The Enigmatic 'Battery of Baghdad'

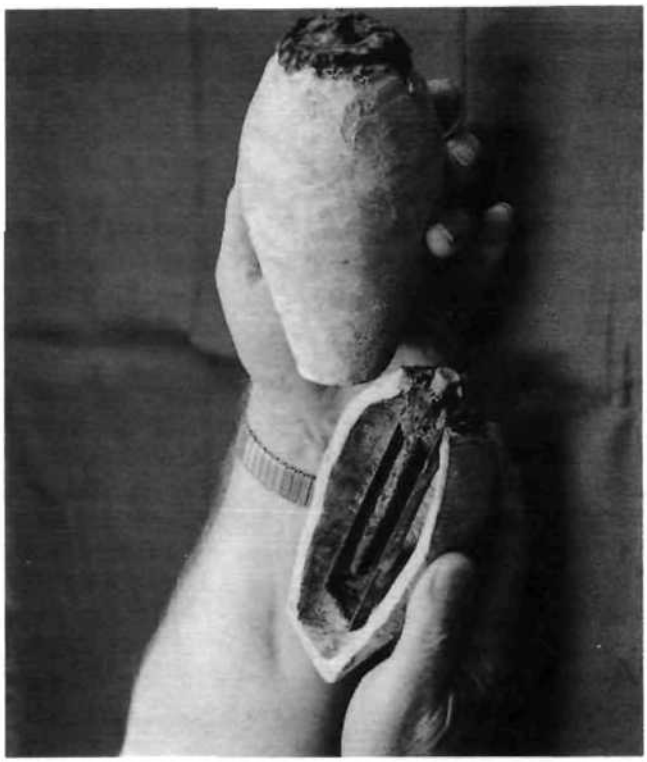
This 2,000-year-old find is considered by some scientists to be an electrical power source. Did it really work?

GERHARD EGGERT

"Nothing is impossible," it is said. This at least holds true for pseudoscientific claims. Looking at Egyptian wall carvings or interpreting ancient texts, some sensationalists see evidence for ancient electricity, including light bulbs (Krassa and Habeck 1994; Von Däniken 1989; Editors of Time-Life 1990). These extraordinary claims that lack substantiated proof can be dismissed. But there is an ancient archaeological find considered by some scientists to be an electrical power source, the so-called "Battery of Baghdad." Did it really work?

A Claim Is Born

The whole story goes back to the painter Wilhelm König (König 1938; Dubpernell 1978), who in the thirties served as director of the Iraq Museum in Baghdad. During excavations at Khuyut Rabbou'a[1] near Baghdad in 1936 an object of unknown purpose (Figure 1) was unearthed in 2,000-year-old Parthian layers [Parthia was an ancient Asian culture]. "In a



Model of the 'Battery of Baghdad' (The Berkshire Museum, Pittsfield, Massachusetts).

vase-like container of bright yellow clay, the neck of which had been removed, a copper cylinder was stuck, held in place by asphalt. The vase was about 15 cm high; the cylindrical tube with a closed bottom made from sheet copper had a diameter of 26 mm and a height of 9 cm. In the latter a completely oxidized rod of iron was found, held in place by a sort of stopper of asphalt. . . ." (König 1940; Dubpernell 1978). König (1938) noted parallel finds from Seleucia: bronze cylinders with papyrus relics inside; and from Ctesiphon: rolled bronze sheets. These later Sassanian finds have been discussed and depicted in detail by Paszthory (1989).

Perhaps the similarity of the object's form (but not the materials) to a modern dry battery with a zinc cup and a carbon rod led König to conjecture: "From its parts and their arrangement one might think that it must be a kind of 'galvanic' element or battery" (König 1938; Dubpernell 1978).

But one cannot say (De Camp 1991) that "the only use that anybody has been able to conceive for them is as battery cells for electroplating small objects with gold." By discussing the magical meaning of metals in antiquity, Paszthory (1989) has argued (like most of the excavators half a century earlier) that such objects might have been containers for blessings or incantations written on organic material. This answers convincingly the question of the claim's proponents: What else could it have been?

Gerhard Eggert is a chemist and heads the Conservation Department of the Rheinisches Landesmuseum, Colmantstr. 14-16, D-53115 Bonn, Germany. He does research on archaeological conservation and ancient techniques. This article is based on a paper presented at the Seventh European Skeptics Conference, 1995, Rossdorf, Germany.

Checking the Claim

One is tempted to assume that it is easy to check the "power source" hypothesis. In reality, the situation is more complicated. Take pieces from two kinds of metals and immerse them in an electrolyte (e.g., a sour or salty aqueous solution), and there will be a potential difference between the metals (simply because they are chemically different). More is needed for a good power source: To be useful, a reasonable electrical current (i.e., a flow of electrons) must flow for a reasonable length of time. The electrons (e) are set free at the anode, here, the iron (Fe) rod ($Fe \rightarrow Fe^{2+} + 2e$). To draw current from the apparatus, an outer electrical circuit must be closed; then the electrons can flow through it to the copper cylinder. There the electrons must take part in a cathodic reaction. But what kind? Because it is unknown which type of electrolyte (if any) was inside the copper cylinder, there are only speculative answers to this question (Table 1).

W. F. M. Gray, who was the first to build a reconstruction model of the "Battery of Baghdad," used a solution of copper sulfate for this purpose (Schwalb 1957). He found that this "worked quite well for a short time" (Ley 1954). Problems may arise from the direct deposition of copper on iron ($Fe + Cu^{2+} \rightarrow Fe^{2+} + Cu$). [Reconstruction models made by Gray are no longer on display but can be seen by appointment in the Berkshire Museum, Pittsfield, Massachusetts.]

Jansen et al. (1993) had the idea to use benzoquinone, which is known to be easily reduced to hydroquinone at the cathode. (Quinones occur naturally in the secretions of some beetles; as much as 300 mg can be found in large centipedes.) Good experimental results were obtained with 100 mg 1,4-benzoquinone in 200 ml dilute acetic acid (vinegar) as electrolyte. Other organic compounds would work also.

König (1938) himself vaguely spoke of an acid or alkaline liquid, and Schwalb (1957) thought that, compared with copper sulfate, "acetic or citric acid, which the ancient chemists had in plenty, should be even better." As Paszthory (1989) and Jansen et al. (1987b, 1993) have shown, naturally occurring organic acids or sour fruit juices (pH 2-3) are too weak: It would take strong mineral acids (unknown at that time) to generate hydrogen gas at the copper cathode in such an element. The small current flowing initially is due to the reaction of oxygen dissolved in the electrolyte. Thanks to the leakproof construction of the copper cylinder of König's find (soldered, sealed with asphalt), no oxygen (O_2) from the outside air can enter into the electrolyte (Figure 2, left). When the small amount of oxygen inside is consumed by the cathodic reaction to hydroxide, the current decreases to negligible levels.

In an erroneous model experiment (copper cylinder without bottom), Jansen et al. (1987a, b) have shown that only elements into which oxygen can diffuse from the outside can operate continuously.

But wait a minute: Most of the parallels to the Khuyut Rabbou'a find are not tightly closed copper cylinders. They are rolled bronze sheets only sealed at the top and the bottom (Paszthory 1989). Because the seam is not soldered, these cylinders cannot hold any liquid, so the whole vase would be filled with electrolyte (Figure 2, right). The walls of the earthenware

vases are porous, and oxygen from outside could diffuse steadily into the electrolyte, which would be tantamount to a steady electrical current. In this new speculative interpretation, the original "Battery of Baghdad" becomes a faulty deviation of the working Ctesiphon type. Nevertheless, a flat, open tray with a copper-wire mesh near the level of the electrolyte would be a much better design for the reduction of oxygen from the air.

But I am not persuaded, even by my own speculation, above. With the help of additional assumptions, one can get some current some of the time from the object. And if the current or the voltage is too low for practical applications, why not connect 10 or 100 or 1000 of them? As is always the case in experimental archaeology, successful experiments alone can show only a supposed ancient technique to be possible, but never its application. For instance, Thor Heyerdahl only showed with his Ra voyage that in principle it is possible to cross the Atlantic in an Egyptian boat. To accept the claim that the Egyptians really did so, one would need archaeological evidence from America (such evidence exists for the Vikings).

Concerning the claim of an ancient power source, where are the ancient electrical apparatuses or processes? Despite claims, there is neither an ancient object that supports the existence of ancient electrotherapy (most recent speculation: electroanalgesia [Keyser 1993]), nor electroplating; nor is there any written evidence. Archaeometry so far could not prove any ancient Near Eastern object to be electrogilded.

Based only on second-hand knowledge of König's mention of finds from Tel Asmar (2500 B.C.) some scientists took for granted the existence of such an ancient technique (Bockris and Reddy 1977). König also used his own observation of a strange galvanic gilding method of contemporary silversmiths in Baghdad as an argument for his interpretation of the find: "A primitive process of gold plating is still in use in Baghdad today on a secret [sic] electrical basis. Probably it is older than one might think?" (König 1940; Dubpernell 1978). The process (Figure 3) combines a current device and a cyanidic gold-plating bath in one simple unit with only two electrodes. As was shown recently (Eggert 1995), the process is very similar to John Wright's invention (1839) in Birmingham, England (Figure 4). This process was included by the Elkingtons in their British Patent 8,447 (Hunt 1973), where also the differences (e.g., the use of a common salt solution instead of dilute sulfuric acid) are described. The only reasonable explanation for this is that the process is not a relic of ancient knowledge ("older than one might think") but at the time of König's publication, only 99 years old.

In my opinion, the "magical container" hypothesis is much more probable than the "power source" claim. The latter is a "mystification by science" (Thumshirn 1986) of the object, which violates Occam's razor.

The Claim and the Scientists

It is no wonder that the claim of Parthian power sources found its way into (multicultural) pseudoscience (Ortiz de Montellano 1991). Von Däniken (1993) repeats it again and again without informing his readers about the disputes. And

Table 1. Suggested Reactions at the Copper Cathode

Cathodic reaction	Reduction of	Source of the reactant	Reference
$Cu^{2+} + 2e \rightarrow Cu$	cupric ions to copper metal	copper sulfate from mineral deposits	Schwalb 1957
$OC_6H_4O + 2H^+ + 2e \rightarrow HOC_6H_4OH$	p-quinone to p-hydroquinone	secretion of centipedes etc.	Jansen et al. 1993
$2H^+ + 2e \rightarrow H_2$	protons to hydogen gas	mineral acids (unknown at that time)	Jansen et al. 1993
$O_2 + 2H_2O + 4e \rightarrow 4OH$	oxygen gas to hydroxide ions	oxygen dissolved in the electrolyte in the closed copper cylinder	Paszthory 1989, Jansen et al. 1987b
$O_2 + 2H_2O + 4e \rightarrow 4OH$	oxygen gas to hydroxide ions	oxygen from the air	Eggert 1996 (this article)

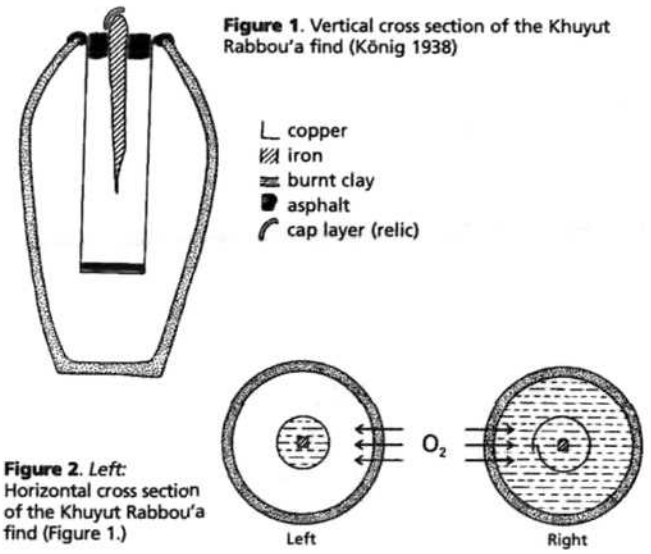


Figure 1. Vertical cross section of the Khuyut Rabbou'a find (König 1938)

Figure 2. *Left:* Horizontal cross section of the Khuyut Rabbou'a find (Figure 1.)

Right: Hypothetical reconstruction of an element with a bronze roll cathode

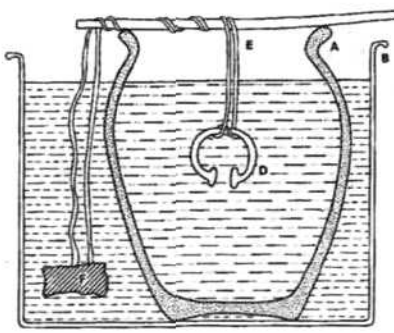


Figure 3. Köing's (1938) sketch of the gilding method of the Baghdad silversmiths with his explanations:

A porous clay jar with gold cyanide solution
B cooking vessel with solution of common salt
C rod for hanging
D object to be gilded
E copper wire
F zinc pole

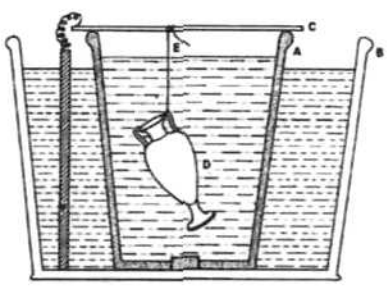


Figure 4. Modified drawing of Wright's invention of 1839 (Eggert 1995):

A ordinary flowerpot containing a cyanide solution
B outer vessel containing dilute sulphuric acid
C (obviously metallic) rod
D object to be gilded
E (metallic) wire
F sheet of zinc surrounding the porous cell

what about the scientists who also often cited the claim uncritically from third-hand information? They apparently liked the idea that electrical current had been used by the ancients and was only rediscovered by L. Galvani and A. Volta. The question regarding the "Parthian power source" was sometimes lost, and so, the conjecture became stated truth. This helped in a public relations campaign for the exhibition of objects from the Iraq Museum in the "Roemer- und Pelizaeus-Museum" in Hildesheim (Germany) in 1978, where the find was presented. While other museums showing the same exhibition correctly called the object "controversial," the Hildesheim museum said, "Unbelievable as it sounds, some 1,800 years before Galvani . . . the Parthians knew an electrical cell" (Catalogue 1978). The museum presented a gilding experiment to journalists with an open reconstruction model of the "battery" (no asphalt stopper on top).

In 1978 German television (ZDF) journalist G. Kirchner let a Hildesheim restorer wearing a white coat pose as a chemist with a reconstruction model to lend more credibility to the claim. In the book accompanying the television series, Kirchner (1979) states after uncritical presentation of the find of a battery that the battery development department of a certain company was to perform experiments to solve the enigma of the Parthian "battery." First publish the results, then do the research?

Such investigations must be done carefully. Coll (1970), for example, fell into the pseudoscientist's trap of not citing his source of information. He denied the existence of the object based on wrong information from an archaeologist; Von Däniken (1978) thus was able to counter triumphantly.

MacKechnie Jarvis (1960) also could not resist speculation: "The following suggestion is made without the opportunity for visual examination of the find. It is that the object found is a cell of modern origin and that its presence in the desert in the neighbourhood of Baghdad can be explained by the activity of telegraph enterprise during the second half of the nineteenth century."

The fact that the construction of the "Battery of Baghdad" is technically not optimal can allow one to indulge in flights of fancy. H. Gebelein, a German professor and both chemist and alchemist interprets this as a hint that the construction plan for the "battery" might be hidden in ancient mythology: the affair of Venus (in alchemy related to copper) with Mars (related to iron).[2] In Gebelein's view, the copper cylinder corresponds to the vagina, the iron rod to the penis. And what about the presumed lemon juice or vinegar as electrolyte? These were used for contraception in ancient times, explains Gebelein.

While Gebelein's interpretation is really alchemy, the idea that the object might be a sexual symbol and not a battery is certainly worth considering (Priesner, see Jansen et al. 1993).

The Claim: A Shocking Discovery?

Although not likely, what if the Parthians really used electricity? Would it be "a shocking discovery" (Gray 1963)? Certainly not. It would add only one item more to these inventions lost in time, which for one reason or another had no significant impact on the course of history despite their potential (Stiebing 1984). The claim of an ancient power source is not an "impossibility" (Von Däniken 1968). But even if it existed there is no need to postulate external influences leading to or surrounding such an invention.

Just the opposite: Had there been extraterrestrial visitors with space travel technology, they could have shown the Parthians ways to produce much less primitive power sources than the ones the Parthians possibly had.

Notes

1. Other transcriptions of the Arabic name in the literature are Khujut Rabu'a and Chujut Rabuah.

2. Background is the view of some alchemists that ancient mythology is an allegoric form of description and proliferation of the secrets of the alchemists (Gebelein 1991).

References

Bockris, J. O. M., and A. K. N. Reddy. 1977. *Modern Electrochemistry II,* 3d. print., note on p. 1265. New York: Plenum Press.

Catalogue. 1978. Exhibit: Sumer Assur Babylon, Roemer- and Palizaeus-Museum. No. 182. Mainz: P. V. Zabern.

Coll, P. 1970. *Geschäfte mit der Phantasie,* p. 114. Würzburg: Arena.

De Camp, L. S. 1991. *The Ancient Engineers.* 8th print., p. 252. New York: Ballantine.

Dubpernell, G. 1978. Evidence of the use of primitive batteries in antiquity. In *Selected Topics in the History of Electrochemistry,* ed. by G. Dubpernell and J. H. Westbrook, 1-22. Princeton, N.J.: The Electrochemical Society. (Contains full English translation of König's papers.)

Editors of Time-Life. 1990. *Feats and Wisdom of the Ancients.* Library of Curious and Unusual Facts, pp. 20-21, 26-27. Alexandria, Va.: Time-Life Books.

Eggert, G. 1995. On the origin of a gilding method of the Baghdad silversmiths. *Gold Bulletin* 28(1): 12-16.

Gebelein, H. 1991. Alchemie, pp. 106-109. München: Diederichs.

Gray, W. F. M. 1963. A shocking discovery. *Journal of the Electrochemical Society* 110(9): 210C-211C.

Hunt, L. B. 1973. The early history of gold plating. *Gold Bulletin* 6(7): 16-27.

Jansen, W., H. Fickenfrerichs, R. Peper, and B. Flintjer. 1987a. Die Batterie der Parther und das Vergolden der Bagdader Goldschmiede. Part 1. *Chemie für Labor und Betrieb* 38(10): 528-533.

———. 1987b. Ibid. Part 2. *Chemie für Labor und Betrieb* 38(11): 586-592.

———. 1993. Ibid. Part 3. *Chemie in Labor und Biotechnik* 44(3): 128-133.

Keyser, P. T. 1993. The purpose of the Parthian galvanic cells: A first century A.D. electric battery used for analgesia. *Journal of Near Eastern Studies* 52(2): 81-98.

Kirchner, G., Editor. 1979. *Reportagen aus der alten Welt.* 2d. print., pp. 99-103. Franfurt (Main): Fischer.

König, W. 1938. Ein galvanisches Element aus der Partherzeit? *Forschungen und Fortschritte* 14(1): 8-9.

———. 1940. *Neun Jahre Irak.* 3d. print., pp. 166-168. Brünn: R. M. Rohrer.

Krassa, P., and R. Habeck. 1994. *Das Licht der Pharaonen.* Frankfurt: Ullstein.

Ley, W. 1954. The Elements of Khujut Rabu'a and Ctesiphon, *Galaxy Science Fiction* 9(3): 44-51.

MacKechnie Jarvis, C. 1960. An early electric cell? *Journal of the Institute of Electrical Engineers* 6: 356-357.

Ortiz de Montellano, Bernard. 1991. Multicultural pseudoscience: Spreading illiteracy among minorities. SKEPTICAL INQUIRER 16(1) (Fall): 46-50.

Paszthory, E. 1989. Electricity generation or magic? The analysis of an unusual group of finds from Mesopotamia. *MASCA Research Papers in Science and Archaeology* 6: 31-38.

Schwalb, H. 1957. Electric batteries of 2,000 years ago. *Science Digest* 41(4): 17-19.

Stiebing, W. 1984. *Ancient Astronauts, Cosmic Collisions,* p. 104. Amherst, N.Y.: Prometheus Books.

Thumshirn, W. 1986. Die "Urbatterie" sollte bloss Dämonen abwehren. *Frankfurter Allgemeine Zeitung,* July 23.

Von Däniken, E. 1968. *Erinnerungen an die Zukunft,* pp. 51-52. Düsseldorf: Econ. (English translation quoted from Stiebing: *Chariots of the Gods,* p. 27. New York: Bantam Books).

———. 1978. *Im Kreuzverhör,* pp. 105-106. Düsseldorf: Econ.

———. 1989. *Die Augen der Sphinx.* 2d. print., pp. 214-223. München: C. Bertelsmann.

———. 1993. *Raumfahrt im Altertum,* pp. 100-113. München: C. Bertelsmann. □