the effect was profound and somewhat upsetting. The chemist Aristide de Grosse, who had previously postulated the existence of "cosmic radio-elements," came into the Museum sometime in 1948 to ask for a large piece of Egyptian wood which could be dated with considerable accuracy through traditional methods. He explained, in terms which were then completely unintelligible to me, his isolation of carbon 13 in Baltimore sewer gas—to be used in medical research. Soon afterwards, he and Willard Libby from the University of Chicago joined forces; Libby suggested they search for natural carbon 14 (hereafter C14), a radioactive isotope which might be used in dating organic materials. Later, some archaeologists met with them at the Wenner-Gren Foundation to discuss funds and the search for organic materials of known age. Four of us spent the next several years turning up such materials for experiments in Libby's nuclear laboratories. The upsetting part came when I turned in some wooden objects from a site where I had worked in the Arctic and received a date nearly a thousand years later than expected.

We did not know then that the measured value of the half-life of C14 was incorrect, that humic acid in the soil affected samples, that there would be methods of counting more efficiently than with solid carbon counters and that the ratio of C14 and C12 in the atmosphere and the oceans had not remained constant throughout the ages. All these problems were to occupy scores of C14 laboratories through the next 20 years and still do at the present time. Moreover, the two worlds of science and the humanities have had their problems of communication. In the early days when we were rather desperately trying to find organic materials of known age to test the theory of C14 dating, some of the archaeologists coyly urged that we give the laboratory misdated objects just to see if the gadget really worked! More recently, when it was discovered that the C14 inventory in the air and the oceans had shifted over the past several millennia and it was announced that all radiocarbon dates older than at least 1000 B.C. must be corrected, there were some who interpreted this to mean that C14 was now discredited.

Actually, I suppose, archaeologists expect too much of the "hard" sciences. We have learned that radiocarbon dating is a highly complex business, based to a large extent upon probabilities (with which we are so familiar in archaeological interpretations) and not yet free of unpredictable "bugs." Let us imagine for a moment that an archaeologist a thousand years hence is attempting to date the ruins of a burned house in New England. He finds objects which clearly date the house sometime in the twentieth century. But in collecting charcoal from the ruins he inadvertently takes a sample from antique paneling made in the colonial period. His C14 dates are then two or three hundred years earlier than he would expect. If that particular piece of paneling happened to come from the inner part of a two-hundred-year-old tree, he would have a date four or five hundred years older than expected. In addition, the enrichment of atmospheric C14 from nuclear explosions and the previous depletion due to the increase in "dead" carbon dioxide as the result of burning fossil fuels since about 1850 would also figure in the C14 reading. Perhaps even the amount of C14 in the atmosphere, changed by some magnetic phenomenon, would affect his date. Actually this hypothetical example of the future happens all the time today when we are trying to establish an absolute date for an archaeological deposit. Clearly, one way to avoid a gross error is to run analyses on several samples from the same deposit and to make all the corrections now known to be necessary. If four samples correspond closely and a fifth is far out of line, it is reasonable to assume that the four give you the actual date.

The most recent upsetting discovery about the C14 method is that fluctuations of C14 have taken place in the air and oceans. This was first called to our attention by the inconsistency between Egyptian archaeological dates and C14 dates for Egyptian materials. Libby had assumed in the beginning that this factor had remained constant. Today calculation of these fluctuations can be made with considerable accuracy up to 7,000 years ago because of the detailed analysis of tree rings from the long-lived bristlecone pines. At the Laboratory of Tree-Ring Research in Tucson, Arizona, C. W. Ferguson has established a master chronology, using living trees of an age in excess of 4,000 years and preserved bristlecone pine logs from the forest floor which overlap the living

trees in age. This 7,000-year tree-growth record, marking each separate year through seven millennia, makes it possible to check the actual C14 values throughout that span of time and thus to produce a fairly precise correction factor for any C14 date. Elizabeth Ralph and Henry Michael of MASCA have recently published charts of the necessary corrections, which can be utilized in correcting all published dates within the time range of the bristlecone pines (see *MASCA Newsletter* 9:1[1973]). Most significant are the dates for the Bronze Age and Neolithic period, before 1000 B.C.; in conventional dating they range from one to seven hundred years too late. The date for the Early Bronze Age (Troy I period) at Chios, Greece, for example, should read 2560 B.C. and not 2150 B.C. as it now appears in the literature.

Unfortunately, there is as yet no tree-ring record against which to check C14 fluctuations prior to 5400 B.C. (The range, however, is being extended slowly each year.) The specific causes for these variations are still subject to argument, but it is possible that prior to 6000 B.C., the divergence between true and C14 dates will decrease until they equalize at the end of the Ice Age.

One episode in radiocarbon dating may highlight the effect of the recent correction factors and the difficult communications between archaeologists and scientists. A conference of vulcanologists, geologists and archaeologists met on the Island of Thera (Santorini) in 1969 to correlate the volcanic explosion of that island with the end of the Minoan period. Several radiocarbon dates on organic materials in cores, taken from the sea bottom, presumably dated the ash fall from the explosion. Burned beams from the Late Minoan site, buried under the debris from that last great eruption, had also been dated by the radiocarbon method. The majority of these dates, both from the sea bottom and the Minoan site, pointed to about 1500 B.C. as the time of the eruption. Professor Marinatos and several other archaeologists were satisfied with the date for the Late Minoan period represented by the buried Minoan settlement. Unfortunately a C14 conference in Sweden, only a few weeks prior to the Santorini meeting, accepted the proof of C14 fluctuations in the biosphere and the need for correction factors. This meant that the "acceptable" 1500 B.C. date should be corrected to read about 1700 B.C., a correction which played havoc with all the archaeological theories about the date of the Late Minoan period.

In attempting to explain the reality of the correction factors, I referred to the Egyptian chronology, the astronomically fixed dates in that chronology that had played such an important role in revising our ideas about radiocarbon dating, and the uncertainty of other Egyptian archaeological dates based upon king lists, inscriptions and other archaeological data. Claude Shaeffer, in a very amusing commentary, observed that we seemed to have used the Egyptian chronology to correct radiocarbon dating and then turned about and tried to correct the Egyptian chronology with C14 dating! Actually, of course, it is not the Egyptian material, but the tree-ring records which have made it possible to work out the correction factors. As for the age of the Minoan site, our C14 dates were obtained from charcoal in burned house beams; they could easily be from trees living two hundred years before the destruction. More recently we have run C14 analyses on short-lived organic materials, such as grain, that now give us dates from the transitional Minoan period of Thera between MM III and LM I of about 1600 B.C. after all corrections are made.

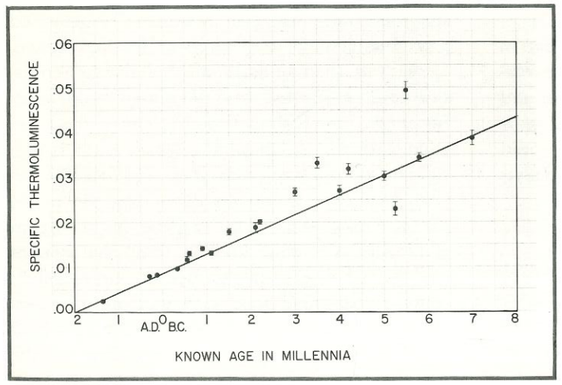
Since the discovery of the radiocarbon-dating technique, eight or nine other atomic or nuclear methods of dating have been, or are in the process of being, worked out. Potassium-Argon, Fission-Track, Uranium and Lead Isotopes and Thermoluminescence (abbreviated TL) methods are the best known. TL is applied most specifically to archaeology, while other methods are applied more to geology or earth history. MASCA and the Research Laboratory for Archaeology at Oxford have been perfecting the TL technique during the past ten years. Elizabeth Ralph and Mark Han of MASCA finally worked out a successful system applicable to archaeological dating, which was first described in *Nature* in 1966. But as in the case of C14, refinement and improvement still continue. It is not my intention here to enter into the technical details of all these various new techniques, but since TL is just now beginning to be accepted as a reliable method and applies to pottery, that mainstay of archaeological interpretation, a brief description may be useful.

The TL method measures the amount of accumulated radioactive damage that takes place (through internal bombardment by alpha, beta and gamma rays) in clay artifacts after firing. To establish a date for the remains of pottery, bricks, tiles or any other fired clay object, one grinds

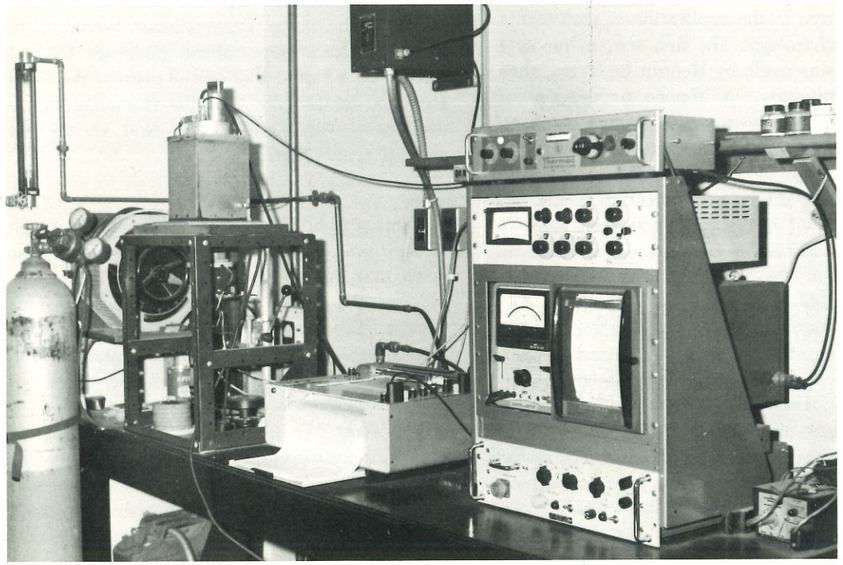
fragments of the artifact to a fine powder and then heats this rapidly so that the released photons can be detected by a photomultiplying device. The resulting glow curve indicates the accumulated radioactive damage since the original manufacture of the object. In general, the older the pottery, the greater thermoluminescence or glow that is recorded.

As with all nuclear clocks, however, there are problems. Tests must be made to determine the original radioactive content of the clay; samples must be bombarded with fixed amounts of x-rays to measure susceptibility to radiation damage, and several samples from each object must be utilized to obtain a reasonably accurate date. Furthermore, thermoluminescence gives a date for only the last firing (above 400°C); if the pottery has been reheated for some reason, the TL date will be too late. Exposure of the pottery to x-rays before measurement of its natural TL will render the technique useless. Despite these difficulties, we can at present use this method to fix, with some accuracy, cultures or events back to the time of the development of ceramics.

As indicated on the accompanying graph, correlation between TL dates and known dates are good, and TL dating may eventually approach the accuracy of C14 dating. It will be apparent



Graph correlating known dates and specific dates obtained by thermoluminescence. The sloping line represents exact correspondence between the two.



Glow curve apparatus to make thermoluminescent tests.

that TL eliminates one great source of error, that is, the inevitable difficulty of being sure that the organic material dated is actually the same age as the archaeological culture or deposit for which a date is sought. Moreover, the system is not plagued by the shift in atmospheric C14 and may thus help to refine the C14 system.

In effect, all these atomic and nuclear methods of dating will potentially cover the entire period of man's life on earth as well as the age of the earth itself. Increasingly, one system checks another so that confidence and certainty increase. All of us in archaeology are now aware of the revolutionary effect upon the whole chronology of human history. One need only mention the correction in our ideas about the end of the Ice Age, the origins of agriculture, the beginnings of ceramic-making (now apparently much older in the Far East than in the Near East) and the relative ages of cultural development in the new and old worlds. Experience over the past 20 years argues in favor of much greater accuracy and more refined methods to come in the next generation.

Electrical instruments for underground search were first brought to my attention in Alaska before the Second World War, where Professor Joesting was experimenting with resistance apparatus in gold prospecting. Just after the war, Paul Fejos of the Wenner-Gren Foundation became interested in the application of such equipment to archaeology. The first test, so far as I remember, was made by Helmut de Terra, then at Yale University, in Mexico at the site of Tepectepan. Such instruments did not catch on with American archaeologists, and I next ran into their application by Professor Case, at Oxford, who was using similar equipment to locate pits and trenches of the Bronze and Iron Ages in Britain. His success encouraged me to make an experiment in the Olmec country of eastern Mexico in 1960.

The famous Precolumbian archaeologist Matthew Sterling, his son and I obtained a commercial electrical resistance instrument manufactured in Minnesota and spent two or three weeks at Cerro de las Mesas, where Sterling had excavated many years earlier. Fortunately, young Matthew was a hi-fi buff and knew something about electronics. Our first "strike" was a large, carved stone stele buried under the alluvial soils of the plain, and, of course, we were elated with this first success. Unfortunately, after it was fully uncovered Mat suddenly realized he had excavated the same monument and published it 14 years before. We did, however, detect not only the stairway buried under the surface of one of the many earth mounds at the site, but other "anomalies" which convinced us that the instrument had promise for that kind of archaeological search.

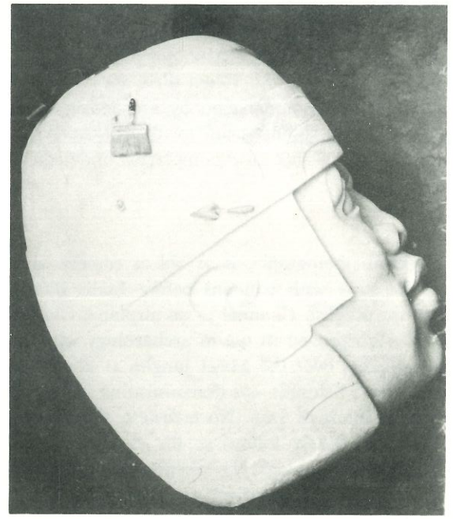
Meanwhile E. T. Hall and M. J. Aitken, at Oxford, had developed the proton magnetometer specifically for archaeology and were demonstrating its success at sites in England. In 1961, the architect Aubrey Trik, the physicist Richard Linnington and I joined the engineer Carlo Lerici and his crew at Tarquinia with a very small resistance instrument made in Germany and a proton magnetometer made by Hall and Aitken. Lerici was then utilizing an Italian-made resistance instrument to locate the buried ramps leading down into Etruscan tombs (cut in the limestone bedrock at Tarquinia) which made it possible to spot the tomb chambers. He had also developed the periscope for examining the tombs without excavation. The surprise for all of us came when we found that the tomb chambers as well as the ramps showed up on our magnetic contour maps. We were soon locating up to six Etruscan tombs each day, and for me that kind of routine survey became boring. But, at the Etruscan acropolis of Tarquinia, Franco Brancaleoni and I learned that we could spot buried stone walls with the magnetometer. We began to cast about for a more difficult challenge. He had discovered a buried wall on the plain of the Crati River in south Italy with his resistance equipment and, with Lerici, urged that we try our new apparatus there.

That search, beginning in 1961, was to result in eight years of trial and error, failures and false starts, then final success in the discovery and mapping of the buried remains of Archaic Greek Sybaris. The Archaic level lay from 4.5 to 6.5 meters beneath the present surface, and we soon learned that the proton magnetometer could not detect structures which were more than 2 to 3 meters deep. We then experimented with sonic devices in collaboration with Texas Instruments and Petty Geophysical Company but did not succeed in designing a suitable portable instrument employing sonic frequencies. We turned next to Varian Associates in Palo Alto to develop a



Cesium magnetometer with precision readout in use at San Lorenzo, Mexico.

more sensitive instrument. Shelly Breiner and Beth Ralph, working in the field, and design engineers at Varian with their capable technician Dean Smith produced the cesium magnetometer which finally solved our problem. Limestone walls with concentrations of roof tiles lying up to six meters deep could be located with this much more sensitive instrument. Moreover, magnetic contour mapping became so rapid that we could cover up to five hectares a day. Although individual buildings could, at times, be recognized in the Sybaris ruins (six kilometers in circumference), we learned from test excavations that destruction of the city in the sixth century B.C. had left little of the structures so that we could not map streets or a city plan. That was to come later at Elis in Greece where Beth Ralph with the cesium magnetometer succeeded in that kind of detailed underground mapping. A circle was closed for me in experiments with magnetometers when I returned with the archaeologist Michael Coe to the Olmec Country in Mexico in 1968 to search for buried Olmec monuments at San Lorenzo. There could be no more dramatic example of the magnetometer's effectiveness in archaeology. Extraordinary stone carvings, some weighing several tons and transported for about 70 kilometers, turned out to be magnetic. The alluvial soil in which they are buried is magnetically "quiet," and hence spotting them with the cesium magnetometer is the straightforward business of



Olmec head found with cesium magnetometer at San Lorenzo, Mexico.

charting their location on a magnetic contour map. Seventeen monuments were discovered where they were not expected, that is, not on the ridges where Coe had discovered many fragments. Moreover, one colossal head, found five meters beneath the surface, was in mint condition.

This false-color composite photograph, made from multispectral imagery, was taken by NASA's Earth Resources Technology Satellite (ERTS-1), on August 22, 1972, orbit 134, from an altitude approximately 900 km. over southern Greece. The area of 32,000 square kilometers encompassed by this image extends from the Gulf of Corinth in the northwest to the Gulf of Laconia, on the southeast coast of the Peloponnesos. Athens, the capital of Greece, with its population of 627,000 can be seen to the northeast. The great seaport of Piraeus lies southwest of Athens on the Saronic Gulf. Subtle shades of blue in the seas surrounding Greece represent varying water depths. West-southwest of Athens the Corinth Canal can be seen connecting the Saronic Gulf and the Gulf of Corinth. Greece is so mountainous and its soil has been so eroded that only about one quarter of the country is arable, a condition shown by the lack of red which, on such composites, indicates the green of vegetation. In addition, the hot, dry Greek summers are reflected in the sere aspect of the image. On the Peloponnesos vineyards along the southern shore of the Gulf of Corinth are visible. Forested areas can be perceived in only a few restricted areas at higher elevations. The paucity of surface reservoirs and streams is also striking.

Magnetometers have now been used at scores of sites all over the world, towed along the sea bottom and flown low over the sea to locate wrecks. They have been of great help in saving archaeological sites from destruction, but treasure hunters also use them to discover and loot rich concentrations of remains, such as Spanish wrecks off the coast of Florida. In volcanic areas and other rocky sites where there is either too much or too little magnetism they are not useful, but on alluvial soils where there are deeply buried remains they are indispensable for any large-scale systematic excavations. When their use and operation are better understood by archaeologists in general, they should lead to the discovery of archaeological sites now completely undetected.

Aerial photography is as old as cameras and got its start with balloons before Louis Blériot flew the English Channel in an airplane. Charles Lindbergh proved its use in archaeology with his early flights over the Maya jungles at about the time Erich Schmidt was demonstrating its use on the grasslands of Iran. Nevertheless, the technological explosion following the Second World War and the photographs taken by the spy planes of the 1960's have given archaeological search from the air a new dimension. Moreover, high-resolution photography from satellites, such as the Gemini series, has led to a new burst of interest in remote sensing which now culminates in the Earth Resources Technology Satellite recently launched by the United States Department of the Interior and NASA. My own introduction to these new aerial sensing devices came through Ambassador Frederich Rheinhardt, in Rome, who had taken a personal interest in the long search for Sybaris. A United States Air Force team making an aerial study of volcanic areas in Italy and Libya also arranged, through the Embassy, to experiment with a multiband camera and an infrared sensing device over the plain of the Crati River where we expected the ruins of Sybaris to be. There were no positive results from that attempt, presumably because the remains lay at such depth and under the water table, but a high school student in Washington, D.C. read of the experiment and mentioned it to his father, who happened to be William Pecora, Director of the United States Geological Survey and the man responsible for the planned Earth Resources Technology Satellite. When he called to suggest I come to Washington to discuss the possibility of archaeological surveys from a satellite, I could hardly take it seriously. But two hours with remote sensing experts from the Department of the Interior and NASA were sufficient to convince me. The satellite is now circling the earth every 103 minutes, and Bruce Bevan of MASCA has proposed various tests, for example, the detection of ancient water courses, which could guide normal aerial photography as to the optimum time for archaeological survey in any given area. Certain growth conditions, times of day, seasons or general moisture content permit an ancient water course to be "seen" more clearly. The same conditions would determine the optimum time for archaeological photography in that area.

A recent report by P. S. Klass explains that early returns from the earth resources spacecraft are better than predicted. So that archaeologists may get an idea of the future possibilities in this field, here are some of the reported findings. Images transmitted from the spacecraft now make it possible to spot: a road only ten meters wide on the band five (red) scanner image; ponds only 92 meters in diameter, all from a height of nearly 965 kilometers; the types of



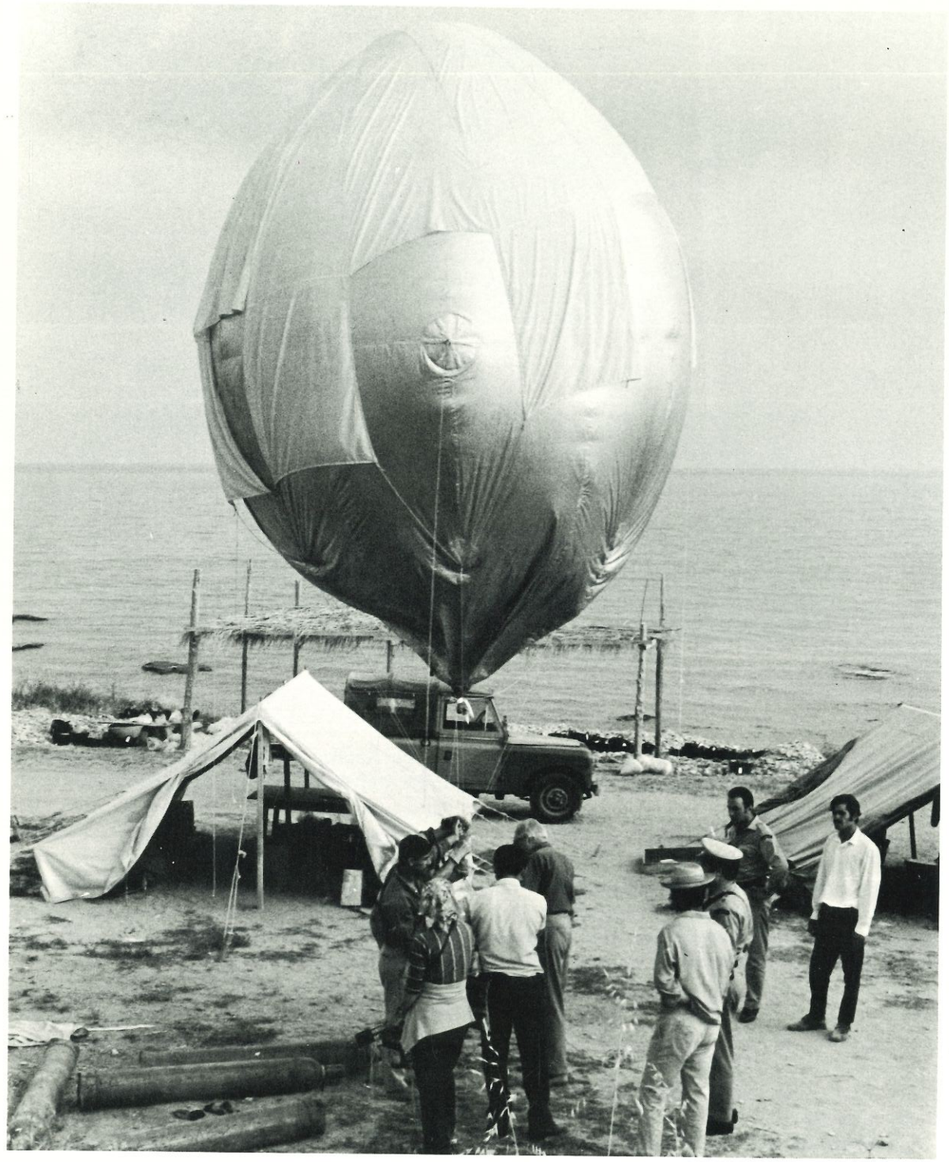
agricultural crops (barley, wheat, sugar beets, etc.); separate fields of only eight hectares; a probable invasion of the Red Tide (plankton which affect shellfish); ice conditions all over the Arctic; the total settlement pattern of Rhode Island as well as clear and turbid waters in oceans, rivers and lakes. With images of such resolution now being transmitted from outer space, surely we should eventually be able to "see" ancient settlement patterns (such as the limit of Roman cultivation in Britain), earthworks, ancient roads and, perhaps, long-abandoned canal and irrigation systems.

The advantage of combining aerial surveys with instrument surveys on the ground was demonstrated recently for us at a Roman site near Kingscote, England. John Hampton of the Royal Commission on Historical Monuments and I had organized an experiment with various types of aerial films at several well-known archaeological sites where excavations and earlier aerial photographs gave us a detailed knowledge of the correlation between images and excavated remains. This project was part of a long-range plan to test new sensing techniques on well-documented sites. At Kingscote a technique enhancing contrasts on aerial photographs accentuated a very faint linear feature, which was possibly an indication of a Roman road leading to the site. To test this we did an instrument survey on the ground with a cesium sensor and a new audio readout. One very foggy day two operators (who were, incidentally, musicians) picked up a peculiar series of pulses or beats on the audio equipment in the open field outside the area of concentrated Roman ruins. They found the same tonal pattern in a series of parallel sweeps across the field and marked out (with bamboo canes) a long, linear anomaly, which might be the road. But then, with a worried expression, Hampton pointed out that it did not correspond exactly with the dim feature on his aerial photos. We groped about in the fog trying to fix base points and sight lines. The fog was so thick that the operators fell back on the curious series of tonal pulses in order to find their way back to our base points. When the fog lifted, Hampton realized that he also had been lost. The aerial anomaly actually did correlate with the line of curious pulses worked out with the magnetometer. Subsequent excavation showed that our anomaly was the Roman road with ditches on each side. M. J. Aitken had joined us that day, and both of us were satisfied that one did not have to be a musician to detect the tonal pattern.

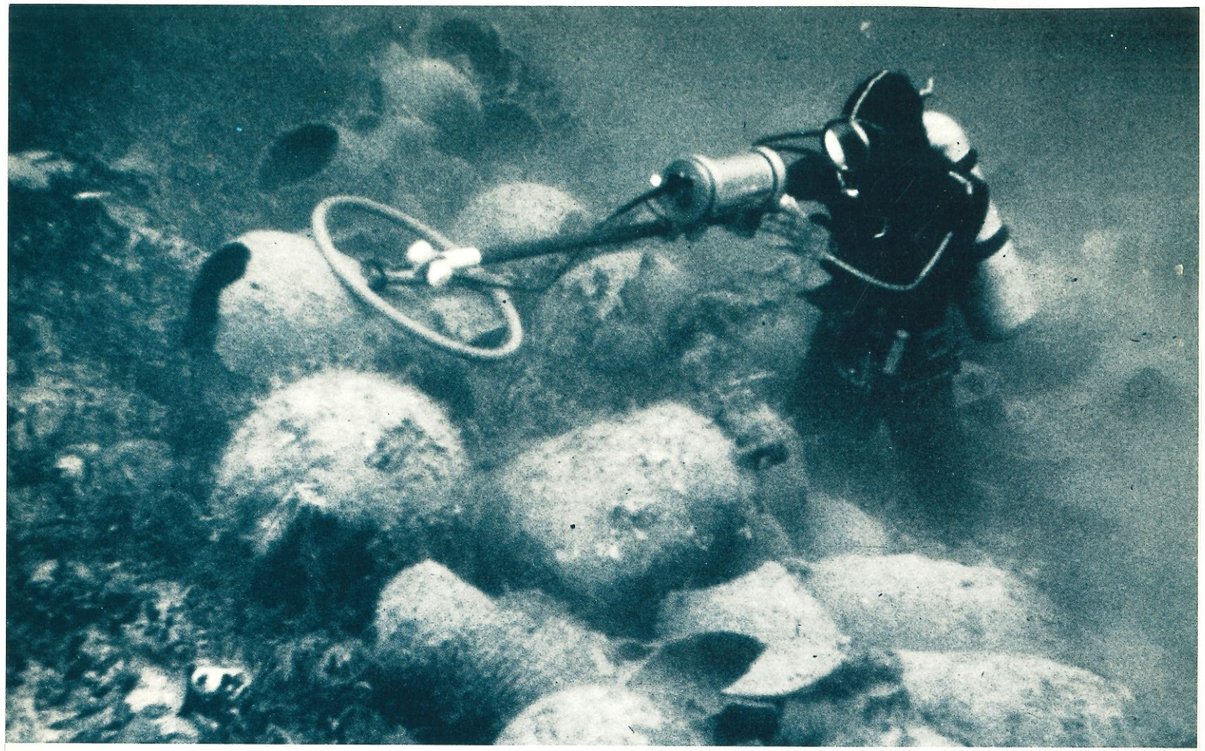
Aerial photography returns to its beginning with balloons these days as the architect Julian Whittlesey continues to demonstrate their value in the recording and mapping of archaeological sites. A hot-air balloon large enough to carry two persons and cameras, hydrogen balloons that carry radio-operated cameras and airfoils, something like wing-shaped kites, that carry ground-operated cameras are all part of Whittlesey's equipment. The balloons are normally tethered over a known archaeological site, but they also can be towed by a land rover or a boat in search of sites. For experiments with different films, such as infrared, the balloons are naturally much less expensive than aircraft. They have also been used to test cameras for aircraft. Photographs taken at 50 to 500 meters over sites, like Sarepta in Lebanon, serve as a perfect ground plan of excavated structures.

Fenimore Johnston, one of the Board of Managers of the University Museum, first called my attention to underwater archaeology in 1948. That was well before scuba equipment and Jacques Cousteau had turned weekend crowds of divers onto wrecks in many oceans, lakes and rivers. Johnston was then building underwater cameras for the Navy, following the introduction of frog men and leech explosives, primarily by the Italians during the Second World War. He came into the office one day with a Naval officer to propose that we begin undersea research in the Mediterranean. However, it was clear at once that we could do it then with only professional divers. The Navy was not prepared to finance the experiment, and the daily cost of a professional diver was far beyond the research budget of the Museum. The Navy officer laughingly suggested that the only feasible economic plan for us was to train Ph.D.'s to dive. None of us guessed at that time that George Bass would do precisely that many years later.

Hydrogen balloon in use at Sarepta, Lebanon.



Rodney Young, head of our Mediterranean section, was just as interested as I in the possibilities of the new field, and by the late 1950's we had found Peter Throckmorton who launched our first attempt off the coast of Turkey. As a graduate student in Rodney's department of Classical Archaeology, George Bass learned to use scuba equipment in Philadelphia's YMCA pool, got his baptism in actual undersea archaeology with Throckmorton and then began his systematic development of expert undersea excavation which was to turn the work into an acceptable academic profession. Between 1960 and 1970 Bass devised a grid system for map-



Metal detector in use over Late Roman shipwreck at Yassi Ada off the coast of Turkey.
The wreck was found at a depth of 50 meters.

ping wrecks, using an airlift for excavation, balloons for lifting heavy materials, a tow-line for underwater exploration, a "telephone booth" (a plastic dome with an air bubble, anchored on the bottom to give the divers rest and security in a pinch), underwater television, stereoscopic cameras for mapping, the two-man submarine the *Asherah* and side-scanning sonar. The culmination of this period of technical development came in the late 1960's when the crew managed to locate a deep wreck off the Turkish coast with the new side-scanning sonar and then, for examination, to descend to it in the *Asherah* reaching the wreck precisely on target—no mean achievement in the open sea.

Unfortunately, all these techniques created for the professionals can also be used by amateurs. Today, one of our most critical problems is the systematic looting and destruction of ancient wrecks all over the world. Some countries manage to protect their unique undersea deposits of priceless historic materials, others do not, and probably in the long run, most can be saved only through great expansion of systematic excavation by trained archaeologists.

The Applied Science Center for Archaeology at the University Museum has concentrated upon dating and exploration techniques, while the other similar center at Oxford has concentrated on exploration and TL dating as well as some of the new techniques for analysis and identification of material. Many other centers in the United States and abroad are developing and using the new analytical techniques.

There is now a whole battery of new methods for measuring very small quantities of a great many elements. When the concentrations are less than 0.01 percent, they are then referred to as "trace" elements. The patterns of concentration of such elements can be utilized as a "fingerprint." One of the most dramatic uses of such fingerprinting in archaeology is to determine the source of the raw material for certain artifacts (for example, the various sources of obsidian used for tools in the Mediterranean) and thus to learn something about trade relations and communications in the prehistoric period. Already this kind of study has shown that seaborne and overland communications in the Stone Age were much more extensive than most of us had

imagined. This rapidly expanding study of trace elements in archaeological materials will probably lead away from the conventional reliance upon stylistic types (subjective at best) for the reconstruction of cultural connections to more objective conclusions about cultural diffusion in general.

A new order of chemistry, also developing over the past generation, is just beginning to have impact upon the conservation of materials both in the field and in the laboratory. My own interest in this came about as a matter of necessity when Rodney Young discovered the famous tomb in the great tumulus at Gordion and, somewhat later, when George Bass began to recover parts of ancient wrecks off the coast of Turkey. In both cases ancient water-soaked wood had to be treated in the field to preserve it. We were then alerted to the need for emergency methods in the field and also to the new methods which could be applied. The extraordinary job of preserving the *Vasa* in Sweden is now well known, but I have the impression that the problem there generated many current experiments and that improved methods are in the making. MASCA also has been involved in experiments with the preservation of mud brick in the field, particularly in Iraq and Iran, where the problem of conserving vast blocks of excavated mud-brick buildings is of particular concern. Several years ago, the archaeologists Teresa Carter and David Crownover tried to pump an inexpensive chemical into the standing walls at Tel el Rimah near Mosul. In the laboratory the chemicals were effective, but when applied in the field, penetration was so shallow that the surface flaked away. At the present moment the chemist Darrel Butterbaugh is experimenting at MASCA with new polymers with promising results, but the real test will come with large-scale experiments in the field.

Judging from the past 20 years, and even from the past two or three years, there are many unforeseeable techniques just over the horizon. I am reminded of the planning board for the 21st Century Exhibition and two of its most creative members. One predicted with assurance that within six or seven years (that was in 1961) all vehicles on our highways would be powered by electricity. Another was quite certain that biochemical knowledge of the cell and the gene would mean the end of aging in human beings within the next decade. On the other hand, another member reminded us that in 1937 a similar group had failed to predict atomic energy, antibiotics and jet propulsion. In archaeology I am also reminded of my early years in graduate school when those who claimed men and mammoth as contemporaries in America were considered by the more conservative to be crackpots. Certainly technology and its rate of growth should convince all of us to keep an open mind.

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Asians led way into Bronze Age

SPOKANE, Wash. (AP) — The Bronze Age started in Southeast Asia some 2,000-years before it started in the Middle East, a leading archaeologist says.

Dr. Cary W. Carriveau of the University of Pennsylvania accompanied a joint excavation in northeastern Thailand last year. He said he was one of 15 men chosen for the project because of his background in archaeometry — the study of dating and elemental analysis of artifacts — and in prehistoric metallurgy studies.

"Up to last year, it was thought the birth of Bronze Age metallurgy was in the Middle East and dated 2,500 B.C.," he said during a recent visit to Spokane.

"In our excavation last year and through analysis of ceramic materials in association with bronze, we have evidence that there were bronze artifacts 2,000 years before that date."

All indications from the expedition change the birth place of the Bronze Age from the Middle East to Southeast Asia, Carriveau said.

The Bronze Age falls between two other prehistoric eras — the Stone Age and the Iron Age — and marks man's transition from using stone tools to making and using more sophisticated implements.

Carriveau said expeditions this year have discovered similar bronze artifacts which may be even older than those found last year.

"The exciting thing found in this year's work were other bronze artifacts three meters below the excavating level at which we thought were the oldest artifacts," he said.

While Carriveau said he hesitates to call his group's specimens the oldest bronze artifacts in the world, he said he feels they are the oldest "any one has excavated and discovered."

"Because we have pushed the Bronze Age back at least 2,000 years, our discovery should cause a rethinking between anthropologists and archaeologists regarding the time and birthplace of the Bronze Age," he said.

Carriveau said he will return to Thailand next year to develop a training program for Thai students in dating and analyzing archaeological discoveries.

The El Paso Times
EL PASO, TEXAS
D. 64,042 SUN. 95,352

JN 23 1974 Bufkin

Ancient Tramp Ship Soon To Go On Display

By STEVEN V. ROBERTS
© 1974 New York Times News Service

KYRENIA, Cyprus — About 00 years ago, a tramp erchant ship set off on a rney through the Eastern editerranean, stopping at ch islands as Samos, Kos and iodes, trading in oil and wine, illstones and almonds.

Less than two miles outside s port on the north coast of prus, the ship sank in 100 feet water, probably while trying ride out a storm.

A bit off schedule the old tramp has finally made it to Kyrenia. Unearthed from the sea floor by a team of archeologists, she is the oldest vessel ever recovered from underwater, and the second oldest known to survive from antiquity, according to Michael L. Katsev, the director of the excavation. The older one is a Nile River boat found in the Great Pyramid of Cheops.

After seven years of work, this "time capsule," as Katsev calls it is going on public display soon, with air-conditioning to preserve the wood. The setting will be the former barracks room of a Crusaders' castle that has guarded the entrance to this lovely harbor since A.D. 1200.

The worm-eaten, weather-beaten skeleton still bears the mark of a skilled and dedicated craftsman. "He built it to last," said the archeologist, gazing up at the wide-bottomed hull, curving gracefully, almost languidly, toward the barrel-vaulted ceiling of the castle. "He built it with his name on it. He was saying, this is my work, and I'm proud of it."

The resurrection of this "giant jigsaw puzzle" began in 1965, when a local sponge diver noticed a large cache of amphorae embedded in the bottom. Katsev, a doctoral candidate at the University of Pennsylvania, and his wife, Susan, a sculptor and draftsman, met on an earlier underwater excavation in Turkey. They came to Cyprus in 1967 looking for a promising wreck, and were told about the vases.

Extensive surveys convinced the Katsevs that the find was worth pursuing, and they went back to the United States to raise money and recruit a team. The total cost of about $350,000 has been borne mainly by the National Geographic Society, the National Endowment for the Humanities, the Cyprus Mines Corporation and the Cook Foundation.

After digging away five feet of sand, the explorers mapped every fragment, exactly as they found it. One problem was an octopus that lived in one of the amphorae and kept moving the small pieces around.

The vessel was cut into sections and brought to the surface in 1969. The water had eaten away the cellulose inside the wood, leaving mainly an outer shell with the consistency of "wet cardboard." When it dried, it disintegrated.

The wood was kept wet in large tanks, while the team worked out a process of bathing each piece in solution of polyethylene glycol. Slowly the chemical penetrated the wood, giving it a new inner substance. Some large pieces took tw years to stabilize.

Although about 75 per cent the craft was preserved several key structural piece were missing, and the cre made several models, trying t determine the exact shape an angle of the hull.

When they finally got it righ the workmen knit the piece together with stainless ste wire. It was a painstakin process.

The 45-foot hull rests on iro scaffolding, but little wa added to the craft itself. Sh remains as she was fou d—wood black, edges jagged, ghost ship carrying a cargo time.

The team is also making small copy of a section of th hull to display in a natur setting some of the 400 am phorae and other object recovered from the ship — few bronze coins, cookware an utensils for the crew of fou and 9,323 rather tastele almonds.

This article received wide attention.

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THE JERSEY JOURNAL
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JUL 15 1974

...Thai village ...holds clues to ... Bronze Age

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By ROBERT KAYLOR

BAN CHIENG, Thailand (UPI) - This isolated farm village holds clues to what may be the world's oldest Bronze Age culture, but archeologists working here often find themselves frustrated by treasure seekers who have plundered the earth in search of ...profits.

Beneath the dusty brown soil ...lie finds of Ban Chieng pottery, a distinctive style of white earthenware with delicate swirls of red-painted decoration.

More than 60 centuries old, Ban Chieng pieces have become sought-after items among collectors around the world.

The existence of the pottery was known to Thai authorities 20 years ago, but it didn't receive much attention at the time. Villagers were using pots they found in the ground to hold swill for their hogs.

Then, in 1967, some of the pots were sent to the University of Pennsylvania, who started a dated by the newly developed thermoluminescence process. The dates ranged from 3...

CHICAGO
SUN-TIMES
D. 536,103 SUN. 709,123

JUL 19 1974

Bronze Age pottery find a gold mine for Thais

BAN CHIENG, Thailand (UPI) — This isolated farm village holds clues to what may be the world's oldest Bronze Age culture, but archeologists working here often find themselves frustrated by treasure-seekers who have plundered the earth in search of profits.

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Then, in 1967, some of the pots were sent to the University of Pennsylvania, who started a dated by the newly developed thermoluminescence process. The dates ranged from 3550 to ...

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...Working through layers of soil 10 to 15 feet deep, Gorman and Pisit have progressed past the red and ...

...uncover a form of polished black earthenware that pron... ...ses to be even older.

...Despite the fact that much of the best material is gone, ...rms of tourists have des... ...d on Ban Chieng in re... ...nths in hopes of getting ...e souvenir. "On some ...we get busloads of ...d Gorman. A brisk ...fake pottery has ...

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Sexism in Religion Traced to Ancient Male Chauvinists

A Philadelphia expert on ancient Mesopotamian literature says male chauvinist theologians 2,000 years before Christ may have deliberately molded the masculine image of God now at the center of monotheistic religion.

This thesis was propounded by Dr. Samuel Noah Kramer, retired curator of the tablet collection at the University Museum, 33d and Spruce sts., Philadelphia, in a report to the 23d International Meeting of Assyriologists in Rome.

Dr. Kramer told delegates that "what may well have been male chauvinist predilections" among theologians in ancient Sumer gradually forced once-powerful female deities down the hierarchical ladder to the point where the advent of monotheism could kill them off.

He said he found this evidence in a reexamination of a number of texts.

Women's Rights Declined

Kramer said this downgrading of female gods coincided with the deterioration of the rights and position of women on the human plane, too.

"I only became interested in this facet of history by the efforts of modern women's lib organizations," Kramer said. "I was directly prompted by the work of women theologians who have been asking point-blank why God is all male."

Sumer, the parent society of Babylonia and considered by many to be "the cradle of civilization," existed until about 1750 B.C. In its literature and legends — inscribed on clay cuneiform tablets — also can be found roots of the Bible.

2d Class Citizens

In latter-day Sumerian society, Kramer said, "by and large women were treated as second-class citizens without power, prestige and status." But there are some indications, he added, that "in earlier days the sumarian woman may well have been man's equal socially and economically, at least among the ruling class."

Kramer said that after becoming interested in the question of the all maleness of the Judeo-Christian God, as opposed to the deities of both sexes in the preceding polytheistic societies, he reexamined texts specifically "looking for what they said about women."

In these connotations, Kramer said, "scholars have rarely ever thought about the positions of women or the female deities."

Changes Noted

He said he found evidence that women's position slipped considerably in the later Sumerian period, after 2000 B.C. Contemporary texts from the early period, before 2400 B.C., showed that women controlled property, ran businesses, were well-known in cultural and literary circles, were spiritual leaders, in some cases got equal pay for certain duties shared with men and, in very early times, could have more than one husband.

It was in the later period, when male dominance in secular society became more pronounced, that theologians' interpretations of the pantheistic hierarchy began to take on a similar tone.

Some Goddesses Worshiped

Not all female deities were "demoted" or discouraged in this time, according to Kramer, and female gods were worshiped until the end of the Sumerian period, and even into the Babylonian era.

But he found several of the more important goddesses were systematically pushed into the lower ranks of the pantheon, a seeming reflection of woman's decreasing role in earthly society.

But Kramer said the goddesses were much more successful in holding on to what position they had than were mortal women.

"The goddesses were not 'pushovers,'" he wrote. "More determined and aggressive than their human counterparts, they struggled to hold or regain at least part of their supremacy to the very end of Sumer's existence as a political entity (about 1750 B.C.)."

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Bourdeau

It took millions of years

Stone tools, skill, thought started growth of humans

A 401

By WILLIAM J. CROMIE

George Schaller and Gordon Lowther were trying to get their food the way men, or near-men, did three million years ago. They moved cautiously through high grass carpeting the Serengeti Plain in eastern Africa. The two tried to capture zebra, gazelles and rodents with their bare hands.

Their luck was good. They captured animals too young or sick to get away. The animals were released by the scientists, but their raw flesh would have sustained the ape-faced, small-brained, dwarflike "southern apes" most anthropologists believe were on the first rung of a five-million-year-long ladder leading to modern man.

The adventurous anthropologists could have made things easier for themselves by using sticks, clubs or stones, because recent evidence reveals that near-men were using these as long ago as 2.8 million years — when their brains were no larger than that of a chimp.

"What would be a mild blow with the fist becomes lethal with a rock in the hand," says anthropologist Sherwood Washburn. "It was the success of the simplest tools that started the whole trend of human evolution and led to the civilizations of today."

Schaller and Lowther observed that animals hunting in groups did much better than those who hunted alone. Any creatures clever enough to make stone tools must have hit on the technique of group hunting. This, in turn, stepped-up development of the brain by encouraging sharing and acting as a catalyst for the origin of speech.

"In the final analysis," says Harvard University's Irven DeVore, "it is language — and all of the symbolic forms in art, religion, science and social organization — that distinguishes man from other primates."

What is man? Scientists say — man is a tool-using, talking animal.

"In the last 25 years," says University of Pennsylvania anthropologist Anthony Wallace, "it has become apparent that tools, hunting, family-life and speech — in short, the possession of culture — forced man to develop a brain large enough to do the complex things he does today."

Sherwood Washburn adds that "it is probably more correct to think of our (physical) structure as the result of culture than it is to think of men anatomically like ourselves slowly developing culture."

Until fairly recently it was thought that man's brain developed first, then he discovered tools and rapidly evolved the new way of life that we call "human."



Field Enterprises Educational Corp.

Human-like hunter used stone weapons when his brain was still chimp-sized.

It was also believed that this development was a comparatively recent thing. In 1959, Washburn wrote: "Tools, hunting, fire, complex social life, speech and the human way evolved along with the brain to produce man of the genus Homo about a half million years ago." Discoveries since have pushed that date back as far as 3 million years ago.

"The brain evolved under the pressure of more complex social life until the species Homo sapiens appeared as recently as 50,000 years ago," Washburn continued. Today, anthropologists believe, men much like ourselves may have hunted extinct varieties of bison, horses and mammoths as long ago as 300,000 years.

Instead of getting up on their hind legs 500,000 years ago, humanlike creatures already walked erect three million years ago.

We don't know when men came down from the trees and began to walk upright," admits philosopher-anthropologist Loren C. Eiseley. "But once he got up, his forelimbs would become sense organs — organs of touch. Hands once used for tree-climbing and moving from branch to branch would make it easy to pick up sticks and stones."

Charles Darwin first advanced the idea that tool use is both the cause and effect of walking upright. Limited walking on two legs he felt, left the hands sufficiently free so sticks and stones could be used. The advantage that these gave near-man over other creatures led to more walking, and more efficient use of the tools.

The tool-using way of life spawned changes in the body, notably teeth, face, hands and brain. With tools for weapons, large, apelike canines were not needed for defense or killing game. The small humanlike teeth found in the ancient skulls of men-apes who roamed the open plains three million years ago bear this out.

Continued tool use produced a sensitive, powerful, skillful thumb not found in other animals. Areas of the brain that control the hand, especially the thumb, became tremendously enlarged.

"The brain seems to have doubled in size between ape-men and men," Washburn says. "It then appears to have increased much more slowly."

But man's brain is not just an enlarged ape brain. It's structure is vastly different. Great masses of it are devoted to memory, planning and language, faculties that made complex social life and technology possible.

Washburn sums it up this way: "The reason that the human brain makes the human way of life possible is that it is the result of that way of life."

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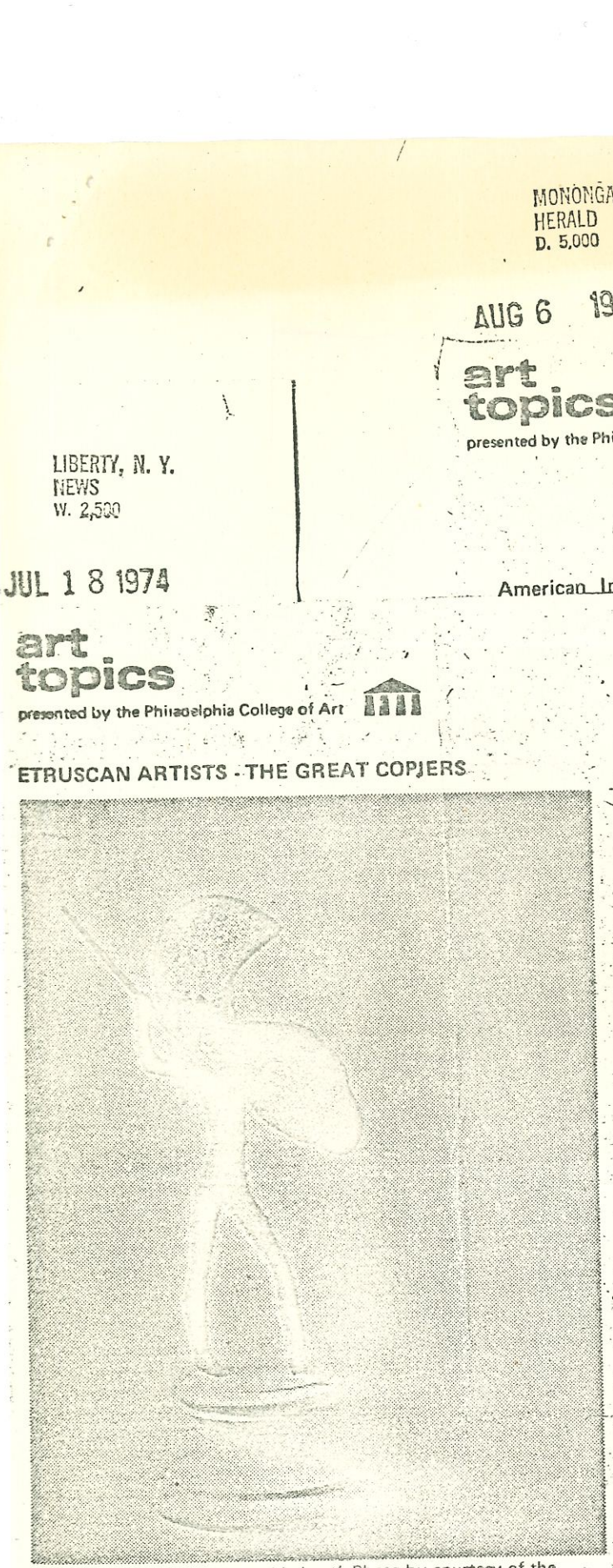
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art topics
presented by the Philadelphia College of Art

ETRUSCAN ARTISTS - THE GREAT COPJERS



'Warrior with shield, spear and helmet'. Photo by courtesy of the University Museum, University of Pennsylvania.

The civilization of a mysterious race of people called the Etruscans has continually fascinated archeologists and art historians. The civilization flourished for 600 years (700 to 100 B.C.) in Tuscany, a lush blend of mountains, valleys and beaches which extends in a triangular fashion from the west coast north of Rome, pointing inland across more than half the width of the Italian penisula.

The Etruscans were the first non-Greek people in Western Europe to develop a higher culture and although they copied much that was Greek, they combined Greek with Eastern culture and adapted it to their own traditions and genius. The Etruscan language which was the language of all the people, has not yet been deciphered, but the 10,000 inscriptions borrowed from the Greek alphabet have provided facts about this obscure race which emigrated from Smyrna in two groups, it is speculated, when famine devastated that near Eastern land.

At the height of its power, the states of the Etruscans extended from the Italian Alps in the north to the Sorrento peninsula in the south. There were 12 independent Etruscan cities. Their elaborate temples were adorned with terra cotta revetments and sculpture which reflected the Greek styles. Their homes had vestibules and atriums and the tombs of the aristocratic Etruscans were luxuriously appointed.

The Etruscans had what can be described as nothing less than a passion for Greek ceramics, especially the Attic vase. Their own metalwork was so outstanding that it was traded throughout the world, as evidenced by the finding of a 6th century cauldron in Sweden. Like the cauldron, the metal tripods, vases, helmets, lamps and incense stands were produced for utilitarian purposes. The carpentry and cabinet work was also exceptional and examples of elaborately carved furniture have been found in Etruscan tombs, along with colored pillows, mattresses and coverlets which hark back to that civilization's heyday.

Products of the 12 cities varied and reflected the preoccupations of their inhabitants. The tomb walls of Tarquinia are covered with painting depicting the sports of hunting and fishing, terra cotta burial urns in Capua have finely carved groups of figures on their lids. Cinerary urns found in Chuisia exhibit the practical nature of the people. One urn is in the form of a seated woman and the head is the stopper (removable). Other urns are in the form of mini-houses with the house door as the opening.

The fortunes of the Etruscans waned and they were forced to fight the Greeks, the Gauls and the Romans. They finally became pirates and by 241 B.C. the Roman ingress marked the end of Etruscan independence. This talented race again proved how adaptable they were by becoming latinized and adopting all the classic art forms of the Augustan Age.

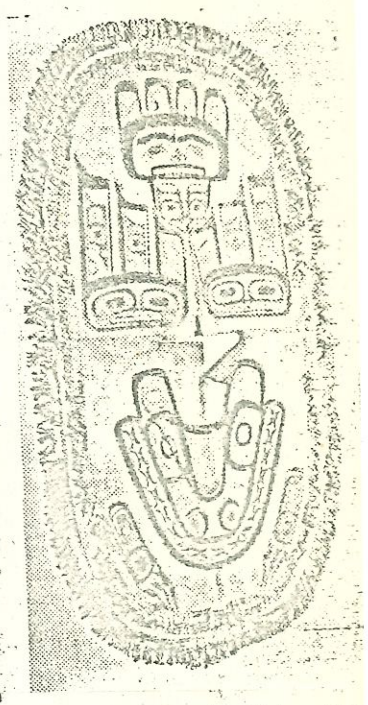
art topics
presented by the Philadelphia College of Art

AN ALMOST EXTINCT CULTURE - NORTHWEST COAST INDIAN LIFE AND ART

American Indian Art has "kenning" and can best be the use of est in other animals and eatures used ancestors by designed the nderbird and e Raven and ome of the s that were hwest Indian was another er creatures, derworld of ower and believed to m some re and the l rites and owers and anded down ation to

d wooden the Indians elished with ors, in this white from s, blue from r blue clay, per sulphide m mud and round up in dishes with mixed with provide an r to tempura graphite was d to give a k color and r mixed with ht vermillion s were made e hair bound d tapered to w point.

ptain Cook west coast in art of the st Indians had ected and according to alents of the th the arrival of the white man and the establishment of trading posts, the Indian culture gradually eroded and a population once estimated to be 50,000 to 60,000 is now less than 20,000. The largest collections of their art are in the Smithsonian Institution Washington, D. C.; th Museum of the Americar Indian, Hey Foundation N.Y.C., the Americar Museum of Natural History N.Y.C.; the Chicago Museun of Natural History, Chicago Ill., and several museums o the northwest coast of th United States and Canad including the Portland Ar Museum, Portland, Ore. an the Washington Stat Museum, University o Washington, Seattle, Wash.



Painted ceremonial hide shirt, Northwest Coast Tlingit Indians, The University Museum, University of Pennsylvania.

This column appears in 800 papers.

HIBBING, MINN.
TRIBUNE
D. 8,500

UL 2 8 1974

N THE LINE

'Great People Of The Bible' Booked Up

By BOB CONSIDINE

EW YORK — Reader's Digest is ing out strong for God these days. ich must be encouraging to the ther. The biggest audience His Son er had was the estimated two or three usand who heard maybe the eatest of His sermons, the one on the unt. But, of course, it lived, as did ncoln's chat at Gettysburg, which so was played before a lot of empty ats.

Whatever, the Digest is preparing its bscribers and followers for that ppy day when we all are admitted to at big PX in the sky.

It has published what must be the ost beautifully printed and illustrated ok of the year. It is titled "Great ople of the Bible and How They ved." Costs $14.95 at the bookstores, hich may discourage a hunger for demption, here and there.

"Great People" has impressive uthors and editors. Some of them: G. Ernest Wright, chairman, Old estament Department, Harvard ivinity School, president of the merican Schools of Oriental research. ghn E. Crawford, curator, Department of Ancient Near Eastern rt, Metropolitan Museum of Art, New ork. Fr. Stephen J. Hartdegen, irector, U.S. Center for the Catholic iblical Apostolate Rev. Dr. Laton E. olmgren, general secretary, merican Bible Society. Robert H. ohnston, dean, College of Fine and pplied Arts, Rochester Institute of echnology.

Also, James B. Pritchard, associate director of Biblical Archeology, University Museum professor of Religious Thought, University of Pennsylvania and president of the Archeological Institute of America; Nahum M. Sarna, chairman, Department of Near Eastern and Judaic Studies, Brandeis University; Msgr. Patrick W. Shekhan, professor of Semitic Languages, the Catholic University of America; Rabbi Marc H. Tanenbaum, national director, Interreligious Affairs, the American Jewish Committee; Howard N. Woodland, of the Revised Standard Version of the Bible, and the National Council of the Churches of Christ.

It's the best look yet at, and sympathetic understanding of, the holy likes of Abraham, Isaac, Jacob and his sons, Moses, Joshua, the 16 judges of Israel, Ruth, Samuel, Saul, Solomon, Elijah, Elisha, Isaiah, Jeremiah, Ezekiel, Esther, and the Maccabees — who bleted the oppressive Syrians about 2,000 years before the Yom Kippur War of 1973.

KING OF PRUSSIA, PA. maps,
TODAY'S POST
D. CIRC. N. AVAIL.

MAY 10 1974

Professor Cited For Paoli 'Dig'

Archaeologist John L. Cotter of the University of Pennsylvania will receive this year's J. Alden Mason award Friday during a meeting of the Society for Pennsylvania Archaeology in Philadelphia.

Dr. Cotter, who is directing archaelogical excavations at Waynesborough, the historic home of Revolutionary War Gen. "Mad Anthony" Wayne in Paoli, will be honored for his contributions to the state's archaelogy.

The University of Pennsylvania professor and his students reportedly unearthed the foundation of the 18th-century barn at the historic site in Paoli earlier this year.

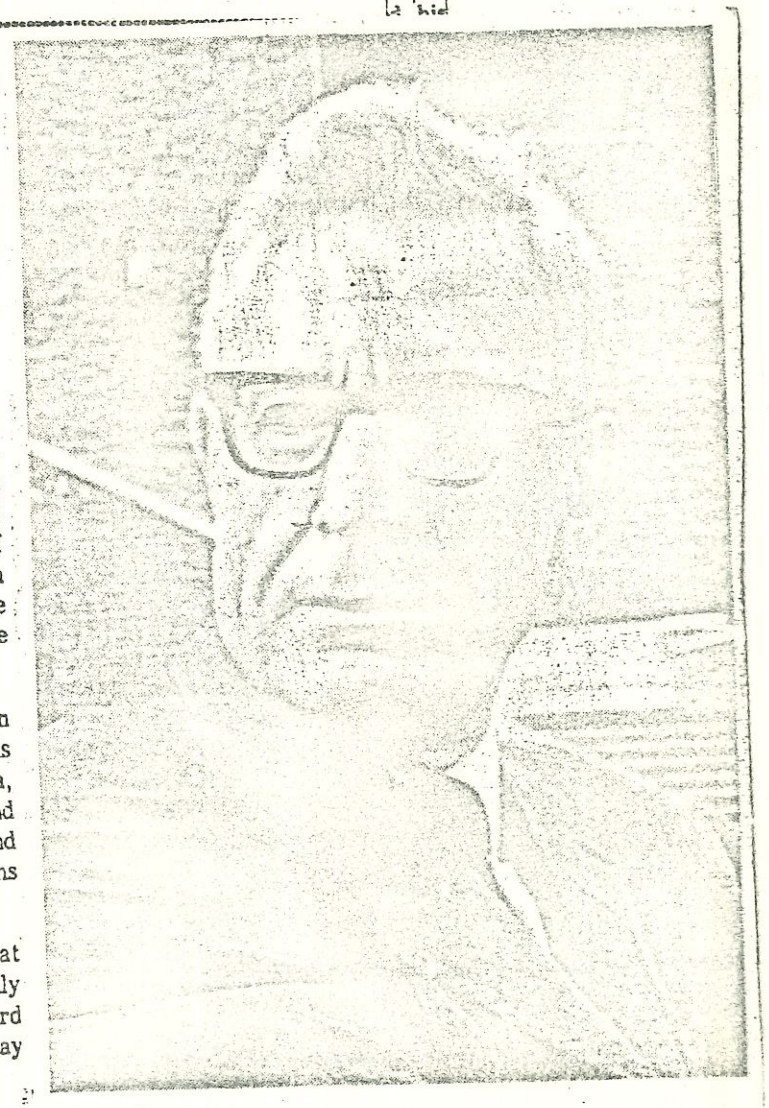
Cotter, who also serves as associate curator of American historical archaelogy at the University Museum and archaelogist with the National Park Service, is planning additional excavations at Wayne's Wayneborough in July.

In addition to his work in Paoli, Cotter has directed digs at Fort Mifflin, the Walnut Street Jail and the Bonnin-Morris porcelain factory, historic sites in Philadelphia.

Jordan River and, just beyond, the

ARDMORE, PA
MAIN LINE CHRONICLE
W. 12,280

MAY 8 1974



DR. LOREN EINSLEY of Wynnewood, noted anthropologist and writer, will speak at Lehigh University.

Loren Einsley To Address Lehigh Univ.

Anthropologist and writer Dr. Loren Einsley of Wynnewood, will speak at Lehigh University's 106th commencement exercises on May 26.

Dr. Eisley will also receive an honorary degree.

He is a Benjamin Franklin Professor of Anthropology and the History of Science at the University of Pennsylvania and curator of the Early Man exhibit at the University Museum.

This story about John Cotter's Above Ground Archaeology was reprinted widely.

LAMBERTVILLE, N. J.
BEACON
W. 3,100

SEP 26 1974

BOUND BROOK, N.J.
CHRONICLE
W. 7,145

SEP 26 1974

Above Ground Archaeology

Local History and the Bicentennial

CAMDEN, OHIO
NEWS
W. 1,320

SEP 19 1974

Nationwide project set for Bi

TOMS RIVER, N.J.
REPORTER
W. 49,877

SEP 25 1974

HUGO, COL.
EASTERN COLORADO
PLAINSMAN
W. 2,008

OCT 24 1974

Anyone Can Con

Bicentennial projects seek attics' memories

WASHINGTON — If the preserved history of the before cars, planes, television,

Children searching for historic

WASHINGTON — If your children suddenly start delving through the attic, basement, cellar or storage shed, don't be surprised.

WILLOW GROVE, PA.
GUIDE
W. 4,221

SEP 26 1974

THE REPORTER
School News

Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Ask for Stock No. 2405-00523.

Text of the booklet was written by Dr. John L. [illegible] Cotter, associate professor

of American civilization [illegible] University

GLENSIDE, PA.
NEWS
W. 4,007

SEP 26 1974

JENKINTOWN, PA.
TIMES CHRONICLE
W. 10,034

SEP 26 1974

Above Ground Bicentennial Pr

Directs Attention To Attic Rese

If your children all of a sudden start delving through the attic or basement, [illegible]

COLDWATER, OHIO
CHRONICLE
W. 3,200

SEP 19 1974

from memories the fullness and flavor of life in earlier times are part of a nationwide Above Ground Archaeology (AGA) Bicentennial project.

Sponsored by the American Revolution Bicentennial Administration (ARBA), the project is one means of tapping the "grass roots" history of the nation. By and large, ordinary citizens have left little recorded testament of their lives, i is living history. A new effort to r previously ade during

derstanding and appreci life was like in the past.

Though developed prim school teachers and st booklet and the program a to any interested group o Above Ground Archa available for 60 ce Superintendent of Docur Government Printing

SPRINGFIELD, UTAH
HERALD
W. 2,512

OCT 26 1974

1976 Bicentennial

If your children all of a sudden start delving [illegible] the attic or basement, cellar or [illegible] be surprised. There's a good ch [illegible] personal part in the commemo Bicentennial.

Should your grandchildren or [illegible] show a sudden interest in how [illegible]

SHIPPENSBURG, PA.
NEWS-CHRONICLE
W. 5,602

SEP 27 1974

424
KENILWORTH, N. J.
SUBURBAN LEADER
W. 2,500

OCT 17 1974

SANGER, CAL.
HERALD
W. 3,206

SEP 19 1974

Bicentennial project to focus on history

Bicentennial highlig

Search for history begins at

Attics, cellars combed by U.S. c

Above Ground Archaeology

Cotter, as Civilization Dr. Crotter American Museum, i

EP 19 1974, Post

'The Creature I Was Excavating Had Never Lived to Be a Man, And I, That Was I Never Going To See?'

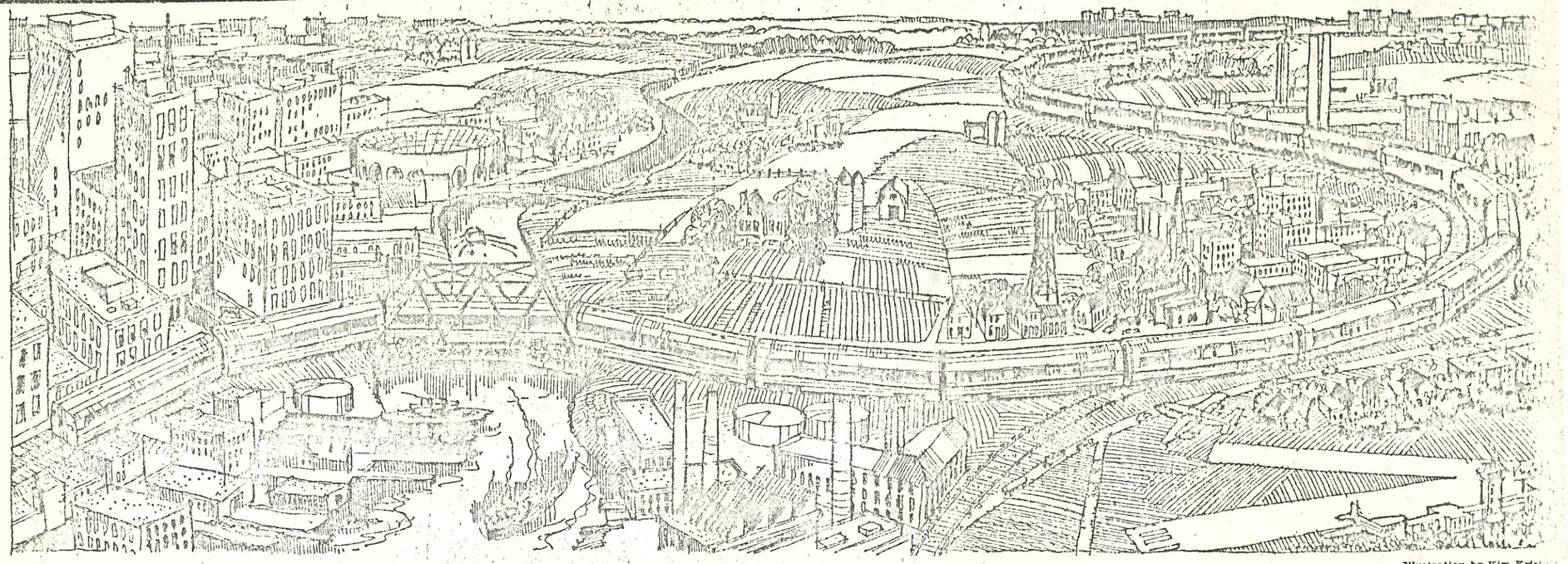


Illustration by Kim Kris

Washington Post
9/19/74

By Tom Zito

Metroliner 113 from New York yesterday afternoon carried the usual mix of corporate executives, blue-jeaned college students and screaming infants, as well as a professor of anthropology with 34 honorary degrees and four inches in "Who's Who."

Loren Eiseley, 67, is acknowledged throughout the world as an expert on human evolution. He's better known, though, as the author of 10 books, including his classic "Immense Journey," that spin poetic tales of creation, evolution, discovery and wonder.

As the sleek train pulled into Baltimore, Eiseley began talking about what archeologists 5,000 years from now might discover as remnants of that city's current civilization.

"About all they'd discover would be objects made from ceramics and pieces of glass from buildings," he explained. "People find it hard to believe that the railroad tracks we're traveling on now will have oxidized away by then. Books will have decayed. Only fire-hardened things can survive—earthenware and some bones caught in fires. We don't know about these damned plastics. They haven't been around long enough yet.

"Of course, this wouldn't be the best place to start a dig. You really want a place where there's a lot of erosion or where dust can build up in heavy layers."

He speaks slowly, gazing out the window at the towns and trees and trestles that roll by, choosing his words carefully, drifting off into thought patterns that interrupt the flow of words. He seems the classic, contemplative academician, his glasses black, squarish horn-rims, his dress the wrinkled brown tweeds of an absent-minded professor, of a man who thinks of clothes in functional and not esthetic ways.

Yet there is another side to Eiseley, the side from which his formidable reputation as a poet of geography springs, his writing side:

"Some lands are flat and grass-covered, and smile so evenly up at the sun that they seem forever youthful, untouched by man or time. Some are torn, ravaged and convulsed like the features of profane old age. Rocks are wrenched up and exposed to view; black pits receive the sun but give back no light."

That, the opening paragraph of Eiseley's "The Immense Journey," seems as if it could not have been written by so terse and dry a man. It is perhaps the classic paradox: The artist or craftsman articulates brilliantly through his medium; who are we to expect him to be a brilliant conversationalist? Eiseley's colleagues vouch for his science; but his writing vouches for the man:

"I would never again excavate a fossil under conditions which led to so vivid an impression that I was already one myself. The truth is that we are all potential fossils still carrying within our bodies the crudities of

See EISELEY, B13, Col. 1



Anthropologist Loren Eisele

Penn Aide Helps Dig Up Italian Mystery Town

Bulletin 11/10/74

American and Italian archeologists, excavating in Italy this summer, have uncovered part of a wall that surrounded a town inhabited by the ancient Etruscans, a people whose origin has remained in doubt.

"Our work may well lead to important discoveries and advancement of knowledge as to who these people were and where they came from," said Dr. Froelich Rainey, director of the University Museum of the University of Pennsylvania.

Like Goddess Diana

Dr. Rainey was co-director of the expedition, undertaken jointly by the museum and the superintendent of antiquities at Florence.

The ancient town was called Artimi, or Aritimi — a name derived from Artemis, an Etruscan diety corresponding to the Roman goddess Diana. The modern community is called Artimino.

The site is down the Arno River from Florence on the grounds of a villa built in the 15th Century by Ferdinando de Medici.

Also recovered from the site during this summer's dig were some pottery sherds, including some black and red-figured Attic pieces dating back to 600 to 700 years before Christ.

These indicate that the Etruscans may have had some contacts with the Greeks at Athens.

North-Central Italy

The Etruscans occupied Etruria in north-central Italy from the 8th or the 7th Century B.C. until 396 B.C., when they were conquered by the Romans, probably by legions led by the dictator Sulla.

The Etruscans attained a high degree of civilization and contributed heavily to Roman culture. But, as most Etruscan towns are buried under present-day Italian cities and towns, little is known about their every day lives.

Their origins especially have remained shrouded in mystery. Oriental influence, evident in their tomb construction, have given rise to numerous theories.

Herodotus Comment

One; supported by the Greek historian Herodotus, has it that they came to Etruria from western Turkey; another is that they acquired a penchant for things Oriental through trade, and a third, that refugees from the East settled among them.

Several cuts were made on the site this summer by the archeologists. Portions of the town wall, 13 feet high in places, were uncovered. The wall encloses an area of about one and a quarter miles in perimeter.

Last winter, during the course of preparing for restorations of the 15th Century villa, the foundations of a 3d Century Etruscan temple were found. Further unearthing of these constructions was a major effort of this summer's dig, and a second foundation, dating to the 7th Century B.C. was found beneath the later remains.

THE WASHINGTON POST
B 8 Friday, Nov. 15, 1974

DIGS

On the Trail Of Tanit

By Judith Martin

The chief goddess of ancient Carthage, who required that infants be burned alive in her honor—thus providing the Romans with ample material for denouncing Carthaginian barbarity—has turned out to be a Phoenician import.

Once thought to be uniquely Carthaginian, the goddress Tanit was also worshipped in the homeland of Carthage's founders, according to the University of Pennsylvania archeologists who have been excavating the Iron Age Phoenician city of Sarepta, now a Lebanese fishing village named Sarafand.

In a paper presented yesterday at the American Philosophical Society meeting in Philadelphia, Dr. James B. Pritchard announced the discvery of an Ivory plaque bearing Tanit's name and discovered in a shrine located in an industrial area of the ancient city and filled with votive objects and cultic equipment.

The plaque, presumed to have been on a wooden figuirine which did not survive, also bears the name of the fertility goddess Ashtart, whose worship was much more widespread in the ancient world.

Dr. Pritchard, associate director and curator of biblical archeology of the University of Pennsylvania's University Museum, translates the plaque inscription as, "This statue made [by] Shillem, son of Maba al, son of Izai for Tanit-Ashtart."

Although the joint worship of a goddess who represents fertility with one who requires child sacrifice may seem strange, no evidence of murdered infants was found in the Phoenician shrine.

In contrast, children buried in jars have been found in several sites in the Punic world.

The Phoenician plaque, discovered last May during the routine washing of figurines, beads, masks, amulets, lamps and other objects found in the shrine, ist he earliest known references to Tanit.

In discussing the Phoenician cultural ties with its Western colonis, Dr. Pritchard said, "The one significant intrusion of novelty in the colonies has been thought to have been the cult of Tanit with its practice of child sacrifice."

That it was more widespread may better explain biblical condemnations of those who "burn their sons and daughters in the fire," he said.

Dr. Pritchard's archeological team has been excavating the site, called Zarephath in the Bible, for five years. An ivory plaque discovered earlier established the identity of the city with the letters "s r p t" for Sarepta on a small stone stamp seal.

MAGAZINE
TO DAY - PHILA. ENQUIRER

The Rainey Season

For a quarter-century, Dr. Froelich Rainey has overseen the University of Pennsylvania Museum's quest for the source of civilization. They may have found it.

By NANCY GRACE



Photo by James L. Link

Dr. Froelich Rainey (center) huddles with archaeologist Chet Gorman (left) and Dr. Beth Ralph, as they try to puzzle out conflicting data on the dates of items found by Gorman in the caves of northern Thailand. Dr. Ralph heads the archaeological laboratory.

It is 9:30 a.m. and Dr. Froelich Rainey has already brought his own paper cup of coffee from the cafeteria. He is seated in the huge, all-white, high-ceilinged office from which he has directed the University of Pennsylvania Museum for a quarter of a century. In the center of the far wall is a huge fireplace. Priceless artifacts are placed around and among the bookcases, long worktable, and the grouping of chairs and sofas where Dr. Rainey sits to talk with guests and students. To the left of the fireplace, on a wooden stand, is a red-on-black Athenian amphora. A Swiss music box serves as a table against one wall. The high, arched windows frame the matching arches of Franklin Field across the street.

The phone rings, and immediately Rainey is involved in the type of problem-solving discussion that has been the substance of his career at the museum. On the other end of the line is Chet Gorman, a young archaeologist just back from northern Thailand.

In addition to dodging occasional bullets from roving patrols of various armies, he has been sifting through the debris of caves inhabited by a Bronze Age culture 6,000 to 8,000 years ago.

(I myself had played a small, if somewhat macabre, role in bringing pieces of the find back to the United States. In Bangkok a year ago a friend of Gorman's had handed me a package to take back to the museum. When the package was opened during a routine boarding inspection at the Bombay airport, I discovered that it contained a human arm bone, still circled by a bracelet.)

Gorman has a problem. He has found, in dating the finds from the lowest portions of the site, that some of the deeper artifacts appear to be more recent than items recovered from shallower levels.

Rainey starts to go through the routine—which of the methods has Gorman used, the newer method measuring thermoluminescence, or the older Carbon 14 method? (Both methods are quite new, and the use of them was pioneered by the museum under Rainey's direction.) How big were the samples? Precisely what equipment was used for the dating?

Rainey makes a series of suggestions for ways to adjust the equipment, and to cross-check the findings. Then he puts down the phone and continues his reflections on what it has been like to head the world's foremost institution of archaeological research, and how it feels to be retiring from that post this year. He will be sorry to go. So will many of those who worked with him.

His tenure as director of the museum is referred to by some of the more droll among the scholars and scientists who worked for him as "The Rainey Season." And there are those who would have liked the season to continue.

Hearing of the work of the museum prompts one to paraphrase the advertising claim of a large textile manufacturer: "If it has anything to do with archaeology, they do it at the University of Pennsylvania Museum, and they do more of it than anyone else in the world."

Such a claim would have the proper level of drama, but would be less than precise. While the museum, under Rainey, does do more archaeological research than any other institution in the world, it has tended to ignore some of the more esoteric searches into lost cultures and the like, which Rainey refers to as "the embroidery." The attention of its scholars, the direction of its expeditions, and the goal of its technological achievements has been to find the beginnings of civilization. "We have stayed in the mainstream," Rainey says.

What has been done so far has already mandated the rewriting of millions of otherwise still serviceable textbooks.

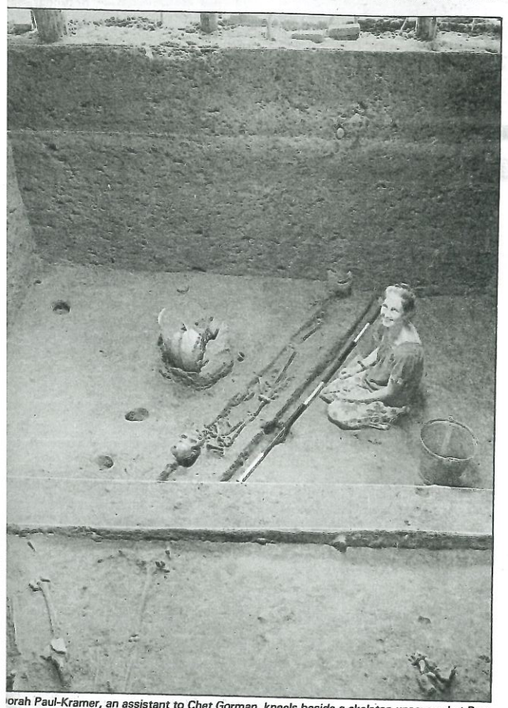
The museum's expeditions and research by others have long since established that the Near East — Mesopotamia, Babylonia, and all— was *not* the so-called Cradle of Civilization it has been cracked up to be. Scholars had long doubted the theory that this area had been the first to nurture civilization. The flaw was that these Near Eastern societies were apparently getting tin for their bronze from an older and more advanced civilization *somewhere else*. The question was —where was it?

Many of the 15 to 20 expeditions that the museum sends out every year have been following the Trail of Bronze eastward and back into time. While not all of the discrepancies in the dating of artifacts at Gorman's caves in northern Thailand have been resolved, it appears that this bronze age civilization is the oldest yet, older than other newly discovered Bronze Age cultures in India and China.

TODAY/The Philadelphia Inquirer
March 23, 1975



Photos Courtesy of Pennsylvania Museum



Deborah Paul-Kramer, an assistant to Chet Gorman, kneels beside a skeleton uncovered at Ben Chai in northern Thailand. The expedition may have found the earliest Bronze Age culture yet known.

Rainey surmises that the vast plains of what is now central Russia were once a "land ocean" across which were brought the new technologies of Asia to the ancient empires of the Russian Steppes, then through the Caucasus Mountains to the Iranian plateau, and on to the Near East.

Besides bronze, these travels and migrations brought to the west the use of the horse, and of the chariot, as well as textile and rug-making techniques, he believes.

* * *

If Rainey were the head of a corporation, or coach of a team, that had achieved a similar measure of success, much would have been written already about his style of leadership. Little has, and something should be. To begin with, there is reason to believe, based on Rainey's career, that the qualities that make successful leaders in other types of enterprise don't necessarily apply in all cases to an archaeological research institution.

For instance, Rainey could not be called a driven man. He does rise early, but after a morning's teaching and other duties, such as receiving, say, a visiting director of antiquities from Cairo for lunch, Rainey takes a nap.

Gloria Swift, his administrative assistant, made herself famous several years ago with an answer on the telephone. "I'm sorry," she told the caller, "Dr. Rainey is in conference now. I have to wake him up at two o'clock.

Nor can Rainey be described as one of those individuals who finds it easy to pay meticulous attention to the details of life. Take for instance the time last summer when the phone of the building superintendent rang. The conversation went about like this:

"Hello, Conyers. This is Rainey. Do you have me on the books for a car to go downtown today?"

Conyers said he had.

"Oh."

A pause.

"What time was that?"

"Two o'clock," Conyers told him.

"Oh."

Another pause.

Then, "Well, can you tell me where I'm going?"

Rainey's informality is reflected even in the physical aspects of the museum. Chairs are everywhere. Instead of formal staff meetings, the staff meets in the coffee shop, so the architects for the new wing hung it in the glassed-in corridor above a garden that connects the new wing with the old. With similar informality, Rainey's classes for University of Pennsylvania archeology students are held in his office.

The office has a back door. At times, the front office loses track of the director when he steps out on some mission of his own.

Recently, it was a search for bones.

The class was working on a whaling exhibit to protest that mammal's possible extinction. It wanted to use a skeleton Rainey had dug up in Alaska of a whaler buried with his harpoon. There are several million catalogued objects in the museum, though. These are continually being moved around and, from time to time, one disappears. Rainey looked in the bone room. He consulted the archivist. He spent some time looking for the anthropologist in charge of the bones.

"It's as bad as looking for Susie," Rainey said when he came back. Susie is an Indian woman skeleton some amateurs had dug up in Broomall in 1943, and which for some reason had been left at the museum, where it became misplaced. Everyone looked for her but no one could find her. From time to time, Susie's owners come back to the museum to claim her, and the search begins again.

"We've been looking for Susie around here now," Rainey told me, "for over twenty years."

* * *

But Rainey has also unmistakeably performed as the Museum's leader. He selected many of the most fruitful sites himself, assembled the museum's team of scientists, and oversaw the introduction of important technological advances.

In 1949, Aristide de Grosse, a Russian scientist fresh from working on the atomic bomb, came to Rainey with the idea of dating or-

ganic material by measuring its radioactive emanations. That was the beginning of the Museum Applied Science Center for Archaeology, one of two major laboratories of its kind in the world. (The other is at Oxford, in England.)

MASCA's dating techniques have cleared up many mysteries — but created others. A piece of wood from Mount Ararat thought to perhaps have been a part of the ark was brought to MASCA for dating several years ago.

The wood, however, turned out to be only about 1,500 years old, much too recent for Noah. However, the scientists were darned if they could figure out how it ended up on the rocky slopes of Ararat. Their best suggestion was that it might have been dropped there by a passing albatross.

MASCA pioneered the use of the magnetometer, a metal detector similar to that used in boarding checks at airports. A Museum expedition used the devices to locate eight-ton stone Olmec heads that are now buried underground in southern Mexico.

Last spring on a Bangkok-Cairo flight, reading *Newsweek*, Rainey ran across a reference to ground radar. Radar has been known since World War II but a new method, recently discovered, can send signals into the earth as well as air. On his return, Rainey immediately made contact with a scientific firm in California. Soon a ground radar applicable to archeology will be in use.

Museum archaeologists have made increasing use of aerial photography to analyze their sites — even when no plane was available. Michael Jamison, excavating an ancient seaport in Greece, went up in the wicker gondola of a two-man balloon to photograph the site. Bob Dyson, in Iran, attached his cameras to a kite.

When an expedition in Turkey was having trouble locating a stone tomb they were sure was buried somewhere within a 10-acre mound, Rainey called the late J. Howard Pew, head of Sun Oil, to borrow an oil rig. It took 84 holes to find the tomb, but that was a lot better than sifting through the entire site, rock by rock.

Rainey also has the knack for getting his hands on money, though he finds it difficult to explain how he does it. "You don't do it by regular fund-raising campaigns, or by buttonholing people," he contends. "I have never received a large gift by asking for it." What he does is simply explain to anyone else who will listen, what the Museum is doing, and why the money is needed.

When an expedition was having trouble finding a tomb, Rainey borrowed a drill rig. Eighty-four holes later, they found it.



Courtesy of Pennsylvania Museum

A dragline shovel and water pumps are in use as a University Museum expedition begins to uncover a stone wall of the ancient Greek city of Sybaris. The Museum also uses submarines, balloons, metal detectors, and kites to locate ancient sites.

It comes in. The Museum has an annual budget of $1.7 million, none of which comes from admission fees. (It's free.) About $500,000 goes for research, which is more than any other institution. Only a few other institutions come close to that figure.

Rainey's museum has spent $1.5 million over 10 years to airlift sawmills, trucks, generators, and work crews to Tikal, a site in the Guatemalan jungle, as well as funds to purchase a two-man submarine for use in underwater excavations.

* * *

Although the primary emphasis at the museum is on research, Rainey has also overseen great improvements in the attractiveness and fascination of its exhibits, which currently attract 288,000 visitors a year.

There are chairs beside the glass cases for people who want to sit down while they examine the intricate designs on pottery shards, or the workmanship on Bronze Age implements. Slide shows are screened in the stairwells.

The skeletons of a couple killed in a prehistoric fire in Iran are on display as they were found — in a final embrace. A mummified Egyptian, who had one leg shorter than the other, is shown buried with his cane. The graffiti on the walls of an Egyptian weekend house reassembled in the museum is 2,000 years old.

One section of the museum is devoted to one of the museum's most important finds—the tomb of Queen Shubad at Ur in the Near East. In addition to providing clues to an unknown civilization, the tomb told its own poignant little story.

Queen Shubad lay quite straight in her tomb where Dr. Leonard Wooley, head of the expedition, found her. Her hair was tied in golden ribbons, her arms crossed and almost hidden beneath her jewels. There was the Queen's chariot dragged by asses, their harness hung with lapis lazuli beads; the Queen's harp; the Queen's gold tweezers; her shell-shaped box for eye shadow; her exquisite golden cup.

In an antechamber, among the Queen's courtiers, guards and musicians, the Queen's handmaidens were found. Each wore silver ribbons in her hair, like the Queen's gold one. Each had a clay or alabaster cup, probably at one time containing sleeping drugs to transport her to the world of her dead Queen.

One handmaiden wore no ribbon.

Dr. Wooley noted it before he continued to clear the body. Then, in what seemed to be one handmaiden's pocket, he found a small silver ribbon.

Was it forgotten? Did the handmaiden dress too hurriedly for her own death? Did she plan to tie the ribbon later?

All of the items from the tomb are displayed from time-to-time in the museum—including the untied ribbon.

* * *

One room of the museum, the Neville Gallery, is designed especially for the blind. The labels are in Braille, and a walnut railing leads to the touchable exhibits, which include old coins, ancient tools, and prehistoric musical instruments.

Over 38,000 school children are bused to the museum each year for special exhibits. On a given day, the visitors may see Afgans weaving rugs in the Chinese Rotunda, a family of Eskimos carving masks. There is also a summer workshop where they bead necklaces, weave baskets, or make clay pots. One year the Education Section ran an international cooking class, teaching everything from Polish cherry soup to African pastries. Class finished up at Levis' on South Street to test out the American hot dog.

The thing the children really adore though are the mummies. Every day, hundreds of small noses are pressed against the mummy cases. Comments run from, "How'd they catch those people to wrap them up like that?" To, "Have they got Cleopatra here?" To, simply, "They cool."

The Women's Committee of the museum has also blossomed in the Rainey Season. In the old days, it was composed of ladies who listened politely while field reports were read, but really warmed up on what hors d'oeuvre to serve on Members Night.

Today, the Women's Committee has changed its style. One offshoot, the Volunteer Guides, accompanies thousands of visitors each year through the museum. Another group takes museum artifacts with them when they go teaching in the schools.

Members Nights have changed too. Social occasions at the museum had been curtailed at the museum prior to Rainey's arrival because of one untoward incident, now often recounted by old museum hands.

The evening, it is said, was brilliant. Guests had gathered in The Rotunda, the gallery that holds the museum's Chinese collections. It is an elegant round room, with a ceil-

.ainey's interest in Italy is partly the result of wading through ice floes in his youth.

ing that rises to eight stories at its domed apex. Two temple lions, the largest pieces of cloisonne enamels in existence, guard the entrance. A crystal ball, second largest in the world, that once belonged to China's Empress Dowager, stands in the center of the room.

Limestone bas-relief of horses that belonged to T'ang T'ai Tsung, the Chinese Emperor who loved his horses so much that he had portraits made of each one, and other fabulous Chinese objects lined the wall, just as they do today.

The Chinese ambassador was there. So were 800 of Philadelphia's first families. And so, unfortunately for the museum, was a Mrs. Cadwallader. Mrs. Cadwallader, of *the* Cadwalladers, was a fox-hunting lady. Exhilarated by the brilliance of the evening and some drinks, she decided on a camel ride.

The camel she chose can still be seen in The Rotunda, standing with the two other camels, glazed pottery, T'ang Dynasty, 7th century. Mrs. Cadwallader's camel can easily be distinguished by his heavy restoration marks.

Rainey revived museum social life, and today the halls again often echo to the sounds of dinners with hundreds of guests. Reports from the field are presided over by Rainey and when he closes with "I'll see you upstairs for a drink now," he says it in such a way that each person present feels Dr. Rainey will be waiting upstairs for a drink with him or her *personally*.

Rainey also developed the prize-winning television program "What In The World," that was aired locally and over network television for many years until 1965. On it, a panel of archaeologists and other scientists would discourse on items



Courtesy of Pennsylvania Museum

Dr. Rainey (second from right) talks with archaeologist Enrico Mueller as they examine a test excavation made in 1961 for the ancient Greek city of Sybaris.

Carleton Coon, one of the museum's archaeologists, charmed audiences with his brilliance and his habit of saying whatever came into his head. Once Coon picked up a small statuette, and said, "Who's this wench?" (It turned out, somewhat embarrassingly, to be a Madonna.)

* * *

Rainey was only 37 when he became director of the Museum in 1947, but he had been around.

At 20, he worked his way around the world. He sold ten-gallon tins of kerosene in the Philippines. He spent a night in jail in Cairo. He was stranded in Shanghai during the Depression. (Rainey's father, a Montana rancher, came to the rescue then by wiring funds.)

Later, he graduated from Yale in archeology and anthropology. He turned toward Alaska. There, he swung on rawhide from a cliff collecting cormorants. Once, when his boat collapsed among the ice floes, he walked across the floes back to civilization. The last lap of that walk was across an inlet near Point Barrows, with the party holding clothes above their heads, dodging the floating ice.

Rainey's present interest in Italian sites, he claims, is the result of many years of being cold.

Rainey had spent the war years producing quinine in the Andes for use by the American troops in the Pacific. Then, at the war's end, for a short time with the State Department, he was U. S. representative on a commission to open shipping on the Rhine.

On arriving in Philadelphia, Rainey's first priority was building a staff. The museum had closed down to a large extent during the war years and there were only three curators. Now there are 33. They come from various backgrounds. The current roster includes an ex-Presbyterian minister, an ex-lawyer, and ex-Merchant Marine seaman.

One of the first of the brilliant men to be enticed to the museum by Rainey was Coon. Coon arrived in Philadelphia, bought land in Devon, engaged an architect to build him "two bedrooms and a kitchen with 200 feet of bookshelves," and disappeared to Iran. Hotu man, a 3,500-year-old skull that was his most sensational find, was uncovered in a cave there.

The latest star in the museum galaxy is Chet Gorman, cave man. With his broad shoulders and orange beard, Gorman looks the part. Also, he likes to dig in caves. He was at Ben Cheng, in Northern Thailand, when Rainey arrived in Bangkok two years ago and, knowing of his work, went north to hire him.

When Rainey reached the site

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Courtesy of Pennsylvania Museum



The limestone caves of Borneo have been inhabited for at least 45,000 years, during which time its inhabitants have painted the walls with pictures and symbols (left), and left remnants for which the archeologists must sift, yard by yard.

RAINEY *continued*

however, Chet had worked his way high into the mountains, along the Burma border and was digging in a cave there. Rainey was making preparations to walk in after him, a three day trek, when, "By the grace of God," Rainey says, Chet ran short of supplies and came walking out.

* * *

"You try to find people you think will make dramatic discoveries," says Rainey. "It's not so difficult. You read their writings, talk to them. You look for imagination, creativity, intellectual energy. It comes out in conversation."

He admits, however, to some mistakes. He sent two archaeologists to Afghanistan, where they came up with nothing to speak of, before another museum expedition made a major find. Rainey is convinced that the first two expeditions failed because they weren't led by the kind of men "who could find something in Afghanistan," and blames himself for not realizing that ahead of time.

Rainey often goes to a suggested site to decide whether to dispatch an expedition. Often the area has been suggested by research that has been done back in Philadelphia. That was the case with the excavation in Turkey that uncovered the principal city of a culture that was an antecedent of the ancient Greeks, and, in it, what seems to be the tomb of King Gordian (of Gordian Knot fame).

Researchers at the museum had come across clues in ancient manuscripts indicating the likely location of the city in Asia Minor. Rainey went himself to the site and confirmed that there was a very promising looking mound at a point near a river that matched the descriptions in the manuscripts. He also took note of other things, including the nearby location of an American military base.

Museum expeditions in the area have had their troubles, including the museum's first expedition, the one led by Dr. Wooley in 1889 that ultimately found the tomb of Queen Shubad.

Interest in the Old Testament was strong then, and possibly for that reason, the museum selected Nippur, a land known in the Bible and located 100 miles south of Baghdad, as their site. Five Americans formed a caravan of guides, guards from the Turkish Government, and 61 horses. They arrived in Nippur after eight days. One hundred and thirty workmen were hired. With considerable enthusiasm, the archeologists began to dig.

Not for long. After three months, a Turkish guard shot and killed an Arab workman. The Arabs retaliated by burning huts and several houses. They fled with the payroll. The members of the expedition fled too — to Baghdad — for their lives. But the museum came back.

Other factors also influence the decision to dig, or not to dig. One of them is the attitude of the local government toward the removal of artifacts. Accessibility to modern equipment, and the cost of labor, can also figure in.

I went with Rainey to Borneo to inspect the Niah Caves, gigantic limestone caverns ten miles inland from the China Sea, with room enough in the central chamber for Veterans Stadium plus parking for thousands of fans. Men have lived in the caves for at least 45,000 years.

Our trip began in an airplane from Singapore to Kuching in Sarawak. Stage two was another plane to Miri, Sarawak's oil city. From there four hours by taxi over rain-season dirt roads. We occasionally got out to push. At the tiny river settlement of Niah, a dugout canoe with outboard motor carried us through the jungle to the resthouse that the Sarawak Museum used when they were excavating Niah, and now maintains for visiting scientists. The last stage into Niah was on foot.

A. Hart Everett, an animal collector, reported crossing the ravines a hundred years ago on felled logs, and wading waist deep through black swamps to get to Niah. In contrast, our approach might seem like a stroll on Chestnut Street.

It was not. I followed Dr. Rainey rivers balanced on eight-inch planks. Some planks were springy. Some were not. The exotic landscape constantly reminded Dr. Rainey of the Guatemalan jungle. To me, however, except for occasional stereophonic birdcalls, the beauty and strangeness of the surroundings were lost in the necessity of looking at my feet.

At the end of a three-mile walk, mostly on planks, Niah rose like a limestone island from the jungle and swamps. Dr. Rainey climbed a narrow ladder, sideways and crablike, and disappeared. I had no alternative. I followed.

The cavern was strewn with enormous rocks, upholstered in black-green algae. It seemed like walking underwater. We climbed two more ladders and walked along a shelf of overhanging rock. We came around a corner into the cave.

Roped off at one side and marked with upright, numbered sticks are 166 burials uncovered by the Sarawak Museum. Some occupants were buried with their pillows and canes. Some were headless. (The heads were found separately in double-spouted jars.) Here and there we passed megolithic skeletons, 6,000 years old, today covered with plastic but left *in situ* to indicate the position in which they were found.

As the digging in the caves went deeper, the age of man's occupation moved back. At 106 inches, the excavators had come on Niah's greatest treasure, the Deep Skull. The Deep Skull is less ape-like than Java Man and Peking Man, and belongs genealogically to modern man. It is 40,000 years old and the oldest inhabitant of Asia known today.

Ten inches under the Deep Skull, a tiny flaked tool was found. This quartzite artifact was the all important evidence of man's unexpected ability more than 40,000 years ago to make and use a tool.

* * *

Although Rainey deals with priceless objects every day, he has no interest in collecting for himself. His activities around his home in Gladwynne include getting up early to chop some wood, or cut the grass. At night, he likes to feed raccoons.

Raccoons live around his house and being fond of them, Rainey has built a squirrel-proof, free lunch for raccoons out in back. The most honored and most frequent guest is Charlie. To get the free lunch the raccoon has to take the top off the box. This rings a bell and announces that Charlie is there. Dr. Rainey [illegible] as to come and watch.

"The [illegible]thing," Rainey says, "is to watch him eat spaghetti." □

NANCY GRACE is a Philadelphia free-lance writer who has been actively involved in activities at the University of Pennsylvania Museum.

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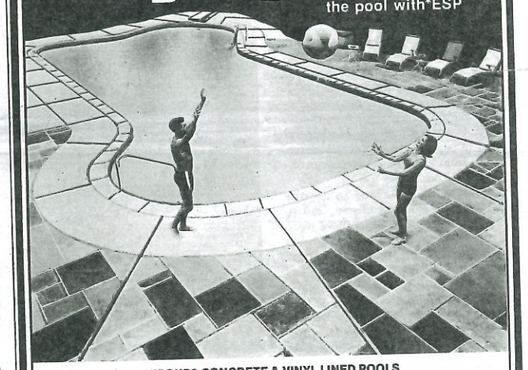
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May 4, 1976

A MOBILE SENSING PLATFORM FOR ARCHAEOLOGICAL SURVEYING

SRI has recently completed development of a sensing platform for locating subsurface anomalies to aid the archaeologist by rapidly and nondestructively providing maps of buried features in advance of excavation. Traditionally, locating archaeological materials has been a combination of trial and error and the archaeologist's experience and intuition. Survey and excavation are highly labor-intensive methods of obtaining information in which large amounts of time, money, and energy may go into the painstaking excavation of a potential site with disappointingly few results. Indeed, if archaeological materials are found, they may not be what was sought. A single survey or archaeological excavation may cost anywhere between $10,000 and $100,000 a year, indicating the advantage of any improvements that would increase the probability of finding the often elusive archaeological objective.

The new SRI platform in use at present consists of a cordless, lightweight, hand-towed cart (Figure 1) to which any type of presently known sensing instrument for subsurface exploration can be readily attached. Such sensors can include ground-penetrating radar, and presently available magnetometers, microgravity meters, or resistivity probes. Since radar is not universally applicable to use in archaeological exploration, other complementary sensors including a high-frequency acoustic sounder are under development at present at SRI. Output from the sensing instrument is automatically transmitted by a radio link to a receiver located in a mobile vehicle parked at some convenient distance where the data are processed by a small computer, printed out within a few seconds, and digitally tape-recorded for permanent record. Simultaneous with the sensor operation, a position-location system (Figure 2) records the cart position on the horizontal plane (to an accuracy of approximately ±1 foot) and plots this information directly on a map or

aerial photograph of the archaeological site. Any detected anomalies can then be superimposed on the map or aerial photograph of the site to give a readily usable presentation to guide the archaeologist in his subsequent exploration and excavation. Working hand in hand with the archaeologist, on site, the survey crew can also provide markers and other on-the-spot information for the archaeologist's immediate use. Where terrain is too rugged for use of the towed cart, the platform can be adapted for backpack operation by one or two men.

The automatic position-detection unit eliminates the need for time-consuming surveys of the site, and the laying out and staking of grids with consequent disturbance of the site. Time and cost requirements for an archaeology survey are therefore reduced, and the site is left undisturbed. Any kind of grid pattern can be chosen, and, since results are available in real time, areas of the site showing unusual subsurface features can be immediately re-explored using a tighter grid spacing to obtain more detail on subsurface features.

Subsurface radar is the most difficult sensor to use and presents the greatest quantities of data to be reduced. Therefore, to qualify for use with the most difficult sensor, the platform was initially built and tested around a family of radars developed at SRI during the past four years. Data processing and recording equipment, electrical power supplies, and cart storage space are at present provided by a mobile laboratory (Figure 3). All equipment can thus be driven to the archaeological site.

The potential usefulness of the platform has been initially demonstrated by a series of field experiments at Chaco Canyon National Monument, New Mexico, where subsurface structural features have been readily mapped by a subsurface radar mounted on the platform (Figure 4).

Archaeologists interested in joint research and cooperation in a survey of their site with this platform should contact Roger Vickers or Lambert Dolphin at [415] 326-6200, Ext. 4422 or 4868. To assist in archaeological evaluation of this technique, SRI is working in cooperation with Professor Ezra Zubrow, Department of Anthropology, Stanford University. Professor Zubrow is available to discuss archaeological applications of the platform and its potential usefulness, at [415] 497-3318.

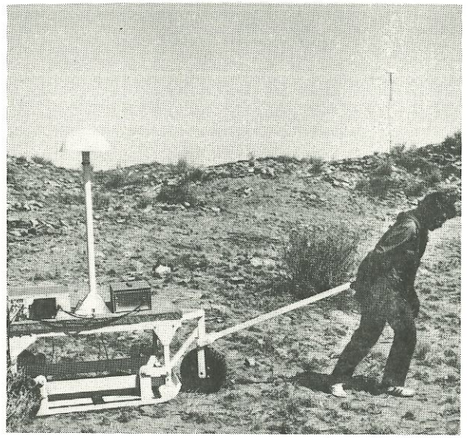


FIGURE 1

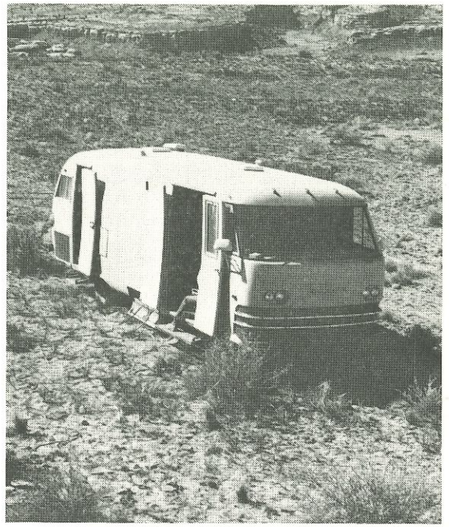


FIGURE 3

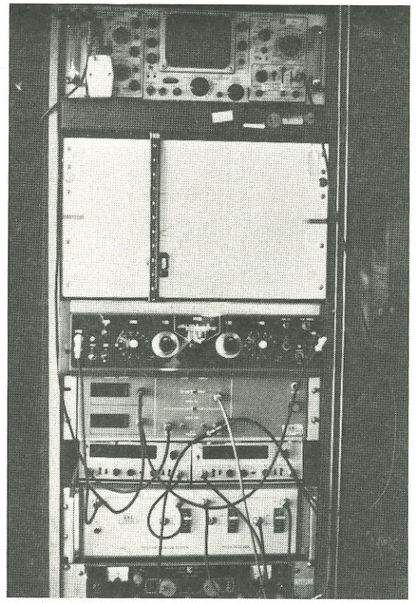


FIGURE 2

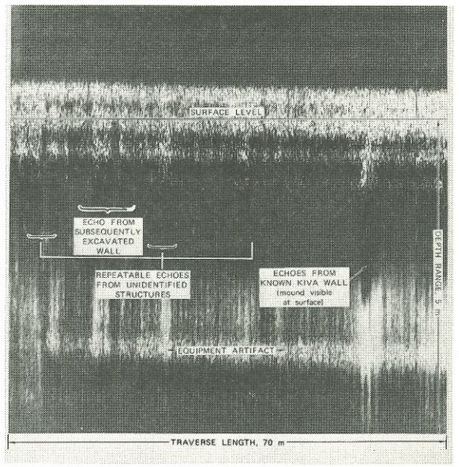


FIGURE 4



Keystone

A 2,000-year-old man: After millennia in a mudpack, perfect skin and perfect teeth

DIGGING THE PAST

One hundred and forty feet beneath the Aegean Sea, off a desolate Turkish-owned rock named Yassi Ada, divers in wet suits swim around the 1,700-year-old wreck of a Roman ship. After surveying the hulk with a television camera, they photograph it in three dimensions, using a powerful strobe light and two cameras mounted on a horizontal pole. Later, after blowing away excess sand and silt with a jet of water, the researchers sweep through the ship with a giant vacuum hose that picks up shards and small relics. Meanwhile, the larger, more valuable objects are floated to the surface by a balloon and stored aboard the sponge boat that serves as the expedition's surface ship.

In northern Alaska, just a few miles from the route of the oil pipeline, a lone professor watches intently as Eskimo hunters skin a caribou they have just shot. Days later, after waiting patiently for the Eskimos to consume all the meat, the professor gathers up the bones and other debris they have discarded—the garbage from one of the last groups of inland hunters on earth.

Ancient wrecks and yesterday's garbage are both part of one of man's most compelling pursuits—the search for his own past. Archeology, by its very nature, moves at a slow and deliberate pace, yet it is in the midst of a quiet revolution today. No longer does the study of history and prehistory confine itself to quests for the exotic art objects that glorified kings and chieftains in times past. Today, archeologists are trying to put together a working picture of how ancient societies—and particularly the common people in those societies—behaved. "We don't concentrate entirely on great temples and palaces," says Dr. William Coe of the University of Pennsylvania Museum. "We are interested in the total population and economics of those sites."

This fresh approach, inevitably termed "the new archeology," embraces a number of separate strands. Sophisticated instruments developed by physical scientists—computers, nuclear sensors and even cameras aboard earth satellites—are helping archeologists to identify and explore promising sites and to interpret the artifacts they excavate there. Techniques gleaned from sociology, psychology and other "soft sciences" are supplying archeologists with reams of statistical data. A few modern archeologists don't even bother to dig any more. They prefer to study such relatively modern monuments as gravestones and latter-day examples of primitive man like the aborigines of Australia and the Bushmen of Botswana.

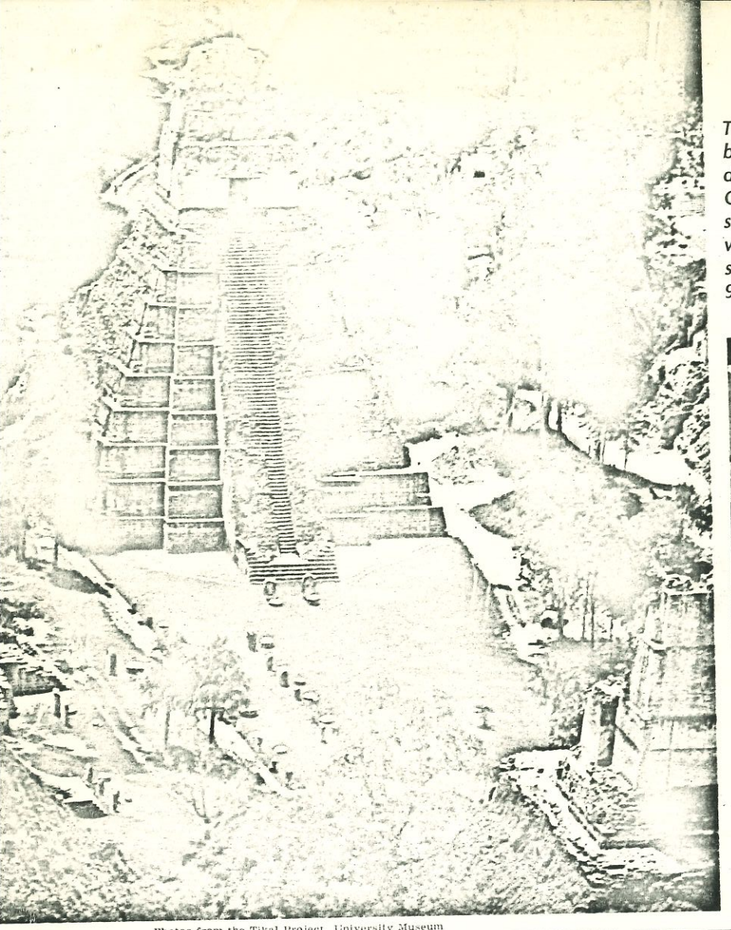
New methods and discoveries are encouraging today's archeologists to challenge some of the most revered theories of their forebears. The notion that the Middle East was the "cradle of civilization," the area that introduced metal-making and urbanization to the rest of the world, is now under spirited attack. So is the long-held belief that American Indians were always wretched nomads who scratched out a bare existence from an inhospitable environment. Recent excavations in Central and South America suggest strongly that the Mayan and Incan societies supported more people more efficiently than do the small nations in those regions today.

The new archeology is already old enough to have developed its critics. "It has all the humorless drive of a new religion," declares Robert Braidwood of the University of Chicago. "There are some archeologists," says University of Pennsylvania anthropologist Loren Eiseley, "who feel that something human is departing a field that more and more has to call in soil specialists, computer specialists and other specialists. The people involved are trying so hard to imitate the hard sciences that they tend to forget that the objects they are handling statistically really represent human beings."

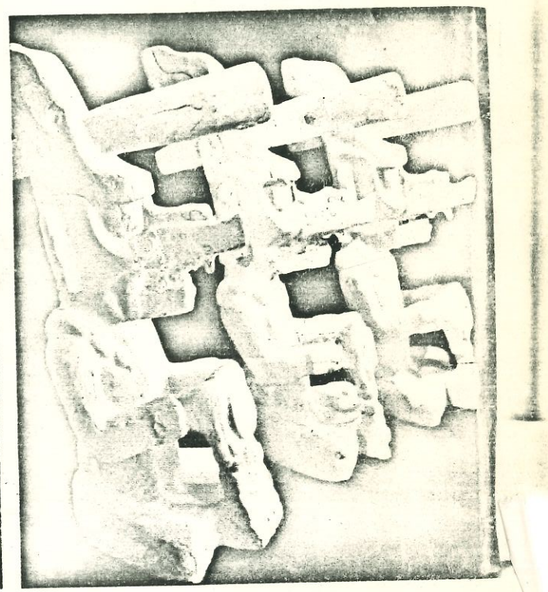
The old and the new archeologists, however, both share one fundamental assumption: that modern man can learn from the mistakes of his ancestors. By analyzing how ancient societies coped with such problems as pollution, overpopulation, scarcity of resources and warfare, archeologists believe that they can suggest means to help deal with the modern versions of these social scourges. "If we can explain the past," says UCLA archeologist James Hill, perhaps a bit overconfidently, "we can predict the future."

Explanation begins with discovery. In recent years physical scientists have provided archeologists with a vast array of instruments for detecting promising sites. Aerial photography from cameras that respond to a variety of wave lengths of light can spot minor changes in vegetation, undetectable on the ground, which can indicate the presence of ancient

The historic city of Carthage (top) has recently been rescued from Tunisian land developers for further archeological investigation. An extensive dig (bottom, left) near Kampsville, Ill., 35 feet deep, is yielding a fresh picture of Indian society as it existed as long ago as 8000 B.C. A copper serpent discovered close to the Illinois site, probably a religious symbol, dates back about a thousand years. In Britain's Manchester Museum, scientists conduct an autopsy on a 2,000-year-old Egyptian mummy.



The 145-foot-high Temple of the Giant Jaguar, built around A.D. 700, towers over the abandoned Mayan capital of Tikal in northern Guatemala. Recently discovered relics from the site include, clockwise from top right, wooden rain gods carved about A.D. 600, small pottery figures crafted about A.D. 900 and a 1,500-year-old jade dancer.



Photos from the Tikal Project, University Museum





structures and artifacts below the surface. Space-agency scientists are even monitoring photographs from satellites designed to prospect for earth resources, to determine if ancient sites may be spotted from orbit.

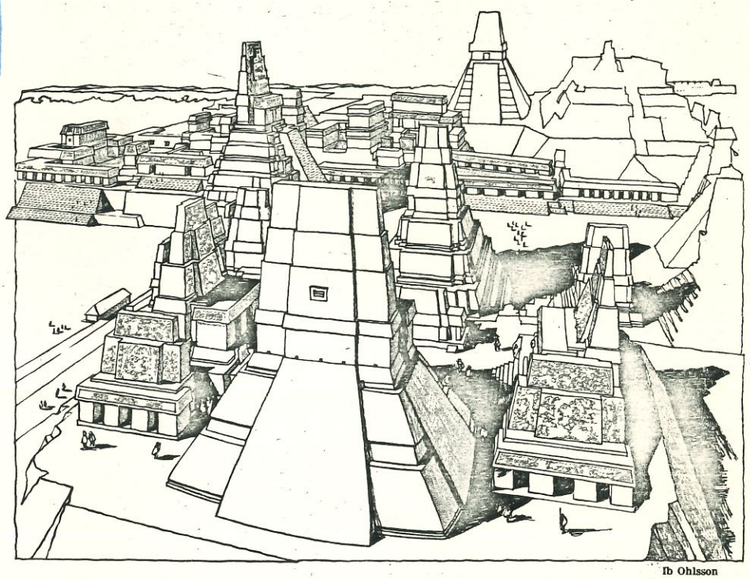
Simple metal detectors something like those used by geological prospectors can sense metal artifacts buried up to depths of 3 feet. Last month, for example, a New York stockbroker equipped with nothing more than a homemade metal detector discovered an extremely rare bronze statue of the Roman Emperor Hadrian buried in an Israeli site 25 miles south of the Sea of Galilee (NEWSWEEK, Aug. 18). Elizabeth Ralph and her team from the University of Pennsylvania Museum used a sophisticated version of this instrument, known as the magnetometer, to find the long-sought Greek city of Sybaris on the instep of Italy's boot. Scientists at the Stanford Research Institute are experimenting with a form of radar that directs the beam directly down into the ground. The reflections indicate the size and shape of any ancient treasures buried below.

Sonar scanners are being increasingly used in a totally new type of archeological venture—underwater exploration. For fifteen years, George Bass has been conducting underwater surveys of ships wrecked as long ago as 1200 B.C. in the Mediterranean Sea. He has found that many of the craft and cargoes are in extraordinarily good condition. "The ships themselves are a vast field of research," says the 41-year-old archeologist, who has helped to train his research team to dive. "Everything that anybody ever made, I think, has been carried at one time or another on a ship. It's what we call a closed context, and many things are better preserved underwater than on land."

Bass's underwater methods (drawing, page 47) are adapted from dry-land archeology. Compressed-air vacuums are substituted for the traditional brush and pick to remove debris. The undersea version of a hoist for moving large objects is a balloon. "Aerial" mapping is achieved with a submarine, or by a diver carrying a camera, who marks his positions with a plumb line. Magnetometers are used, just as on land, to detect metallic objects in the ships' cargoes. A watertight telephone booth allows communication with the surface, and divers are supported in their work by a submersible decompression chamber.

Less dramatic than the hardware, but even more important technologically to archeologists, are recent laboratory developments in dating ancient finds. For a quarter of a century, archeologists have relied on the carbon 14 method, developed by University of Chicago chemist Willard Libby, to determine the age of the remains of once-living materials. While they are alive, all animals and plants take in small amounts of the radioactive form of carbon known as carbon 14. When they die, this intake is halted, and the radioactive isotope starts to decay at a constant speed. Because the ratio of radioactive to normal carbon decreases at a precise and predictable rate, measurements of the ratio have provided the accepted ages of nearly all important finds.

Now, however, carbon 14 dating is being both modified and extended. Studying the rings laid down each year in ancient bristlecone pines on the border between California and Nevada, University of Arizona scientists have helped calibrate carbon 14 dates back to 5400 B.C. In many cases, these carbon dates appear to have been in error by several hundred years. Researchers attribute the errors to fluctuations in the total amount of carbon 14 in the atmosphere from century to century, caused by alterations in the intensity of cosmic rays and the strength of the earth's magnetic field.



Ib Ohlsson

Reconstruction of Tikal in its days of glory: Wheels were for children

Another method of dating human remains turns on the nature of amino acids. In living creatures, these acids occur in what scientists term a "left-handed" form. Once the creature dies, the acids begin to transform to their "right-handed" equivalents. The ratio of the two, according to a technique developed by Dr. Jeffrey Bada of the Scripps Institution of Oceanography, among others, reveals the age of the remains—and extends beyond the 40,000-year limit of carbon 14 dating. Bada has recently used the method, which is called racemization, to date human skeletons found in the San Diego area. His conclusion—that the bones are 48,000 years old—has astonished skeptical archeologists, who had long believed that man spread to North America over a land bridge joining Siberia and Alaska between 20,000 and 30,000 years ago. Experts still consider racemization extremely experimental.

Nonetheless, there is more evidence of an early arrival by humans in North America. This has come from excavations near Avella, Pa., south of Pittsburgh, by a team from the University of Pittsburgh led by James Adovasio and Joel Gunn. At a rock shelter (a long overhang of rock affording protection from the elements), they have unearthed rudimentary tools and charcoal from a fire pit that have been dated by Smithsonian Institution scientists to 14,225 B.C., making Avella one of the oldest inhabited sites in the Western Hemisphere. The Pittsburgh team thinks that it has also found another fire pit perhaps 3,000 years older. If these datings are confirmed, they would cast further doubt on the date of 20,000 B.C. for the crossing from Siberia because archeologists are sure that the movement eastward across North America was a tortuous process lasting thousands of years.

Just out of the laboratory is a fourth dating method—the first to be applied to the pottery that is so commonly dug up by archeologists. This technique, known as thermoluminescence, aims to detect a very slight glow that starts to build up in pottery the instant it is fired, owing to radioactive processes. By heating a few specks of a pottery sample and using sophisticated detectors, scientists believe that they can measure this glow accurately enough to determine when the artifact was made.

Using thermoluminescence, archeolo-



Jeff Lowenthal

Struever at Koster: Beyond the naked eye

gists from the University of Pennsylvania have reached tentative conclusions that undermine some of the most fundamental tenets of prehistory. In the remote village of Ban Chiang, in northeast Thailand, they have spent ten years excavating a 1-mile-square ancient burial mound. There they found a trove of bronze artifacts and swirled clay pots that they have dated by thermoluminescence to about 3500 B.C.

What this means—if the conclusions stand up to further tests—is that the bronze artifacts are 500 years older than any found in the Middle East. Archeologists have long thought that the skills needed to alloy copper and tin into bronze were perfected in the Middle East and exported to relatively backward settlements in Asia and Europe. "It may be," says Jean Kennedy, a member of the Ban Chiang team, "that Southeast Asia gave metals to the West and not the other way around." More cautiously, excavation director Chester Gorman suggests that the practice of metallurgy—a sign of emerging civilizaton—may have developed independently at several places in the world.

Further evidence to support this theory has been produced by recalibrations of carbon 14 dating in Europe. Modified dates for Stonehenge in England, megalithic tombs on the Iberian Peninsula and in Brittany and tablets from the Vinca culture of Transylvania indicate that these monuments are actually older than the pyramids and other Middle Eastern artifacts, rather than younger, as commonly believed.

Many authorities, of course, remain unconvinced. "One doesn't have to say that culture turned around," says Pennsylvania's Eiseley, "just because the dates of Stonehenge and some of these other megalithic monuments in Europe may be older than we previously thought. We shouldn't make the mistake of jumping off whole hog on another theory of diffusion until we've laid the last one to rest."

In North America, archeologists are stretching their craft to such levels of sophistication as the study of ancient societies under stress. To detect traces of sociological change, Lewis Binford of the University of New Mexico has traveled to Alaska to see what present-day Eskimos do with caribou bones and other bits of refuse that have not essentially changed over the past 60,000 years. Then, by comparing these wastes with the bones from ancient sites, Binford believes that he can get an excellent idea of how society was surviving at the time. If he discovers, for example, that ancient peoples were breaking open small bones for the tiny amounts of food they contained, Binford thinks it reasonable to assume that the society was under great pressure, perhaps an extreme shortage of food. Similarly, he argues, the various uses that primitive men made of bone, such as fashioning weapons, can reveal their relative sophistication and ability to adopt energy-efficient means of feeding and clothing themselves.

The search for sociological hints extends beyond such direct evidence. Experts in pollens are called in to analyze seeds discovered on ancient sites, perhaps to provide an insight into the local environment and agricultural practices. Osteologists are consulted on the age, sex and economic status of skeletons and odd bones discovered at grave sites. Programmers catalog every artifact discovered on a dig for insertion into large-scale computers that store all the wealth of data for later study.

A prime example of the new archeology in action is an Illinois-cornfield dig presided over by Dr. Stuart Struever of Northwestern University. The dig is both the biggest prehistoric Indian site in all of North America and probably the best preserved. Struever's excavators have identified fourteen separate levels, each representing a specific era of occupation, and each fortunately separated from those above and below by a layer of sterile soil. In most sites, artifacts from different centuries and even different millenniums are hopelessly mixed together. At the Koster dig, as this Illinois site is known, each era of occupation from A.D. 1000 down to 8000 B.C. is clearly defined. So extensive is the dig that it boasts its own archeology center in the nearby town of Kampsville, where experts in botany, zoology, chemistry, statistics and other sciences prepare data for and ask questions of a computer. "When you dig up 200,000 units of information a season," explains Struever, "eyeball analysis is not enough."

The Koster site and a smaller but similarly ancient one on Virginia's Shenandoah River under computerized excavation by Dr. William Gardner of Catholic University in Washington, D.C., are disproving stereotypes of the early American Indians. They were neither noble red men corrupted by the white man's culture nor coarse savages who did not possess the necessary ingenuity to produce monuments. "The early Americans were not brutish, stupid or disorganized," says Struever. "They were successful in maintaining their stable existence without the benefit of the technology we depend on so heavily today."

Early inhabitants of the continent did not live continuously on the brink of hunger or extermination, forced to use every spare moment to gather and hunt for food. The intricacy of the Clovis-type spear points unearthed by Gardner indicates that the Indians had more time on their hands than today's workingman.

Yet the North American Indians never, for some reason, reached the level of sophistication of ancient Indian cultures in the rest of the Western Hemisphere. Pennsylvania's Dr. Coe and his team recently completed an extensive investigation of Tikal, a 222-square-mile urban complex of monuments, palaces and causeways built by the Mayans in northern Guatemala. Unlike Old World cities, Tikal is nowhere near a river valley. Like their ancient counterparts, the Mayans knew of the wheel—but they never used it, possibly because its shape suggested the sacred disk of the sun. The only wheels in Mayan culture were toys for children to play with.

The mines of archeology are far from exhausted: startling new discoveries continue to be made all over the world. Last month, the Chinese Government



Robert R. McElroy—Newsweek

Gardner (right) in Virginia: Indian lore

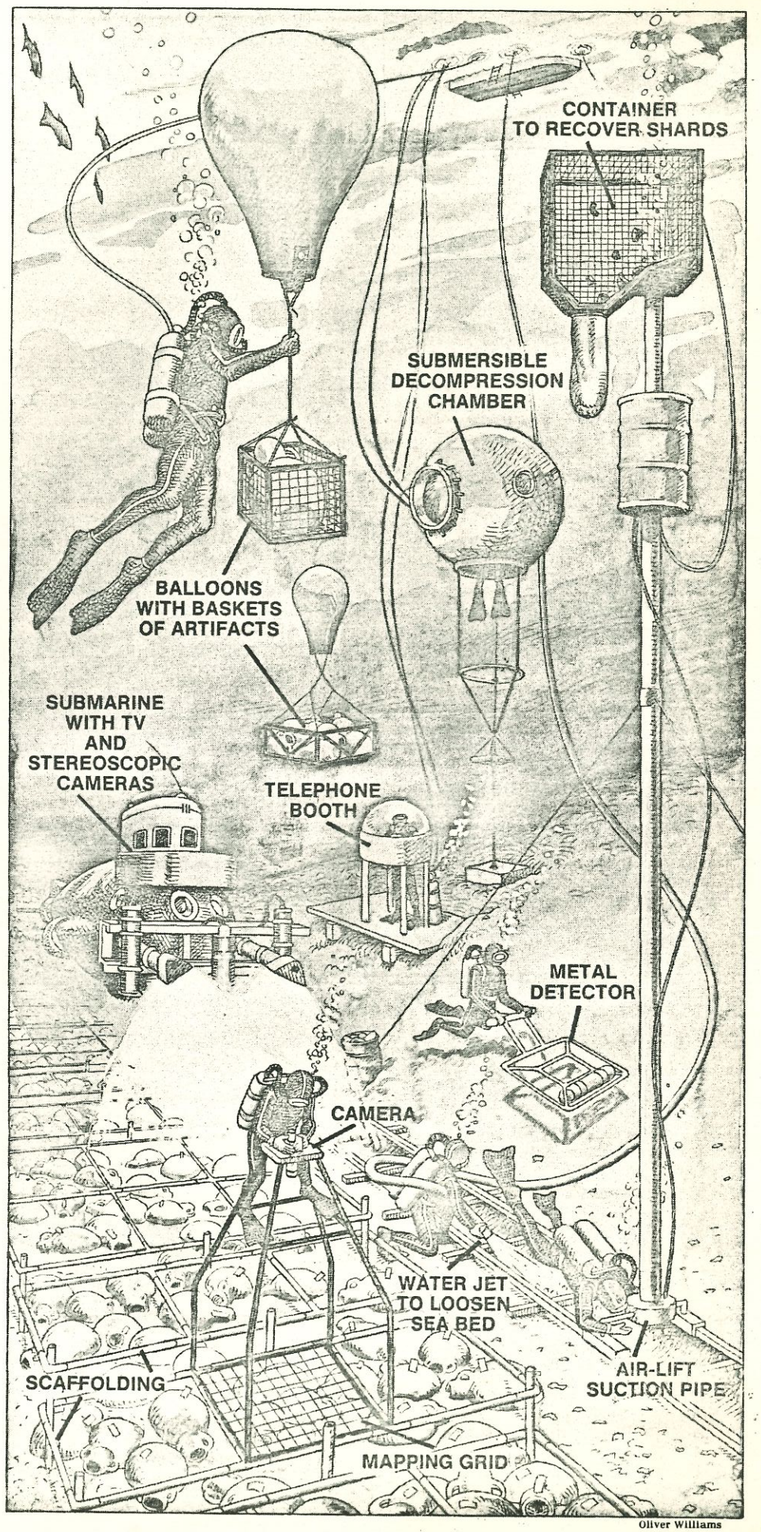
announced that in the northwestern province of Shensi, a 2,000-year-old "army" of life-size warriors, horses and chariots had been unearthed. Chinese medical scientists are also currently investigating a naturally mummified human body discovered in the red liquid mud of the central province of Hupeh. The male body, which contains a full set of teeth and a perfectly intact skin, is thought to be more than 2,100 years old.

An Egyptian mummy of almost the same period was recently removed from its textile covers in Britain's Manchester University Museum and proved to be a girl, perhaps 14 or 15 years old, who for some undetermined reason had had her legs amputated. Following the beliefs of the Greek rulers of Egypt in the period around 200 B.C., the embalmers had sewn false legs on the body to make it whole for the next world. "We hope to find evidence of disease and the cause of death," says Rosalie David, who heads the investigating group. The mummy is expected to provide clues both to health conditions and medical treatment during the period.

In Egypt itself, a classical but highly unusual site is now being excavated by a team under the direction of Dr. David O'Connor of the University of Pennsylvania. This site consists of a mile-long canal and huge inland harbor, 1 mile long by half a mile wide, which was built on the west bank of the Nile in the fourteenth century B.C. by the Pharaoh Amenhotep III. "It's unique in the surviving archeological world," says O'Connor. "It must have been one of the biggest harbors, if not the biggest, ever attempted." O'Connor surmises that the harbor was intended to provide access to a developing urban center. Across the Mediterranean, Princeton's Leslie Shear has dug into the agora, or marketplace, of ancient Athens. He has recently uncovered a row of ancient shops and a library, offering what he calls "a new perspective on the routine life of the ancient Athenians."

So fast are the archeologists digging that often they do not take the time to report their findings. Tikal, for instance, has been under excavation for fourteen years with no published results; detailed information about it is known only to experts who have been there. A Palestinian dig conducted in 1921-1933 has still not been reported in full, and no report at all has come from a Turkish dig that was begun in 1950. The paucity of information has led some archeologists to suggest that a ten-year moratorium on digging be declared to allow the profession to put its records in order.

But archeologists can't afford to wait. There is too much danger that the study of ancient civilizations will succumb to



Oliver Williams

The new archeologists now even 'dig' underwater. At right, a submarine panorama of their sophisticated techniques.

modern political and social conditions. In Jerusalem, a team headed by Hebrew University Prof. Binyamin Mazar has been excavating the Temple Mount since Israel took over the Old City in the 1967 war. Since that is also the site of two Muslim holy places, UNESCO—at the urging of several Arab states—last November condemned Israel for "persistently altering the features of the city and undertaking excavations which constitute a danger to its monuments." Only quick action against land developers enabled UNESCO to save the ruins of Carthage, the city in modern Tunisia that was one of the great colonial centers of the Phoenicians and other civilizations. Full-scale excavation of the site is expected to begin later this summer.

Amid this welter of political bitterness, land developers' bulldozers and often outright looting, the once languid profession of archeology is in a hurry as never before. With their new tools and methods, archeologists are rushing to provide fresh understanding of man's past—before it is eradicated forever by the future.

—PETER GWYNNE with STEPHEN G. MICHAUD in Philadelphia, ELAINE SCIOLINO in Kampsville, Ill., HARRY ROLNICK in Ban Chiang and bureau reports

Magnetic Monopole

Electricity and magnetism resemble each other in every important respect except one: while the basic units of electricity—positively charged protons and negatively charged electrons—are common in nature, the fundamental units of magnetism are extremely rare. Physicists have tried for a long time to find a unit of magnetism—with only one pole instead of the normal two—in such places as magnetic rocks, the ocean floor, atom smashers and even lunar soil, but the search has been so fruitless that many scientists decided that the "magnetic monopole" did not exist. Last week, however, a team of researchers from the University of California at Berkeley and the University of Houston announced that they had finally tracked down the elusive monopole in the earth's upper atmosphere.

Order: The discovery, if it is confirmed by subsequent experiments, will have a profound effect on the esoteric world of particle physics. For the existence of the magnetic monopole cannot be assimilated into the accepted theory known as quantum electrodynamics (QED). Since it was first formulated about 40 years ago, QED has brought remarkable order to the collection of fundamental particles that has been called the "sub-nuclear zoo." It has predicted the most abstruse events with remarkable accuracy, and it has led to the concept of particles known as "quarks," which according to the QED theory are the true building blocks of nature. But the complex mathematics that underpins QED requires the assumption that magnetic monopoles do not exist. Thus, last week's discovery could shake physicists' understanding of the basis of matter.

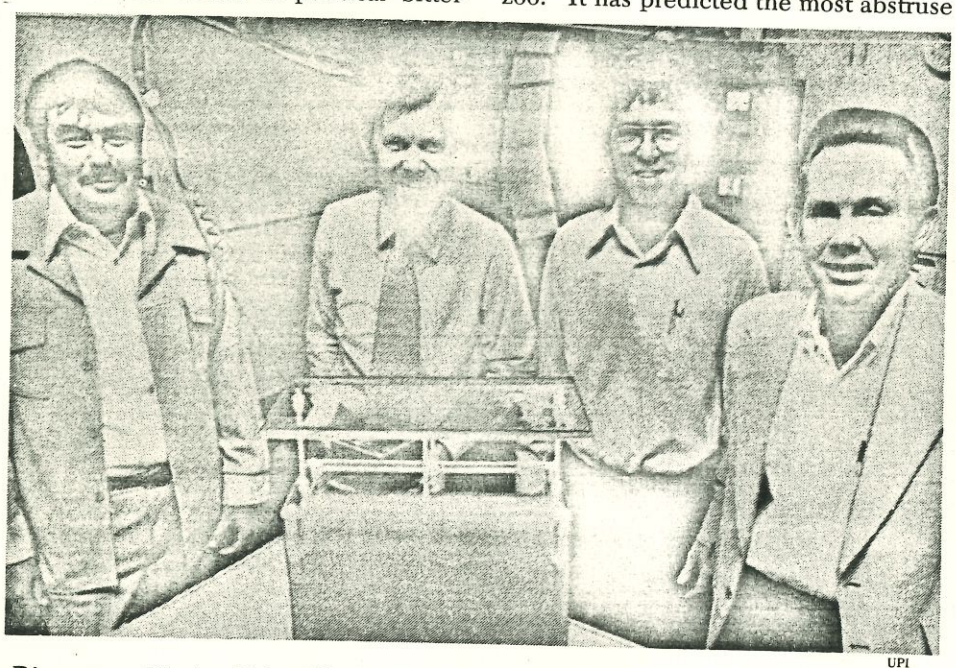
To find its monopole, the Berkeley-Houston team used a method known as particle-track analysis. In this technique, scientists expose materials through which particles have traveled to chemicals that enlarge the particles' tracks. Experts analyzing the treated tracks can make reliable estimates of the masses, speeds and other characteristics of the particles. The Berkeley-Houston detector consisted of a layer of photographic film and emulsion packed inside 33 sheets of .01-inch-thick Lexan, a plastic used in airplane windows. The apparatus, whose purpose had been to detect ultra-heavy cosmic rays, was flown for two and one-half days in a balloon hovering 130,000 feet above Sioux City, Iowa, in September 1973.

After the detector was returned to earth, Houston physicists W. Zack Osborne and Lawrence S. Pinsky spent almost two years identifying all the tracks in the photographic film and emulsion. They then turned the equipment over to P. Buford Price and Edward K. Shirk of Berkeley for analysis of the Lexan. All three materials contained one extremely unusual track, which the astonished researchers concluded could only have been produced by a magnetic monopole.

The characteristics of monopoles are fairly awesome. Two of them with opposite poles, north and south, would meet with a force 18,000 times as great as that released when a proton and an electron collide. The monopole seems to be hundreds of times as massive as anticipated even by many physicists who believed in its existence. "Monopoles haven't been found up to now," said Price last week, "because we have had some misconceptions about their properties."

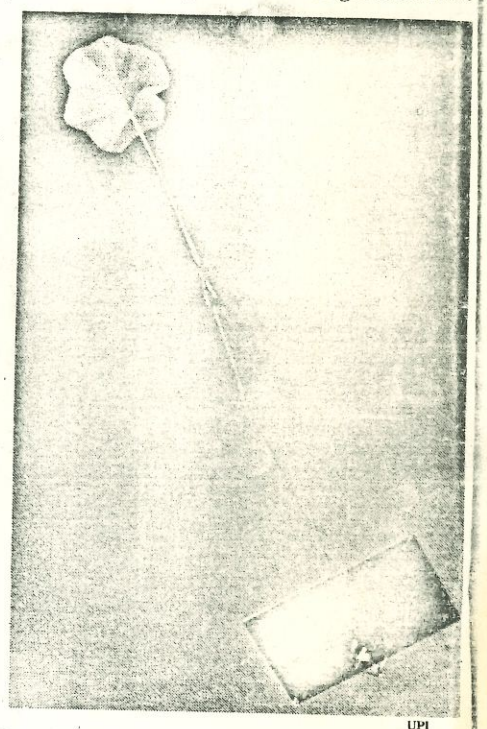
For the present, the possible applications of magnetic monopoles are largely theoretical. But some physicists are already conjuring up grandiose dreams. According to Price, it could one day be possible to harness the monopoles' enormous energy to drive ships across the sea—by confining the particles in a ship and relying on the earth's magnetic field to draw them in the appropriate direction. Conceivably, doctors could destroy tumors by moving monopoles around inside them using magnets. But these possibilities seem far away: even if the discovery of the monopole is confirmed—which some scientists still doubt—no one has yet figured out a way to capture a bunch of them.

—PETER GWYNNE



UPI

Discoverers Pinsky, Price, Shirk, Osborne and their detector: Serendipity in the sky



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HOW TECHNOLOGY IS REVOLUTIONIZING MODERN ARCHAEOLOGY

By Froelich Rainey, Ph.D., Director
The University Museum
University of Pennsylvania

The transition from the ancient world to contemporary life is nowhere better dramatized than in the application of technology to explain and discover the development of civilization. Electronics now supplies some of the major tools of archaeology. To picks, shovels, a knowledge of history and a dash of intuition have been added complex electronic equipment as necessary gear for the modern excavator. Even the explosion of knowledge about cell biology is now being applied to the dating of ancient human skeletons.

During the past 25 years of my career in archaeology, nuclear clocks for dating the past and magnetometers for locating ancient remains have led me into the exploration of sites of ancient man in Italy, France, Mexico, Greece, Turkey, the Arctic and several other regions rich in archaeological artifacts.

The University Museum of the University of Pennsylvania, with the financial assistance from the Social Sciences Division of the National Science Foundation, established many years ago an Applied Science Center for Archaeology (MASCA) specifically to adapt new scientific techniques to unravel the ancient past. Now we are working with remote sensing devices not only from airplanes but from satellites, various types of magnetometers, underground radar, and other instruments for exploring the earth's surface. To interpret what we find there, we employ now x-ray diffraction and fluorescence, nuclear activation analysis,

and other advanced electronic equipment for the analysis of ancient materials. Moreover, since the discovery of the original radiocarbon system, some seven or eight other methods for atomic nuclear dating have been devised.

In the development of exploration techniques here at the University Museum, we worked with an Italian team in south Italy for eight years to discover the ruins of ancient Sybaris. With electronics engineers we worked in the field and in the laboratories to adapt and develop electronic equipment now used widely throughout the world.

Sybaris is the fabled city founded in 720B.C. which may well have been the wealthiest center in the Hellenic World, marked by historians for its luxury, wealth, and decadence. The Sybarites had carried luxury and refinement to the point where they trained their horses to dance at feasts to the accompaniment of pipes. The story is told that when the Greeks of Croton attacked Sybaris in 510B.C., they struck up the dance tune of the cavalry horses who proceeded to dance away and desert to the Crotonians with their riders on their backs. All signs of the original city had been lost, a community with walls 10 kilometers long and a population of from 100,000 to 300,000.

Our University Museum group introduced the proton magnetometer in Italy in 1961, an instrument developed originally a few years earlier by the Research Laboratory for Archaeology in Oxford, but this instrument was not sensitive enough to detect the deeply-buried walls of the ancient city. In collaboration with Varian Associates, we finally developed the cesium magnetometer which made it possible to produce a magneticccontour map of the city buried 15-25 feet below the plain of Crati.

Quite familiar to most engineers who have read articles about archaeology is the story of radiocarbon dating, now in its 26th year. It shows in dramatic fashion both the possibilities and limitations of this technique and the need to be ever prepared for changes in thinking.

When a radical new tool is introduced into a field you regard as your area of expertise, it can be profound and unsettling. Aristide V. de Grosse, the chemist, came into our University Museum after World War II and asked for a large piece of Egyptian wood which could be dated by us with considerable accuracy in a traditional fashion. This was in 1948 and, in 1934, he had anticipated the existence of "cosmic radioelements."

He explained to us, in terms which must have seemed arcane at best, how he had isolated carbon 13 in Baltimore sewer gas and hoped to use it in medical research. He and Nobel Laureate Willard Libby along with others then used carbon 14 (C14) as a radioactive isotope to date organic materials. I was amazed to learn later on that some wooden objects from a site I had worked in the Arctic received a C14 date 1,000 years later than we had expected.

It took us time to learn that the measured value of the half-life of C14 was not right and that the ratio of C14 and C12 in the atmosphere and oceans had not always been constant. During the fruitful 25 years which followed, and are still continuing in labs throughout the world, we have now established a guide to C14 accuracy by means of the measurement of the tree-rings from long-lived bristlecone pines. A master chronology--we call it a table to dendrochronological dates--has been established at three differenct places: the University of Arizona, the University of California at San Diego, and our Museum.

We can date with reasonable accuracy back to 5400B.C.--a span of almost 7,400 years. Ancient sequoias are also used in tree dating. Interestingly enough, this technique goes back to the 1901 work by A.E. Douglass, an astronomer, who had hoped to correlate climatic changes and sunspots.

Many archaeologists have challenged the validity of using the bristlecone pine-sequoia time scale as a base for checking C14 dating but independent studies seem to bear out its significance. Elizabeth K. Ralph and Henry N. Michael of MASCA have published articles in Science (Vol. 153, No. 3743, Sept. 23, 1966) and in the American Scientist (Vol. 62, No. 5, Sept.-Oct. 1974) as well as in MASCA newsletters with corroborating data. The sequoia and bristlecone pine projects have been supported by NSF grants through the Earth Sciences Division.

From a practical archaeological standpoint, the most significant dates are those of the Bronze Age and Neolithic period, before 1000B.C. For example, the Early Bronze Age at Chios, Greece should read 2650B.C. and not 2150B.C. as often was reported. At a 1969 conference in Uppsala, Sweden, 74 radiocarbon dates of 55 Egyptian arabheological samples were assembled and divided into three major classes: short-lived, such as linen, cloth, reed matting, human bones and tissues; long-lived, such as supporting timbers, parts of wooden coffins or sarcophagi made of large pieces of wood with many discernible rings; and "mixed" such as charcoal samples which may have come from young or old wood. Evidence obtained then and since that meeting is overwhelmingly in favor of the successful correlations of C14 and archaeological dates from Egyptian dynastic samples.

What is the significance of this finding? It means that the Bronze and Iron Age cultures of Europe, instead of being influenced directly by Egyptian and Mycenean civilizations, may have developed independently in southeastern Europe.

Now we have a host of other atomic or nuclear methods of dating including potassium-argon, fission-track, uranium and lead isotopes, and now thermoluminescence, abbreviated TL. We find that we can use thermoluminescence most effectively in archaeology while the other techniques seem to work best in determining geological age or earth history. Miss Ralph and Mark Han of MASCA announced the successful application of TL for archaeological dating in 1965. We believe that TL will become a strong force in dating.

How does it work?

It measures the amount of accumulated radioactive damage that takes place through internal bombardment by alpha, beta, and gamma rays of clay artifacts after they have been fired. The archaeologist grinds fragments of an artifact of pottery, bricks, tiles, or any other fired clay object. The fine powder is heated rapidly so that the released photons can be detected by photomultipliers. The glow curve shows the accumulated radioactive damage since the clay artifact was originally made. In general, the older the pottery, the greater the thermoluminescence or glow. Despite complexities and some difficulties, archaeologists feel that they may eventually approach the accuracy of C14 dating.

It was in Alaska before the Second World War that I first became aware of electrical instruments for underground search of hidden artifacts. The first test, I believe, was made by a Yale

archaeologist in Mexico at the site of Tepectepan. Later Professor Case of Oxford was locating pits and trenches of the Bronze and Iron Ages in Great Britain. His success encouraged a group of us to make an experiment with a commercial electrical resistance instrument in the Olmec country of eastern Mexico in 1960 where we found a large stone stele. The proton magnetometer was then developed at Oxford and we used it with other instrumentation at Tarquinia in Italy to locate buried ramps leading into Etruscan tombs. Using a periscope, we were soon finding up to six Etruscan tombs each day. Then came a search, futile for eight years, of trial and error, to find deeply buried ancient walls.

We used sonic devices developed by Texas Instruments and Petty Geophysical Company and eventually, with Varian Associates in Palo Alto, produced the cesium magnetometer with the aid of that company's engineers. Dean Smith was the engineer who produced the cesium device which solved our problem so that we could locate limestone walls with concentrations of roof tiles buried six meters deep. In addition, the speed of magnetic contour mapping enabled us to cover up to five hectares a day. Streets and city plans were mapped in Greece and other countries.

I still get excited about archaeology and there was no more thrilling moment than our return to Olmec Country in Mexico in 1968 to search for buried monuments at San Lorenzo. Extraordinary stone carvings (some weighing several tons and carried for 70 kilometers) turned out to be magnetic. A magnetic contour map could be used to

chart the location of the carvings since the alluvial soil in which they are buried is magnetically quiet. We discovered 17 monuments in unexpected areas including one colossal head in mint condition. While magnetometers are of aid to archaeologists all over the world, on land and sea, they are also used by unscrupulous treasure hunters and pirates.

Another vital tool of modern technology is aerial photography from balloons and planes, such as Charles Lindbergh's famous flights over the Maya jungles and Erich Schmidt's mapping of the grasslands of Iran.

It is high resolution photography from satellites that has proved a particular boon, including the Earth Resources Technology Satellite (ERTS) launched by the U.S. Department of the Interior and NASA. The satellite which circles the earth, and which I first doubted as an effective archaeological survey instrument, is producing results being monitored by Bruce Bevan of MASCA and others. We have been able to detect ancient water courses and also can learn the optimum time to perform archaeological photography in an area. Images transmitted from the spacecraft can show a road 10 meters wide on the red scanner image, ponds which are 92 meters in diameter, agricultural crops, a possible invasion of the Red Tide (plankton) which can affect fish, ice conditions in the Arctic, and clear and turbid waters.

In addition to searching for archaeological sites on land and from the air, there has been an explosion of underwater archaeology since 1948. We had budget crunches even then, and when we could not afford professional divers, Ph.D.'s learned how to dive and explore.

In the late 1950's, the first attempt was made by Peter Throckmorton and George Bass off the coast of Turkey. Engineers will appreciate how Bass used an airlift for excavation, balloons for lifting heavy materials, a tow-line for underwater exploration, a "telephone booth" (a plastic dome with an air bubble anchored on the bottom to give divers rest and security), underwater television, stereoscopic cameras for mapping, the two-man submarine, the Asherah, and side-scanning sonar. The crew a few years ago located a deep wreck off the Turkish coast with the new side-scanning sonar and descended to it right on target in the open sea.

Newer techniques now being explored at MASCA and other centers of archaeological research include examinations of "trace elements" with concentrations less than 0.01 percent, a kind of fingerprinting of the ancient world. Examinations of certain artifacts such as obsidian used for tools in the Mediterranean show that seaborne and overland communications in the Stone Age were much more elaborate than we had thought.

Preserving ancient remains which come to light is another important problem we are attacking. When the late Rodney Young of the Museum unearthed ancient Gordion in Turkey, the site where Alexander the Great is reputed to have cut the Gordian Knot and thus was undisputed conqueror of the ancient world, emergency methods had to be employed to keep water-soaked wood from deteriorating. MASCA is also looking at experiments for preserving mud brick in the field, particularly in Iran and Iraq, where large excavations may be imperiled if allowed to weather.

What tools will engineers and scientists use in the future to discover our ancient ancestors, lost civilizations, and forgotten languages?

We don't know. But we do know that there is a fruitful partnership between archaeology and technology and science with a better mutual understanding of the distant past in human affairs. This understanding can help to relate the lessons of human experience to the issues and events of contemporary life.

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