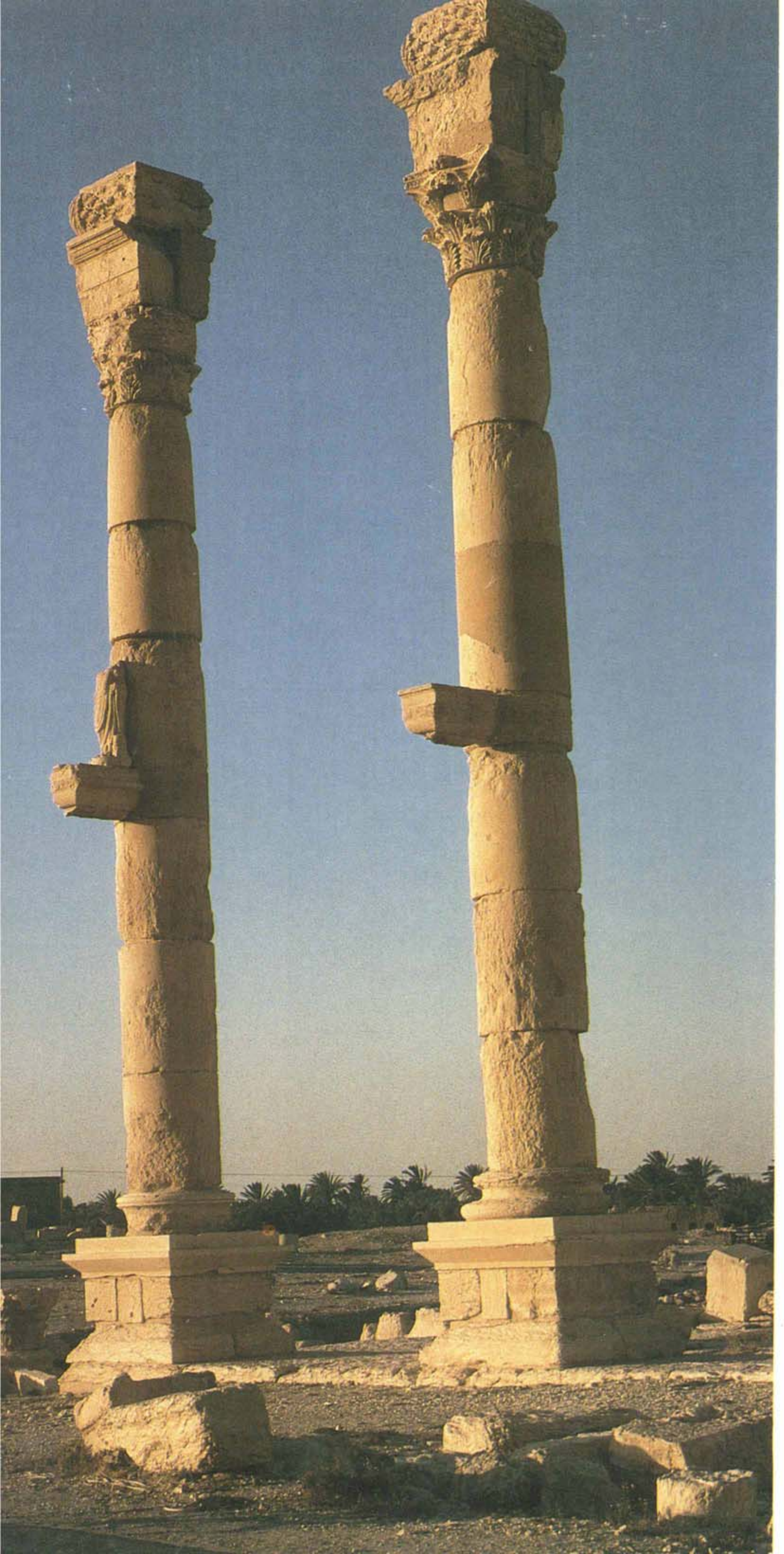

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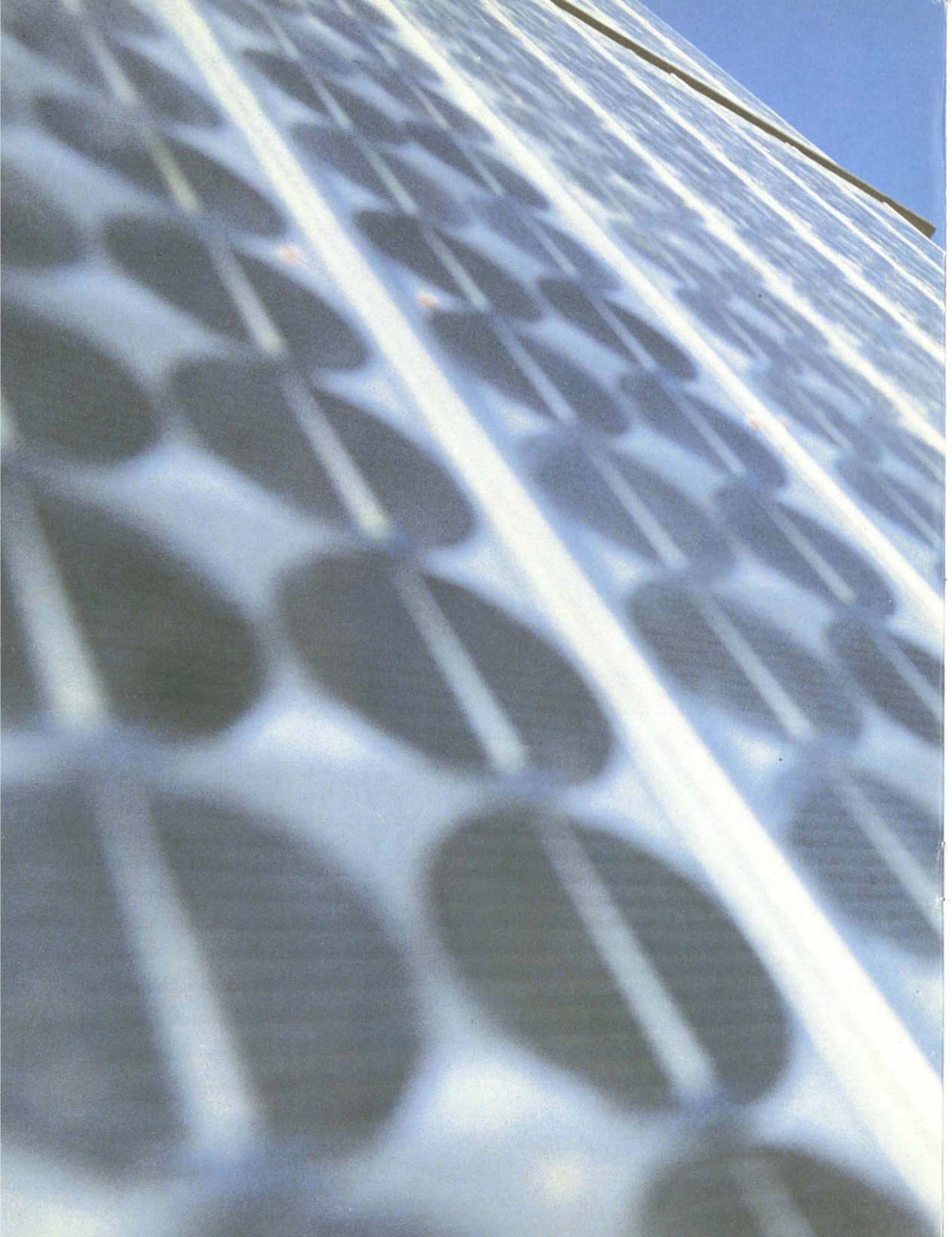
SEPTEMBER – OCTOBER 1981

SAUDI ARABIA AND SOLAR ENERGY
A SPECIAL SECTION

THE SINDBAD VOYAGE



ARAMCO WORLD magazine

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Cover: Poised against the skyline, the *Sohar*, a replica of a ninth century dhow constructed in the traditional manner, drops anchor in Singapore enroute to Canton, in China, as did the legendary Sindbad the Sailor, hero of hundreds of fables, but possibly, says the *Sohar* crew, a real man whose real adventures gave birth to the myths that endure to this day. Photograph by Tor Eigeland. Back cover: A view of Palmyra's ruins. Photograph by Katrina Thomas.

◂A panel in an experimental photovoltaic system, set up to see how solar energy can help in Aramco's endless struggle against corrosion in pipelines and well casings.

"Gold has always fascinated man-for fascinating reasons..."

A SPECIAL LUSTER

WRITTEN BY ROBERT OBOJSKI
COINS PHOTOGRAPHED BY MICHAEL DI BIASE

Since the late 1970's numismatists – coin collectors – have begun to explore a relatively new and potentially invaluable source of coins for their collections: coins in gold from the Muslim world – what they call the "Arab-Asian Empires."

Until then, most Western collectors had skipped over Arabic gold coins, as they had silver coins (See *Aramco World,* July-August 1978). They avoided Muslim-world coins because, as one expert put it, "all the coins look alike to the average Western eye," and because they simply couldn't read the Arabic inscriptions. But in the late 1970's, gold coins in general began to attract the eye of both collectors and investors – collectors because they needed new fields to explore, investors because the price of gold suddenly skyrocketed; between early 1979 and early 1980 gold shot from about $200 per troy ounce to $800.

A gold dinar minted in 769 at Baghdad by al-Mansur.

Gold has always fascinated man – for fascinating reasons: because of its luster, its beauty and its value, of course, but also because of its extraordinary properties.

Gold, for example, is highly malleable; it can be beaten into sheets less than 1/250,000 of an inch thick, and one *ounce* can be drawn into 60 miles of wire. It is also exceptionally heavy – a 14.2 inch cube weighs one ton – and does not tarnish or rust, since it does not react to moisture, air or most acids. Thus, gold coins of ancient

A gold dinar struck in 998 at Cordoba by Hisham II.

Greece, Rome and Byzantium often look as if they're fresh from the mint, and centuries-old coins dredged from the wrecks at the bottom of the ocean still retain their luster – the special luster of gold.

Gold, of course, is also rare; that's the secret of its value. Since the beginning of recorded history, the story goes, some 6,000 years ago, all the pure gold wrested from the earth could be compressed into a cube measuring no more than 13.5 meters (45 feet) on each side. As a result, gold has been the symbolic – and actual – foundation of monetary economics since civilization began.

In modern times, gold has been a force for stability. When the United States went off the Gold Standard, in June, 1933, the price of the metal had been fixed at $20.67 per troy ounce – and then in 1934, under the provisions of the Gold Reserve Act, President Franklin D. Roosevelt, by executive order, froze the price of gold at $35.00 per ounce, a price that endured for nearly 35 years, and was, in effect, the world price too, since the United States then held a high proportion of the world's monetary gold reserves.

In 1968, however, gold reached $40 in London, and in 1969 reached $47 in Paris. By 1972 the price was up to $70 and on May 14, 1973, the London market closed at $102.50. And that was just the beginning. In 1974 it became legal for U.S. citizens to own gold and not long after prices touched the $200 mark. Then, after three years of fluctuation, gold, in early 1979, skyrocketed. By the end of the year prices reached $500 an ounce and in mid-January, 1980, shot up to $800.

For numismatists who were already showing an interest in coins, those prices were frosting on the cake and the result is a small boom in gold coins with significant interest in Middle Eastern coins. "It's truly amazing how many collectors in the West are now taking a serious interest in Middle Eastern gold and silver coins," commented Louis DiLauro, Los Angeles numismatist, who has specialized in coins of the Arab lands for many years. "Newly-published numismatic catalogs and guidebooks giving translations of Arabic, Persian and Turkish inscriptions have done a great deal to help collectors attribute their specimens properly," DiLauro added.

Such catalogs also measure the degree of collector interest. One example is Robert Friedberg's *Gold Coins of the World: Complete From 600 A.D. to the Present,* in which he introduced a new "Arab-Asian Empires" section, created especially for the book. The first edition of the book was entirely sold out within a few weeks after it was released in mid-1980 by the Coin and Currency Institute in New York and when a second printing was ordered for the fall of 1980, that, too, was sold out within a very short time.

This gold half pound coin shows Ramses II driving a chariot.

Even Friedberg's book, however, perpetuates the belief that Arabic coins look alike. The author, for example, says that while it would have been possible to make a complete catalog of the coins struck under each ruler (as has been done for other countries in this book), "it was decided not to do so because all the coins look alike to the average Western eye and because the monotony of type and appearance remains unbroken over centuries of issue."

Actually, as DiLauro has indicated, numismatists are coming to realize that Friedberg's contention is not entirely valid. Designs and inscriptions *do* vary from one period to another, though the changes are more subtle than variations we see on Western money and catalogs are now beginning to reflect this. Furthermore, a study of these coins – like the silver "coins of history" – offers a convenient view of the history of the Arab lands and the Muslim empire.

This gold bezant, which comes from Antioch, was issued by the Crusader King Bohemund I between 1098 and 1111.

This gold coin, issued by the Umayyad Caliph 'Abd al-Malik, was struck at the Damascus mint sometime around 693.

In the Middle East, objects crafted of gold were utilized as currencies long before the first coins were ever struck. As early as the 17th century B.C., for example, gold "money rings" circulated throughout much of Egypt and its environs. Examples can still be seen at the British Museum in London, the Bibliothèque Nationale in Paris and the Smithsonian Institution in Washington, D.C. Much later, as empires waxed and waned, Greek, Roman and Byzantine coins were circulated throughout the Middle East too, some of which were still in use when Islam's Umayyad dynasty was founded and began to accept tribute from its territories.

Up to this point the Arabs had not yet produced coins of their own, having been content to use the Byzantine gold *solidi* they found in the former imperial provinces now under their jurisdiction. By the end of the 7th century, however, the conquered territories were delivering considerable amounts of tribute to the court at Damascus and a mintage of new coins became a necessity – though even then the coins were really imitations of Byzantine *solidi.* The Christian emblems were altered, of course, but otherwise they adhered to Byzantine designs. According to most numismatists, the first purely Islamic coins to be issued were the gold *dinars* struck by the Umayyad Caliph 'Abd al-Malik at the Damascus mint, and one, minted in 693, shows that they were patterned after a *solidus* of the Byzantine emperor Heraclius (610-41).

The Byzantine gold piece features standing figures of the Emperor and his two sons, while the reverse side displays a cross at the top of a flight of four steps, presumably meant to represent the cross of Calvary. On the Arab *dinar,* the figures hold staffs or swords rather than crosses, and on the reverse side, of course, there is no cross and the inscription reads: "In the name of God, there is no god but God; Muhammad is the Messenger of God."

These coins, apparently, were an experiment – few specimens have survived – and by the time the Umayyads commenced a fairly large-scale coinage of gold *dinars,* in 696, 'Abd al-Malik had settled on more severe, non-pictorial designs that were to distinguish Islamic coinage throughout the centuries. *Dinar,* the Arab term for a gold piece, is a development of the word *denarius,* the principal silver coin of Roman times, but under the Byzantines was used as a synonym for the gold *solidus.*

The Ottoman Sultan Mehmet II issued this gold altun. The coin was struck in the mint at Constantinople in 1478.

Some 50 years after the coinage of gold *dinars* began, the Umayyad dynasty was overthrown, and the powerful Abbasids who succeeded them transferred the capital – and the mint – from Damascus to Baghdad. But though the Abbasids remained as caliphs until they were overwhelmed by the Mongols in 1258, and were responsible for the "Golden Age", their coinage shows little change; the Abbasid caliphs followed the Umayyad patterns closely and any variation in design was minor. One example is the *dinar* of the Caliph al-Mansur (754-75). Its central inscription, in Arabic, is "There is no god but God", etc., and inscribed around the edge and on the reverse are additional quotations from the Koran and the date A.H. 152, the equivalent of A.D.769 (Muslim dates are given as A.H., meaning "Anno Hegirae" and begin from the year Muhammad went from Makkah to Medina.)

Coins also tell the story of Muslim Spain. Gold *dinars,* for example; were minted under 'Abd al-Rahman III (912-61).

The 100 piastre coin issued by Sultan Abdul Hamid II in 1876.

The head of Ataturk, founder of modern Turkey, on a gold coin issued in 1960.

Like silver *dirhams* of the same period they are inscribed with the *Shahada,* the date, the name of the ruling caliph and the mint. One, for example, was issued under the Caliph Hisham II (976-1013) and was struck in 998 at Cordoba, the Moorish capital. It was one of the most magnificent cities of Europe: a spacious breezy metropolis extending for a dozen miles along the banks of the Guadalquivir River, and one of the world's greatest centers of commerce, learning and art.

Muslim coins of Moorish Spain, especially the gold *dinars* soon found their way into Christian hands – and were welcome since virtually no European gold coins were being struck at this time, except in the distant Byzantine Empire. Indeed, a sizable percentage of the gold coins circulating in Poland during the 10th, 11th and 12th centuries were of Arab origin.

There are, in fact, gold coins preserved from most of the important periods in Muslim history, and one coin, issued in 1478, announces the arrival of what, for centuries after, would be one of the dominant powers in the world: the Ottoman Empire. This coin, introduced by the Sultan Mehmet II, was the first of a new series called the *altun* – "gold" – or, in Europe, sequin, which was itself a corruption of *zecchino,* the name of a Venetian gold coin, in turn derived from *sikka,* the Arabic word for mint.

Turkish coinage, like most other Islamic issues, carries inscription designs only. On the obverse we see a line inscription indicating the name of the Sultan, his father (Mehmet I), and the date, according to the Muslim calendar, 883. The two upside down "v's" and the elongated "r" at bottom are the Arabic-Turkish forms of the numerals 883. The reverse inscription translates as "Striker of gold, lord of might and victor by land and sea." Mehmet II was not noted for his modesty.

Modern rulers have also issued gold coins, but many of them tell more of the ancient past than the era of their issue. In 1955 and 1957, for example, the Cairo Mint struck a number of interesting gold pieces that recall Egypt's heritage: the one pound and five pound sets commemorating the third and fifth anniversaries of the 1952 Egyptian Revolution.

A Syrian one pound gold piece issued in 1950.

The Coins that weren't

In Saudi Arabia, gold coins have always been important in the monetary system. For years, in fact, paper money was unacceptable, and to pay royalties to the government, Aramco once flew kegs of both gold and silver coins to Jiddah. In 1952, when the Saudi Arabian Monetary Agency (SAMA) was formed, the first coin issued was a Saudi sovereign – a gold coin equal in weight and value to the British sovereign – that was later demonetized and today sells for about $124.

To collectors, however, the most interesting Saudi gold coins weren't coins at all; they were "gold discs." Similar to coins, they were minted by the Philadelphia Mint in the 1940's for Aramco, and bore, on one side, the U.S. Eagle and the legend "U.S. Mint, Philadelphia, USA." and, on the other side, three lines on the fineness and weight. They looked like coins, they were used as coins, but, technically, they weren't coins.

In the 1950's, numismatists were puzzled by these "discs," until – in 1957 – the story emerged in The Numismatist. *Aramco, required to pay royalties and other payments in gold to the Saudi government, could not obtain the gold at the monetary price fixed by the United States so the U.S. government specifically began to mint the "discs" – actually bullion in coin form for these payments. In 1945, for example, the mint turned out 91,210 large discs worth $20, and, in 1947, 121,364 small discs worth $5, according to* The Numismatist.

Because most of the discs were melted down for bullion, or later redeemed for the Kingdom's gold sovereigns, the discs are interesting additions to art collections. But care is necessary as counterfeits are common.

The designs on both issues are identical except for the dates: the powerful Ramses II (1304-1237 B.C.) with a bow and arrow, driving a chariot, with the word "Egypt" written out in hieroglyphics above the horse and in Arabic below. On the reverse, there's a winged sun, an Arabic inscription – that reads "Republic of Egypt," one pound – or five pounds – and the date, given according to both the Christian and Muslim calendars.

In 1968 Egypt issued another five pound gold coin; featuring an open Koran set upon a globe, it commemorates the 1,400th anniversary of the first revelation of the Koran to the Prophet. Other modern Egyptian gold pieces commemorate the establishment of the United Arab Republic, the beginning of the construction on the Aswan High Dam, and the diversion of the Nile at the dam site.

Modern coins have also been issued in Saudi Arabia (see box), Syria, Iran and Turkey. Syria's output is low – one set in 1950 – but Turkey's was prolific: 100 varieties from the 1870's to now including a coin for 100 piasters struck under Sultan Mehmet VI in 1919, and a coin for 50 piasters in 1959, portraying Kemal Ataturk, the Father of Modern Turkey.

All Turkish coins issued under the sultanate carry the *tugra,* the Sultan's calligraphic emblem, on the obverse, and in most cases the value appears directly under the *tugra,* with the dates, according to the Muslim calendar, on the reverse.

A Saudi one guinea coin issued in 1957.

Mehmet II's gold *altun* is a seminal issue in numismatic history because Turkish sultans for nearly 350 years utilized his basic design; only the sultans' names and the dates were changed from one reign to another. But then, after the Ottoman Empire fell and Kemal Ataturk founded a republic, a new coinage system was introduced in 1933 in which Christian dates and Western numerals were indicated. This reform made it possible for Europeans to handle Turkish currencies far more easily. The 50 piaster coin is part of an Ataturk portrait series, minted between 1942-61; it also includes 25, 100, 250 and 500 piasters values which are generally known as "De Luxe" gold coins, actually, souvenir and presentation pieces. Though you won't see them in circulation anywhere in Turkey, they are highly popular as collectors' items. And last, another fine coin from Turkey; there is a 500 lira gold piece of 1973 which commemorates the 50th anniversary of the Turkish Republic and, the end of the Ottoman Empire. This coin features a facing bust of Ataturk with a symbolic shooting star on the reverse; it contains about a fifth of an ounce of bullion and in 1980 was selling in the $225-250 range on the numismatic market.

Last, there are the gold coins of Iran which, until 1854, avoided portraits on their coinage, in accordance with tradition. Recent rulers – Riza Shah Pahlevi (1925-1941) and his son, the late Muhammad Shah Pahlevi (1941-1980), were more forthcoming; their portraits appear on gold and silver *pahlevi's* and *riyals;* on the reverse side of one coin, the quarter *pahlevi* there is a striking design: the arms of Persia, a lion standing before a radiant sun with a sword upheld with one paw. The value is inscribed below the lion in Arabic script. The Shah also issued a single gold commemorative coin, a five *pahlevi* piece struck to celebrate his marriage to Farah Diba in 1961. The coin features the dual portrait of the couple.

All the historic Arab and Turkish gold coins discussed here – except for the *dinar* of 'Abd al-Malik – were comparatively inexpensive since they were struck in large quantities for general circulation. Even as the price of gold began to climb, the Mehmet II *altun* of 1478 was still selling for about $200, and it had a catalog value of only $75 not so long ago. But since the gold bullion prices soared even the most ordinary gold *dinars* have gone up sharply – in some cases more than 100 percent. While the price of gold is subject to market fluctuations, the historical value of coins from the Muslim world remains undiminished.

Robert Obojski is a regular contributor to Aramco World.

THE SINDBAD VOYAGE

WRITTEN BY JOHN LAWTON PHOTOGRAPHED BY TOR EIGELAND AND BARBARA WACE MAP BY NEVILLE MARDELL

From Oman to Canton, in the wake of a legend

ONCE UPON A TIME there really *was* a man called "Sindbad the Sailor" – at least according to the crew and captain of the *Sohar,* a replica of a ninth-century Arab dhow that they sailed from Oman to China.

The point of the voyage was to prove that Sindbad's legendary voyages are rooted in historical fact – and they certainly proved that the voyage itself is possible. In a hand-built craft stitched together with coconut string, and navigating with medieval navigational instruments, British author-explorer Timothy Severin and a crew of 25 sailed the dhow 9,600 kilometers (6,000 miles) between Muscat and Canton.

Severin and his crew, of course, did not have to cope with the innumerable monsters that plagued Sindbad's voyages, but they did face other hazards. On several occasions they were nearly crushed by giant tankers; another time their mainsail spar broke; and for almost a month they were becalmed with little food and water. Finally, as they raced the monsoons across the South China Sea, they faced the threat of pirates.

In all, the voyage took just under eight months. In addition, however, Severin spent some three years in research, travel and construction during which he traced the history of Arab seamanship back to Egypt and followed its development in

Left: The Sohar *sailed into Singapore's harbor just two weeks behind schedule, thanks to winds in the Malacca strait.*

places like Oman, China and India.

The first people known to have used the sail were the ancient Egyptians; the earliest record of a sailing boat – a drawing of a ship with a mast amidships and a broad square sail hung from it – dates back to about 3900 B.C. And it was an Egyptian who provided the first known mariner's tale: an anonymous first-person account of a shipwreck in the Red Sea around 2000 B.C. – in which the mythical embellishments of the Sindbad period are instantly obvious.

"I had set out for the mines of the king in a ship 180 feet long and 60 feet wide; we had a crew of 120, the pick of Egypt. A storm broke and we flew before the wind. The ship went down; of all in it only I survived. I was cast upon an island... then I heard the sound of thunder and thought it was a wave; trees broke and the earth quaked. I uncovered my face and found a serpent. It was 45 feet long and its beard was two feet long. Its body was covered with gold and its eyebrows were real lapis lazuli."

The serpent's looks, it turns out, were deceiving; it was a most considerate creature. It took the sailor tenderly up in its mouth, carried him to its lair, listened sympathetically to his story and then comforted him with the news that one of the Pharaoh's ships would soon come along and take him back home. When the rescue ship, as prophesied, did come along, the serpent sent the sailor off with a cargo of incense, and two months later he was safely home.

Later, and farther east, the people living on the shores of the Arabian Peninsula also learned to sail and in time discovered that they could earn a profit by risking their lives on the sea. Among them were the boat builders and sailors of Makkan (or Magan) – today's Oman – who traded copper and ivory with Mesopotamia. Copper was mined in Makkan itself, but the ivory could only have come from India – or Africa and the implication seems clear: Omani traders, even in 1000 B.C., probably ventured beyond the Arabian Gulf and sailed the open waters of the ocean.

About 500 B.C. these seamen – the early Arabs – also introduced the dhow: a broad-beamed, shallow-draft vessel with lateen-rigged sails, ideally suited for the coastal waters of the Arabian Gulf and the comparatively mild waves of the Indian Ocean. Although relatively flimsy, it was light and maneuverable and could speed quickly out of the path of threatening weather. Its triangular sails, moreover, were designed to catch even the slightest breeze.

The key to their success, however, was the ancient secret of the monsoon winds: the fact that they could rely on prevailing winds to carry them eastward in winter and westward in summer across the Indian Ocean. They could not explain these "monsoons," but this is not surprising since even today there are mysteries about them. One theory is that when the summer heat of India causes the air to rise over the subcontinent, winds from the Indian Ocean rush into the vacuum left by the rising air; by the same token, the comparative coolness of Indian winters causes a reverse movement of winds from India to Africa. Whatever the cause, by the first century A.D. the south Arabian merchants were riding the monsoon winds eastward as far as Ceylon, and by the sixth century, according to one geographer, had established a monopoly of the sea trade with China.

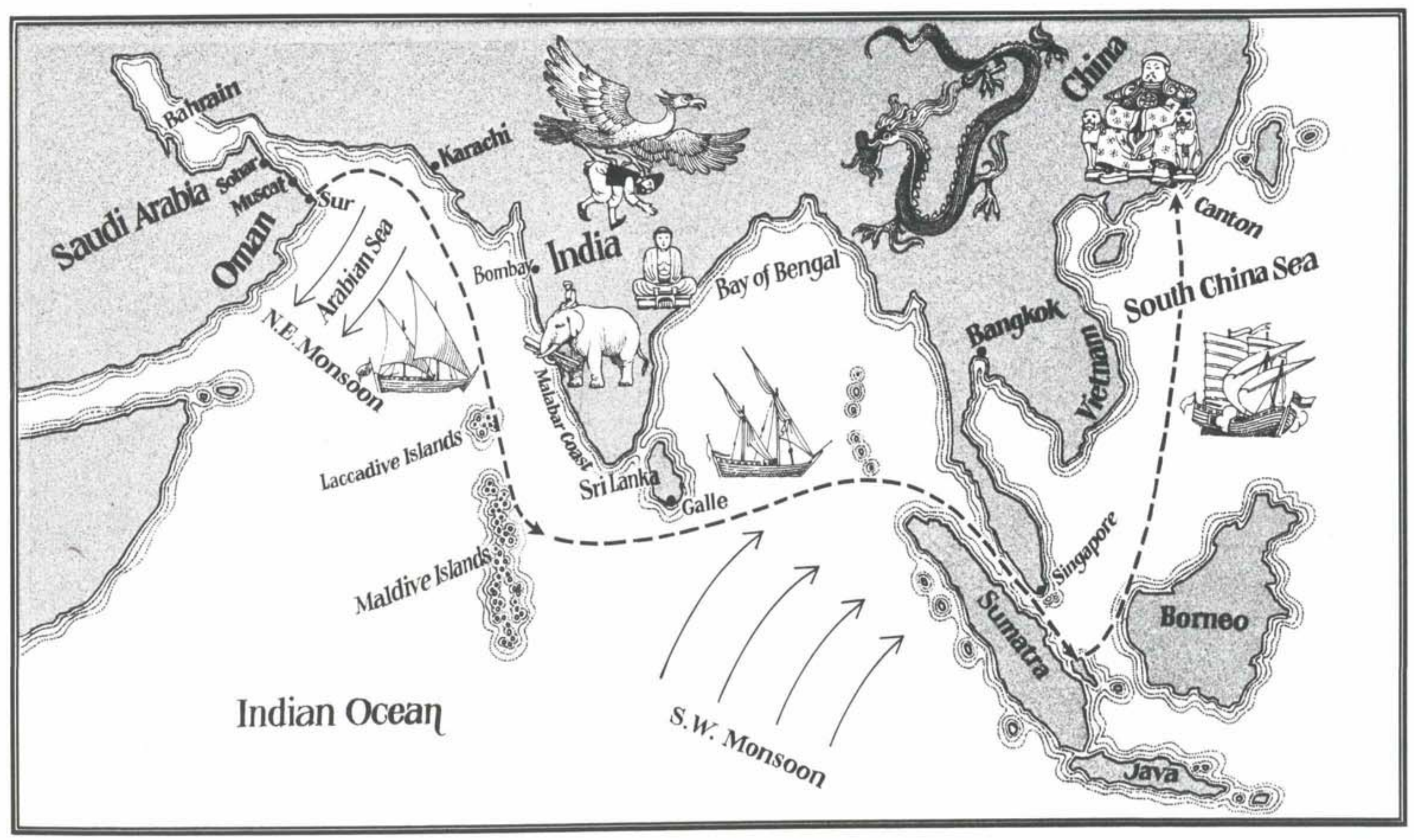
In that era, the 6,000-mile voyage from the Arabian Gulf to China took at least 120 days and was then the longest sea trading route in the world: the ocean equivalent of the old Silk Road. It was probably the most dangerous too, with corsairs from the

Hadhramaut prowling the Indian Ocean and Vietnamese pirates preying on shipping in the Gulf of Tonkin. Those that survived, or bought off the pirate threat, might still disappear without trace: sunk to the bottom of the sea, wrecked on some lonely, hostile coast or blown completely off course into the Pacific where, the Chinese believed, the drain spout of the world's ocean sucked the unwary sailor into oblivion.

For those who did succeed, however, profits were high. Because no European power had ever found a sea route to China, the Arabian role as intermediary in East-West trade grew and flourished. By the middle of the eighth century the flow of such precious goods as gold, ivory and gems from India, and silk and fine porcelain from China, had made Baghdad the most important commercial center in

Left: The dhow's lateen sails fill as it heads for Canton. Above: The Sohar's *builders, called "green shirts," resting.*

As the Sohar's *departure from Sur coincided with the 10th anniversary of Sultan Qaboos' accession, Omani naval ships escorted the dhow as far as international waters.*



The Sindbad Stories

WRITTEN BY SAMUEL PICKERING

The *Arabian Nights* appeared in English in the 1740's when John Newbery began publishing children's books in London, and by the end of the century three tales from the *Nights* had established themselves as children's "classics" in both Great Britain and the United States: *Ali Baba and the Forty Thieves, Aladdin and the Wonderful Lamp* and, perhaps the most popular in the New World, *Sindbad the Sailor.*

Sindbad first appeared in an American children's book in 1770, when a portion of the third voyage – in which he killed a cyclops – was tacked on to a version of Jack the Giant-killer.

Jack-the-Giant-killer was not the only adventurer with whom Sindbad associated in children's books. Much as Sindbad's third voyage had been tacked on to the account of Jack and the giants, an early American children's book added *The Celebrated Travels and Adventures of the Renowned Baron Munchausen* to the end of an account of Sindbad's voyages.

Since Munchausen and Sindbad always traveled to new lands, American children could easily identify themselves with them. America, then, was a new land and thus the youngsters could easily imagine themselves journeying into the unknown. To the west were broad plains, and beyond stood uncharted mountains – just the sort of place where a Roc might build her nest – while to the north there were vast fields of ice and to the south deep swamps crawling with alligators and snakes.

To American children of that era, therefore, Sindbad was believable. More important, he was reassuring; because in early America infant mortality was very high and death hovered over childhood like an ogre, Sindbad's victories offered reassurance and hope. Buried alive in the Cavern of the Dead, for example, Sindbad simply refused to die and finding a way out of the cave metaphorically overcomes death itself. As Sindbad escapes the tomb and returns to Bagdad wealthier than before, so a determined child might hope to escape the clutches of death and look forward to a richly rewarding life.

This reassurance, of course, is true of many fairy tales. Jack-the-Giant-killer suggests that by using their intelligence, underdogs can overcome oppressive, threatening forces or people. And as Jack tricks giants, so does Br'er Rabbit outwit foxes, Puss in Boots fool ogres and Sindbad escape monsters: serpents with bodies thicker than the trunks of palm trees, cannibals who fatten his comrades like sheep and eat them, and the Old Man of the Sea wrapping his legs around Sindbad's neck like an iron yoke.

To adults, the Sindbad stories have a deeper appeal; simultaneously they touch both our duties and our dreams, the adult and the child.

At the beginning of the tales, Sindbad the Porter, staggering under a heavy burden, rests outside a magnificent palace, and laments his laborious lot in life. Suddenly a page invites him inside where he meets the owner – and his namesake – Sindbad the Sailor, and for seven days is entertained with accounts of Sindbad the Sailor's fabulous travels. In addition Sindbad the Sailor gives Sindbad the Porter 100 pieces of gold at the end of each visit. The two Sindbads, then, represent two aspects in everyone, one a responsible citizen, the other an adventurer. The two Sindbads meet in the morning and enjoy each other's company throughout the day, but at night go separate ways as in life dreams and responsibilities often diverge and pull a man in different directions.

Today, Sindbad's appeal to adults may be even stronger than it was to children. Although it is impossible to match Sindbad's discoveries – a valley glittering with diamonds – or adventures – sailing across the sea on the back of a whale, and flying through the air tied to a Roc's leg, many men – and women – still search for excitement. Across the globe groups of aspiring Sindbads clamber over icebergs in Antarctica, back-pack through the Himalayas, or snorkel in the Great Barrier Reef. By making seven voyages, one for each day in the week, Sindbad symbolically traveled forever. So long as man lives, Tennyson implies, he will dream:

"Tis not too late to seek a newer world.
Push off, and sitting well in order smite
The sounding furrows; for my purpose holds
To sail beyond the sunset, and the baths
Of all the western stars, until I die."

Tennyson, of course, was speaking for Ulysses, but he might well be speaking for Timothy Severin, too, who, not content to "rust unburnished," has set out to prove that though the Sinbad voyages may have been dreams, they were not myths.

Samuel Pickering, Jr., has taught in both Syria and Jordan and has published articles in some 40 magazines.

the world, and for the next 500 years Muslim dominance of East-West trade continued.

In the 13th century, however, the Mongols appeared and, in conquering China, razed the great port towns. As a consequence, Far East trade waned, and though it continued sporadically for some time – with Arab merchants meeting their Chinese counterparts in Ceylon and Malaya – the heyday of Arab trade with China was over – partly because of the Mongol destruction, but mostly because, 200 years later, Vasco da Gama, a Portuguese explorer, rounded the Cape of Good Hope and opened a new trade route between Europe and the East.

This voyage, completed in 1448, effectively ended more than 700 years of Arab domination of Eastern trade. Ironically, though, it was an Arab seaman, the great navigator Ahmad ibn Majid, who guided the Portuguese on the last vital leg of the voyage.

By then, of course, the Arabs had left an indelible mark on Southeast Asia; their dhows had not only carried merchandise, but had also spread Islam and Islamic culture as far as Indonesia and China. By then, too, the intrepid Arab sailors, roaming through 9,600 to 16,000 kilometers of unknown territory (6,000 to 10,000 miles), had brought back endless tales of mishaps and adventures – as well as reports of exotic kingdoms bordering the Indian Ocean and China Sea. These stories – repeated, embroidered, expanded and exaggerated – were the basis of the epic of Sindbad the Sailor, as immortalized in *A Thousand and One Nights*.

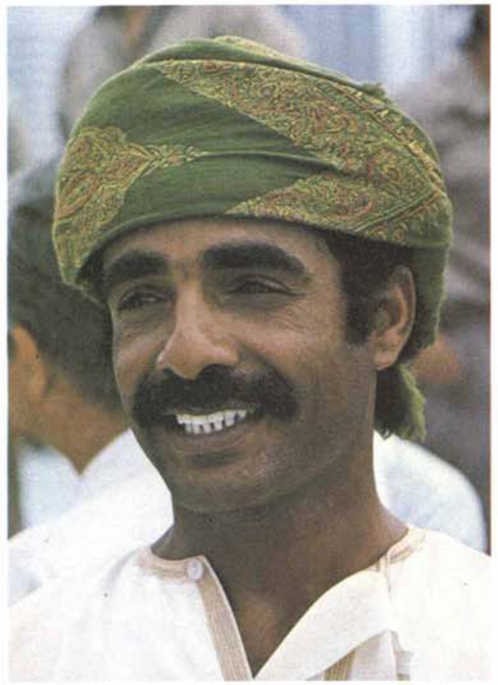
Until recently, the consensus among scholars was that Sindbad, the world's most famous sailor, never actually existed. The scholars said that the fables spun around him may have been versions of actual exploits and gave examples. One was Sindbad's method of collecting diamonds from a serpent-filled canyon: by dropping chunks of raw meat into the canyon and retrieving the meat – with gems stuck to them – through the use of large birds. This story, they said, was first told by troops of Alexander the Great returning from India.

Another example was a story of an island that turns out to be a great fish. This tale, as Severin had cause to know, also figures in the life of the Saint Brendan, the medieval navigator-monk; on his voyage to Newfoundland, Saint Brendan and his Irish sailors did exactly what Sindbad and the Arab seaman did: they aroused the huge creature by lighting fires on its back.

In Oman, however, where the modern Sindbad voyage was launched, some Omanis firmly believe that Sindbad was real. "We believe," said Musalam Ahmad, one of the nine Omanis on *Sohar*, "that there really was a sailor called 'Sindbad' who had some adventures."

Severin agrees. "The Sindbad chroniclers took one captain and added other adventures to his own," he said, adding that it was this embellishment and expansion of his exploits, that eventually turned Sindbad from a man – "who came from Sohar but operated out of Basra" – into a myth. Severin and the Omanis, in fact, believe this so strongly that they named the dhow that they planned to sail to China *Sohar*, after the town in Oman where they say Sindbad was born.

In a sense, Severin, a tea planter's son born in India, is the ideal man to explore a



Musalam Ahmad taught westerners how to sail the dhow.

world where fact and fantasy mingle. While an undergraduate at Oxford, he rode a motorcycle along Marco Polo's route to China – a trip resulting in his first book *Tracking Marco Polo*. This was followed by *Explorers of the Mississippi* – for which he navigated the length of the river by canoe and launch – and four other books on the history of exploration.

Those journeys, however, were just practice for his first major success: sailing an open leather boat across the North Atlantic to show that Irish monks could have been the first Europeans to reach North America, as medieval legends about Ireland's sixth-century Saint Brendan suggested. In a boat of oxhide – a type used by medieval Irish sailors – Severin survived fierce storms off Greenland and a puncturing caused by a small iceberg and then wrote a book about it: *The Brendan Voyage* which became an international best seller translated into 16 languages.

The Saint Brendan voyage, Severin says, also led to the Sindbad voyage. "We were sitting off the coast of Newfoundland, when I suddenly realized I had a winner: building and sailing replicas of ancient boats."

But to create public interest, he went on, he also had to have a character like Saint Brendan. "Suddenly," he says, "the figure of Sindbad appeared in my mind".

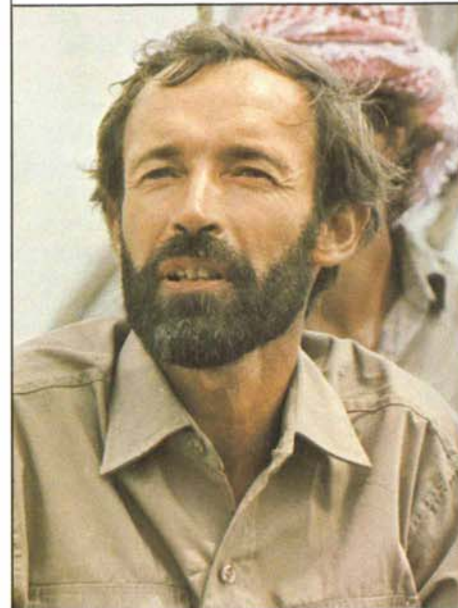
It was a natural. The legendary voyages of the world's best known mariner, never seriously studied before, "were ripe for investigation." On publication of *The Brendan Voyage*, therefore, Severin began to pore over ancient trading documents, maps, shipwrights' plans and museum exhibits. Later, when his research led him to Oman, he also began to walk the coastline – measuring and sketching the rotting rib-cages of long-abandoned dhows half buried in the sand.

At first, the Omanis took little notice of the stranger poking around their beaches. "I had written to tell them about my project but apparently they had forgotten," says Severin. But then, on the eve of his departure, he was asked by the Ministry of National Heritage and Culture to give a lecture and showed his audience, which included the minister himself, a film he had made of *The Brendan Voyage*.

Severin, of course, thought he had finally attracted some attention, but though he was presented with an old Omani sword in appreciation, nothing more was said. Hardly had he returned to his home in County Cork, Ireland, however, when he received a telegram asking him to return immediately to Oman. There the ministry, with approval of His Majesty Qaboos bin Said, Sultan of Oman, offered to sponsor Severin's Sindbad project.

"I never actually asked them to sponsor it," says Severin, "they simply decided to do it themselves".

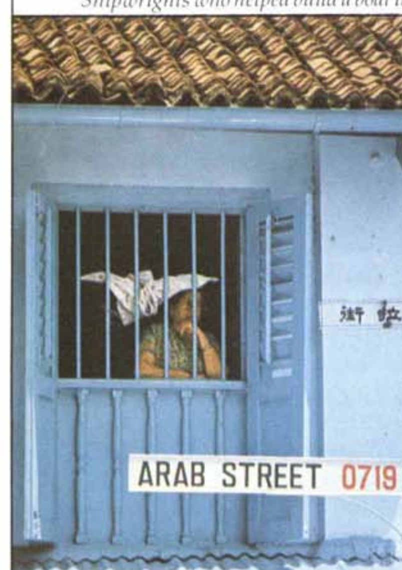
At that point, the research phase ended and the construction phase started. With the help of Omani shipwrights, Severin set about building an authentic replica of the kind of boat Sindbad might have sailed to China over 1,000 years ago. Based on early Arab and Persian sketches and written descriptions of ninth-century, deep-sea trading vessels, he and the shipwrights designed a ship 26 meters long (87 feet), with a 6.4 meter beam (21 feet), and two meter draft (six feet). It was built of hand-sawn wooden planks sewn together with hand-rolled coconut rope – no nails – and was powered by two



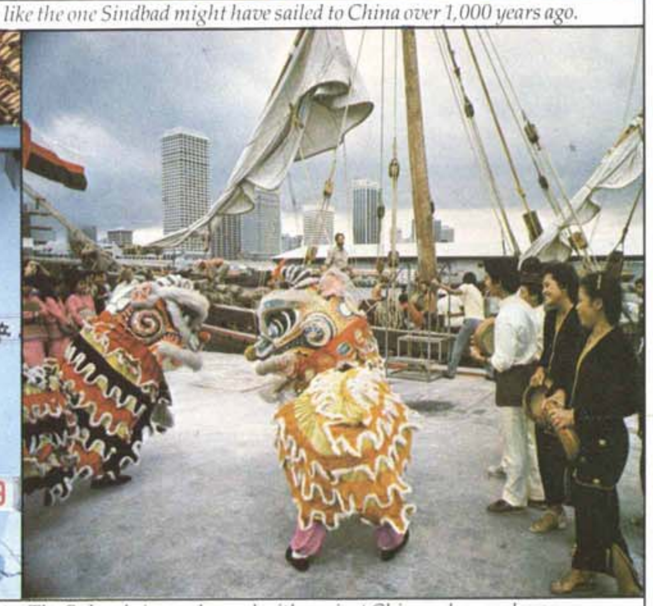
Timothy Severin, the man who organised the voyage.

Omani workers play drums during a break in construction work.

Shipwrights who helped build a boat like the one Sindbad might have sailed to China over 1,000 years ago.



Singapore's Arab Street is a link with the past.



The Sohar *being welcomed with ancient Chinese dragon dance.*

triangular cotton sails – no engine.

They quickly found out, however, that both the materials for such a craft – and the craftsmen were scarce. To find both, Severin had to scour the most backward and remote places of the region – where traditional boat-building methods still survive. He found some shipwrights in Oman, for example, but to recruit the rest also had to go to Laccadive Islands, a territory of India off India's western coast. For timber for the hull he had to go to the forests of southern India; there Arab shipwrights of long ago had found and selected their timber and had it hauled out by elephants.

The coconut rope, also from India, was far more difficult to find. As it would be the only thing holding the ship together, it had to be very strong, but most Indian rope makers had long since abandoned the practice of soaking it in seawater – a process once used to give it the strength Severin needed. For weeks, therefore, Severin roamed the west coast of India chewing rope – literally. "People thought I was mad, but it was the only way I could tell it had been soaked in salt water," says Severin.

Finally, from the island of Agatti, came some coconut rope soaked in seawater.

In Singapore a smiling welcome for the Sohar *and crew.*

But as he was forbidden by government restrictions to go there himself, Severin had to remain on the mainland "tasting" coils of rope sent over by the islanders until he had enough: in all 640 kilometers (400 miles).

At last, however, Severin was able to assemble his men, his wood and his rope at Sur, on the southeast tip of the Arabian Peninsula. Once one of the busiest boat building and trading towns of the Gulf, Sur, when Severin arrived, was a ghost town in which declining trade with India and East Africa, had forced its traders to sell their boats, and had compelled its famous shipwrights to put away their tools.

The arrival of Tim Severin, his 45-man work force and their tons of materials and supplies soon revived Sur. Spurning modern accommodation, for example, the boat builders chose as their headquarters a 300-year-old, sea front home, empty since the drowning of the owner and his six sons in a sea tragedy 30 years before. Severin and his "green shirts" – so called because of the green smocks his Arab shipwrights wore – gave the rambling, two-story house a fresh coat of whitewash, moved in and set to work building the *Sohar.*

The first step was to shape and lay the single 16-meter keel log (52 feet). Next, hand-shaped planks were placed edge-to-edge and sewn into position with criss-cross stitches of coconut rope. Then wadding, from 75,000 coconut husks, was packed into the seams; when wet they would swell and make the hull watertight.

Those steps, of course, are only the basics; in addition, the finished dhow would require four tons of rope for rigging, hawsers to carry its 23-meter-long main spar (76 feet) and four tons of sail. Nevertheless, the *Sohar* was completed in a record seven months – two years before western shipwrights had predicted – partly, says Severin, because of the dedication of the workmen. "It seems to have touched a chord," he said, "some appreciation of their heritage."

Next, Severin and his crew had to learn to sail their ship – as well as test it. They took a shake-down cruise across the Arabian Sea to practice ancient Arab sailing techniques and methods of navigation; their aim, after all, was to live and sail as Sindbad might have done 1,000 years before, not simply retrace his route. Apart from scientific apparatus and essential safety gear, the *Sohar* had no modern equipment aboard. There was no auxilary power, all meals were prepared on a charcoal fire on deck, and their only guide to China were the stars – plus an early Arab navigational aid known as the *kamal.*

The oldest known instrument for latitude observation at sea, the *kamal* dates back to before the 10th century and is still in use in some Arab dhows even today. It is a rectangular board with a cord running to its center point and with knots in the cord – or wooden tablets strung from it – corresponding to the latitudes of the ports of call.

To use it, the navigator holds the selected knot or tablet to his eye – the board in front of him at the full stretch of the string – aligns the star with the top edge of the board and the horizon with the bottom edge and measuring degrees of latitude in *isba,* the width of one finger; the depth of the board is four *isba* and 224 *isba* were considered to equal 360 degrees.

Ingenious though it was, however, the *kamal* was but one of a number of navigational instruments developed by Arab mariners. Indeed, says Severin, "the Arabs invented astral navigation."

This is not just rhetoric. Arabs, for example, wrote navigational treatises in the form of poems to make it easier to memorize the immense amount of data – and one, by Ibn Majid, has 1,082 verses containing such data as Pole Star altitudes for places on the coasts of the Red Sea and Indian Ocean, "compass" bearings, sailing dates and distances. The poems on record today date from the 15th century, but the tradition dates back to 1000 A.D. and possibly earlier.

The Arabs were not only master navigators, but also experienced meteorologists and geographers – true scientists of the sea. In keeping with this tradition the *Sohar* carried three marine scientists, who carried out numerous experiments during the voyage, along with a film crew, an artist, a photographer, a driver, a radio operator, a doctor and a cook.

On November 21, 1980 – almost three years after Tim Severin first conceived the Sindbad project – the *Sohar* set sail from Sur. As its departure coincided with celebrations marking the 10th anniversary

of Sultan Qaboos' accession to the throne, the dhow was given a rousing send off and was escorted to international waters by ships of the Omani navy. Severin's last words, shouted back across the waves as the *Sohar* headed out to sea were: "Thank you Green Shirts" – a heartfelt tribute to the men who built his boat.

At first the ship was a brute to handle. "It didn't sail well at all," says Peter Hunnam, the expedition's scientific leader. One of the problems was that the European and American scientists and technicians, who had also to double as crew, were not experienced sailors like Severin and the Omanis. "We had to teach them," says Musalam Ahmad. To raise the enormous mainsail, for example, was a tremendous task; hauling it and its 23-meter spar to the top of the mast (76 feet) took at least eight men. "The Omanis," says Severin, "would break into old sea chanties and continue until the task was done."

With experience however, the performance of crew and boat greatly improved. "Things got much better as we went along," says Hunnam. "Lashings improved and you got to know which rope was going to be a 'pig' and which wasn't." And soon, says Severin, the *Sohar* was sailing "like a witch." With a good wind behind her, he said, she "rose out of the water like a high-speed train." In fact, added Ahmad, a former merchant seaman and officer in the Omani navy, the *Sohar* proved a "better ship" then any of the modern ones he had ever sailed in.

From Sur, the *Sohar* had headed east across the Arabian Sea, then south down India's Malabar Coast to the Laccadive Islands and the expedition's first landfall was Calicut, on the south-west coast of India, just before Christmas, 1980. Here the crew gave the *Sohar* a "1,000 mile service check" – removing and cleaning her ballast, and checking the coconut rope stitches that held the ship together. "She was in remarkably good shape and had stood up to the first leg of our journey in a way that made us all truly proud of her," said Severin.

It was at Calicut too that Severin learned that three weeks after the *Sohar* left Sur, a French archeological expedition had dug up in Oman a porcelain Buddha astride a Chinese lion – establishing, beyond doubt, Oman's long trading links with the Far East. "And there we were," said Severin, "on our way to China."

On January 10, 1981, the *Sohar* resumed its journey in what turned out to be the most pleasant leg of the voyage – sailing down the coast of India to the southern tip of Sri Lanka. The wind pattern led them to the port of Galle, and there, says Severin, "not 500 meters from our anchorage (1,600 feet) was the first Islamic shrine ever to be built on Sri Lanka."

This indicates he says, that "this was the area the first Arab sailors came to all those hundreds of years ago on their way to the East," adding that the now-famous gem mines of Sri Lanka may have been Sindbad's "Valley of the Diamonds."

The *Sohar's* average speed during the two-month voyage from Sur to Galle was between three and a half and four knots – its fastest speed in a storm was seven knots. After leaving Sri Lanka, however, their progress slowed; caught in the Doldrums or Equatorial Trough, renowned throughout history as a serious sailing hazard, the *Sohar* was becalmed, in merciless temperatures, for nearly a month. Eventually, as a result, food and water began to run short and the 25 men on board had to exist on a diet of Omani dates, rice and fish caught from the sea and to catch rain water in hastily rigged tarpaulins during the occasional rain storms. As undoubtedly happened during the original *Sindbad* voyages, tensions developed among the crew. "Trivial things," says Hunnam, "became major issues." As the days crept by with nothing to do but keep watch, read, play cards and listen to cassettes – one of their few modern comforts aboard – one British biologist developed a "longing for cream cakes," while another lamented later: "We couldn't even make a cup of tea."

Finally, however, the wind rose and the *Sohar* set her sails again for Sumatra. But hardly had the ship escaped from the Doldrums when she was once more crippled – this time by too much wind. At 4 a.m. one morning, when most of the crew were sleeping, a sudden gust caught the mainsail on the wrong side of the mast, sending the 23-meter horizontal spar (76 feet) holding the sail crashing into the upright and snapping it in two. Fortunately no one was injured in the incident, but it led to further delays, and only by jury-rigging a spare sail was the crew able to continue. Finally, nervous and exhausted, the crew and their crippled ship limped into Sabang, on the northern tip of Sumatra, on April 19th.

Their problems, however, were not yet over. They were now in a main shipping lane, and sailing through the narrow straits between Sumatra and Malaysia they were nearly run down several times at night by giant freighters.

"One ship came within 50 feet of us," says marine biologist Andrew Price, a former Aramco consultant. "We flashed lights against our sail to attract attention but there seemed to be no one on watch. We changed course by 90 degrees but they still kept coming at us. Then at the very last moment they saw us and veered away."

After that incident, the crew fixed a powerful strobe, used for light while filming, to the top of the *Sohar's* mast. "It was so bright," says Hunnam, "that one ship actually took us for a lighthouse and stopped."

Sharks proved bothersome too. Once, when the diver went overboard to renew frayed ropes lashing the rudder to the hull, a particularly vicious White Tipped shark suddenly appeared close to him. But the diver turned around and growled at it – a personal technique he had developed for scaring off sharks – and it swam away. On the other hand, sharks also provided food while they were becalmed. "We once caught 15 sharks in 15 minutes," says Musalam Ahmad proudly. Grimaced Severin: "It was shark for breakfast, shark for lunch and shark for dinner".

The *Sohar* crew was also on the lookout for whales – but for a very different reason. One of the marine surveys they carried out was a "whale watch" to chart their types, numbers and positions in the Indian Ocean. The fact that they saw very few, says Hunnam, should provide further ammunition for conservationists fighting to protect whales.

Hunnam also hopes that information collected by the *Sohar* will prompt some action to save the dugong or sea cow – whose nursing breasts may have given rise to stories of "mermaids." Sea cows are an even more seriously endangered species than whales. "We sighted only two dugongs in 750 square kilometers (300 square miles) of prime habitat off Sri Lanka, which indicates they are now almost extinct," says Hunnam.

Yet another *Sohar* survey focused on barnacles. The purpose of this study was to collect information which may help chemists develop a barnacle repellant paint for ship's hulls.

Curiously, the *Sohar,* although a replica of a 1,000 year old craft, proved far more suited for some types of marine research than many modern vessels. Because the boat was relatively small and slow moving, it provided an excellent platform near the sea surface from which scientific observations and recordings could be made.

Because fair winds in the Strait of Malacca enabled *Sohar* to make up some of the time it had lost in the Doldrums, it sailed into Singapore on June 2, only two weeks behind schedule.

Again, though, there was danger. Entering the third-largest port in the world, and one of the busiest, was terrifying. "We came at night under full sail the wrong way (against outgoing traffic)," said Severin. "We went right under the anchor chain of a super-tanker. My hair was going white."

Finally, though, Severin dropped sail and waited for a tug to tow them into harbor, where they were greeted on the quayside by a traditional Chinese dragon dance welcome. "When I was small I saw an Indian movie about Sindbad the Sailor and grew up thinking he was Indian," said a cheery Port Authority official watching the arrival. "Later I saw an English movie about Sindbad and thought he must be English. Now after all these years I finally learn the truth – he was an Arab."

Correcting Western and Eastern misconceptions about the Arabs is one of the main purposes of Severin's voyage. "Most people consider Arabs people of the desert," said the tanned and bearded explorer as he relaxed at Singapore's famous Raffles Hotel after landing. "But they are also people of the sea. I want to prove that the Arabs are a people who have not only come to prominence recently because of oil, but also have great seafaring history."

Evidence of this abounds in Singapore's old Arab quarter – you can still buy Omani dates in "Muscat Street" – although it is fast disappearing as developers bulldoze the old parts of town to put up new multi-story buildings.

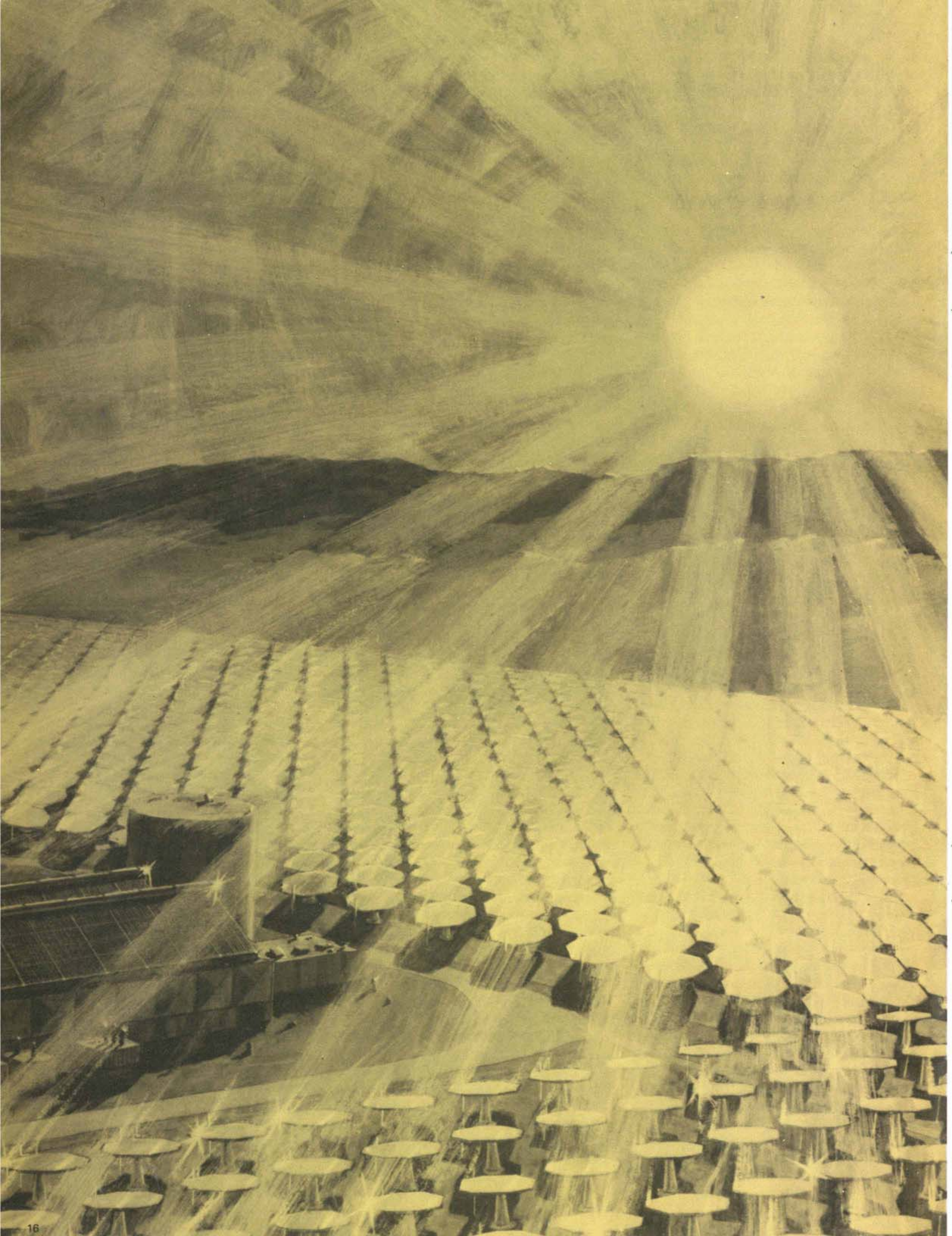
The last leg of the voyage, from Singapore to Canton, was the one that worried Severin most. "There are still pirates in the South China Sea and we could run into storms," he said before leaving Singapore.

For this reason, one British scientist said, they were "armed to the teeth," and had aboard an Omani "weapons expert" and an ex-member of the famous British Special Armed Services.

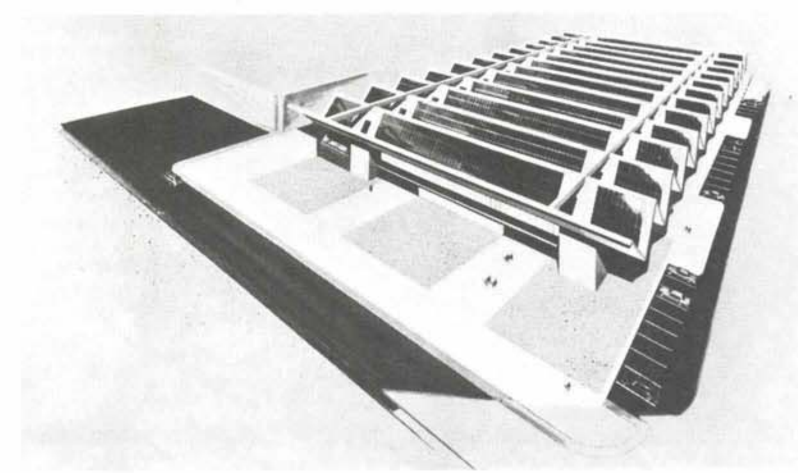
As it turned out, however, there were neither pirates nor storms in the South China Sea, and the *Sohar* reached the mouth of the Pearl River in the last days of June, well ahead of schedule. In fact, they had to cool their heels for more than a week at Whampoa before sailing triumphantly up to Canton, on July 6, for the official Chinese welcoming ceremony that, some thought, probably equalled the reception given Sindbad.

From Canton, Severin sailed the *Sohar* to Hong Kong for transportation, via the Omani navy, back to Sur, where, perhaps, the gallant dhow may become either a tourist attraction or a training ship. Whatever happens to it, the story of its epic voyage will certainly go down in the annals of Arab seafaring history – alongside "The Adventures of Sindbad the Sailor."

John Lawton is an Aramco World *correspondent.*



SAUDI ARABIA AND SOLAR ENERGY



To some observers, Saudi Arabia's effort to develop solar energy is decidedly a coals-to-Newcastle situation. With close to 113.5 billion barrels of proved oil reserves, Saudi Arabia hardly requires more energy. To put it another way, who needs it?

The kingdom, nevertheless, is sponsoring a variety of experiments in solar energy with particular emphasis on the use of the photovoltaic cell – to power a desalination plant in Jiddah, fend off corrosion in underground pipelines, heat a school in Tabuk and provide a full megawatt of electricity to a village north of Riyadh. That total is, no doubt, a drop in the bucket compared to the 292.8 megawatts being generated by traditional means in the Eastern Province, but is important, nonetheless, with regard to the future.

Solar energy has been discussed, in theoretical terms, for years, and some countries have even undertaken large experiments. France, for example, built a massive array of solar collectors in the Pyrenees, and Switzerland has done the same in the Alps. Until the energy crisis of the early 1970's, however, the industrialized countries of the world had not paid serious attention to solar energy – or other alternatives to conventional sources of power except nuclear power; with both petroleum and coal still cheap, there seemed to be no need.

But then, realizing that petroleum was running out in some areas, that coal contributed heavily to pollution and that nuclear power might be expensive and dangerous, the industrialized world began to look more closely at alternatives and especially at developments in solar energy – what one man has termed "the next revolution in technology."

As a result, breakthroughs are already being recorded. One California firm, for example, has developed a solar powered microwave repeater costing 75 percent less than existing equipment, a new skyscraper in New York has included a giant solar collector on its roof and, in July, an airplane powered by 16,128 solar cells flew from France to England in five and a half hours.

There are, certainly, enormous problems to be solved before solar power is economically acceptable and technically satisfactory and there are doubts as to the amounts of energy that present technology can provide. Nevertheless, it is already obvious that solar energy is a clean and inexhaustible source of energy.

It is ironic, of course, that countries like Saudi Arabia, Kuwait and Mexico – and regions like Texas – are as rich in sunlight as they are in petroleum. As one wit summed it up, "them what has – has." But the response, in the case of Saudi Arabia, is also an impressive example of national foresight. Years ago, for example, Saudi Arab officials, learning that U.S. government agencies had refused to fund an experiment in solar energy at the Gerraset Elementary School in Reston, Virginia, put up $625,000 to install solar collectors.

This foresight continues to guide Saudi policy. Though the kingdom will neither need nor benefit from solar energy for decades, it is committing vast sums to its development now while there is still time, and for reasons that were summed up crisply by Shaikh Ahmed Zaki Yamani, Minister of Petroleum and Mineral Resources: "The oil won't last forever."

– The Editors

SAUDI ARABIA AND SOLAR ENERGY

A Solar Village

WRITTEN AND PHOTOGRAPHED BY AILEEN VINCENT-BARWOOD

Nestled against the west wall of the Wadi Hanifa, 45 kilometers north of Riyadh (28 miles), the tiny villages of al-Jubaila and al-'Uyaina lie dreaming in the hot bright light of the Saudi Arabian sun, their 3,000 or so residents largely unaware that a new system of power generation is about to catapult them into the forefront of the solar age: a $16.5 million effort to provide the two villages with electricity through direct conversion of sunlight into electricity by using the world's largest photovoltaic collector system.

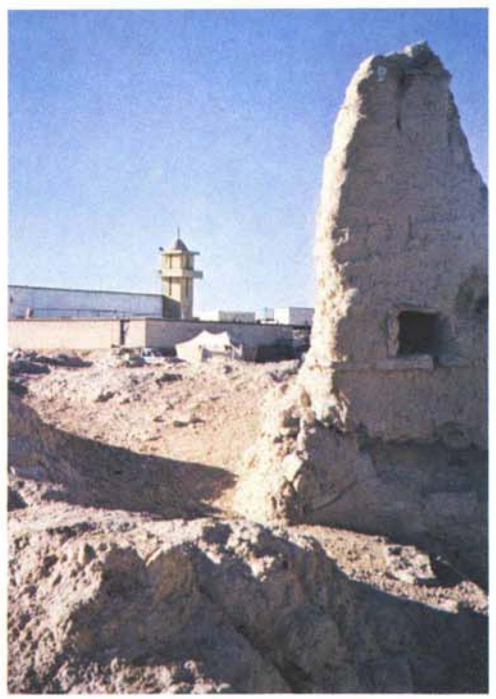
The villagers know, of course, that a major project is under way – and some can't wait. In al-'Uyaina, for example, 'Abd al-'Aziz, the 14-year-old son of shopkeeper Muhammad 'Abd Allah, is eagerly awaiting completion of the construction he can see on the escarpment above the palm-thatched porch of his father's shop where the men of the village gather to sip cool drinks and talk. Though 'Abd al-'Aziz is too young to realize the full import of what is happening, he is certainly confident that it is going to happen; on the gate of his house, next door to the shop, his father has installed two overhead light fixtures in anticipation of the day when solar energy will replace the generators chugging away in the wadi.

The experiment in al-Jubaila and al-'Uyaina is but one of several projects being carried out under the ambitious program called SOLERAS (Solar Energy Research American Saudi). A joint Saudi Arab-United States venture in bilateral cooperation, SOLERAS is a five-year endeavor to which the U.S. Department of Energy and the Saudi Arab National Center for Science and Technology (SANCST) have each committed $50 million, and for which the Solar Energy Research Institute (SERI) in Golden, Colorado is responsible.

The project at al-Jubaila and al-'Uyaina, however, is by far the largest of those projects. Indeed, it is the largest venture of its kind ever undertaken anywhere: installation of a solar energy system capable of delivering one megawatt – i.e. a million watts – of power.

Cost, of course, is a factor in solar energy, as it is in all forms of energy, and the cost of electricity produced directly from the sun has been dropping dramatically in recent years. Since the photovoltaic cell was first used in an American space satellite, prices overall have decreased 20 times.

And the future, leading solar experts believe, is even more promising. They say that five years of mass production could reduce prices substantially – conceivably to as low as 70 cents a peak watt, roughly competitive with oil.



At an al-'Uyaina well solar energy will power the pump.

At al-Jubaila and al-'Uyaina, the electricity will be produced – up on the escarpment's edge – by arrays of photovoltaic modules mounted on giant arms. Each module uses four fresnel lenses to concentrate the sunlight on four high-intensity silicon solar cells. These are bonded to an aluminum arm and a passive heat dissipator, with four such cells enclosed in a common housing.

The principle at work here is a fairly simple one: when sunlight hits the semi-conducting silicon material of the cell, it knocks some of the electrons loose and – as they flow in between the layers of silicon – creates a current of electricity. With 64 such modules mounted on a horizontal tube that rotates about both axes in pursuit of the sun, and a total of 160 arrays, the photovoltaic field, under peak conditions, is expected to produce a million watts – one megawatt.

One question about Saudi Arabia's solar energy program that surfaces constantly is "why?" Why is Saudi Arabia, with its massive resources of petroleum, spending so much on experiments?

Part of the answer, says Dr. Bakr Khoshaim, the Saudi Arabian program director for SOLERAS, is that solar technology can speed up the kingdom's modernization. "Our aim is not to become the solar energy exporting nation of the world," he says in his dry, smiling way, "but to use this new technology to make life better for our people all over the kingdom. It may take 10 years for a power grid to reach some of our villages. They could have solar power in three."

Economist Cecil Thompson, director of the Solar Energy Research Institute (SERI) office in Riyadh, definitely agrees. "While it is true that this country has enormous fossil fuel reserves," he says, "and while this is fine for large energy generating facilities, you still must distribute this energy. This country has many villages waiting to be hooked up to an energy grid and this will take a lot of time and money. The trade-off then gets to be between urbanization – moving people closer to the centers of production and perhaps disrupting their lives – or finding another way of generating and distributing electricity to them. This is the context within which such things as solar-powered heating and air-conditioning, water desalination and solar controlled environment greenhouses become feasible here."

The solar village experiment, it is true, has already confirmed the existence of obstacles: dust, for instance, which daily coats the lenses and thus hinders the development of power. Nonetheless, the logic of solar energy is inarguable: two weeks of sunshine provide as much potential energy as all known global reserves of fossil fuels. Furthermore, solar energy is pollution free and – a vital factor – it is inexhaustible.

Even so, solar energy development by Saudi Arabia, a country that controls 25 percent of the world's petroleum resources, arouses curiosity. Skeptics wonder why Saudi Arabia is investing vast sums in projects like SOLERAS? Isn't solar power irrelevant in, and to, Saudi Arabia? Isn't there a danger that Saudi Arabia might become dependent on U.S. solar technology?

No, says Dr. Khoshaim, that's not the case. "SOLERAS is structured so as to serve the best interests of both Saudi Arabia and the U.S." SOLERAS, he goes on, is "a model of cooperation between two nations in pursuit of a technology which will benefit them both."

SOLERAS, in fact, is a unique concept. It is not only jointly funded by two governments, but requires that each country relinquish a degree of sovereignty – with a board of directors from both countries deciding all matters. Which, says Cecil Thompson, precludes SOLERAS from taking on any project which is not in the best interests of either the United States or Saudi Arabia. "Saudi Arabia is not buying our technology; we are developing a solar technology together."

It is, in fact, a rare example of national foresight, says such spokesmen as Dr. Khoshaim, Faisal al-Bashir, the Saudi Arabian Deputy Minister of Planning and the University of Riyadh's Hammad Safrata. "Solar technology certainly faces a host of major obstacles," says Dr. Safrata, "but it has come a long way in a few short years and there is every indication its growth is likely to be even more dramatic than in the past. Solar is a new child – and yet we're already asking about its cost of growing up!"

Hammad Safrata, Muhammad Zakzuk, Bakr Khoshaim.

As to the possibility that Arabs might become dependent on western solar technology, Dr. Khoshaim says philosophically, "When you come right down to it, all countries are one country, aren't they? Nothing we develop is ours alone. It's for the world."

Saudi Arabia, furthermore, is developing its own solar potential – by participating in projects that SOLERAS is researching and developing in the U.S., as well as in the kingdom. In the U.S., for example, $3.8 million in engineering field tests of commercial solar cooling systems are being undertaken by three American companies: Carrier Corporation of Syracuse, New York, United Technology Research Center of Hartford, Connecticut, and Honeywell, Inc. of Minneapolis, Minnesota, each of them working to reduce the cost and improve the efficiency of air cooling systems.

In Saudi Arabia, three other SOLERAS activities are already well advanced. Workshops on solar cooling have been held, research grants have been made to the kingdom's four main universities, and a solar data collection station has been established. In addition, two solar-controlled greenhouse systems will be completed this year: one in Saudi Arabia for a hot-arid climate, the other in the U.S. for a hot-humid climate. These will advance the technology of controlled environment agriculture in areas not already serviced by an electric power grid.

Since it extends the reach of solar experiments, the $8 million university grant program is particularly important. Managed by SANCST, which is headed by Dr. Rida 'Ubaid, the grant program involves the establishment of solar cooling labs, each to be equipped to conduct design, analysis, system integration,

PHOTO COURTESY OF SOLERAS

Photovoltaic array north of Riyadh, part of the world's largest collector system which SOLERAS is establishing.

Also under way in the U.S. is a $4 million project to design large-scale solar-powered desalination systems. The first phase of this program calls for a conceptual design of desalination systems capable of producing a million or more gallons of fresh water per day.

The second and third phases involve the construction of pilot plants, one in the U.S. and one in Yanbu, the new industrial center and oil port just dedicated on Saudi Arabia's west coast. Contracts have been signed with Boeing, Chicago Bridge and Iron, Donovan, Hamester and Rattien, Catalytic and Exxon Engineering Research to construct the pilot plants by 1982.

Compared with Jiddah's three existing desalination plants – the smallest of which can produce 22.5 million gallons a day – these pilot plants may seem insignificant, yet some experts agree that the use of solar energy may be the most economical way to produce water for small communities in remote areas, because solar desalination can be applied on a small scale more easily than conventional desalination methods and obviates the need to transport fuel.

and experimentation on new and advanced cooling concepts. King Faisal University in Dammam, King 'Abd al-'Aziz University in Jiddah, the University of Petroleum and Minerals in Dhahran and the University of Riyadh have signed agreements to cover the first phase of the three phase effort.

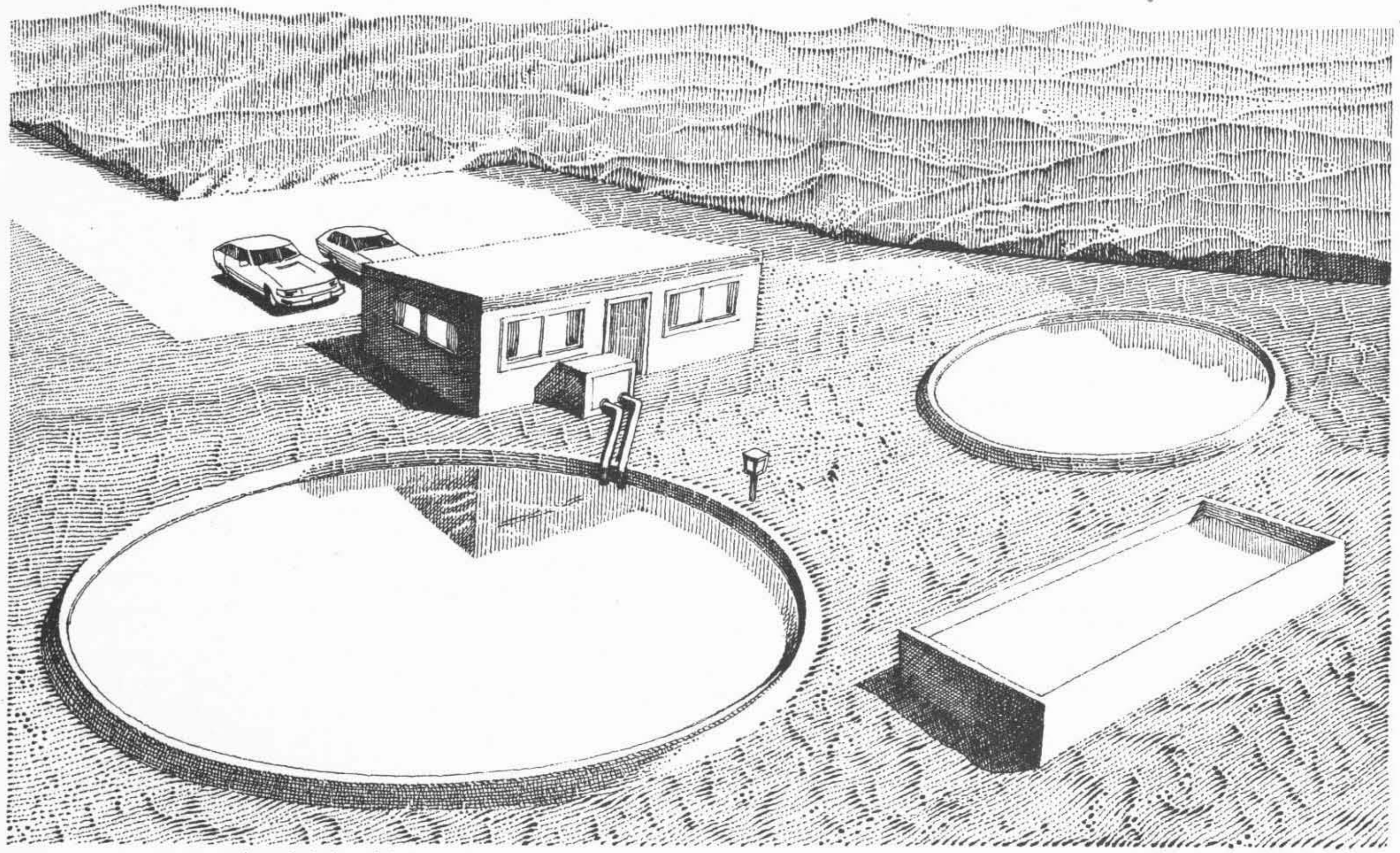
To develop technicians to run the new solar programs, the program also schedules workshops in the kingdom and tours to the U.S. solar energy labs. In the last several years three such tours have been conducted for Saudi Arabian and U.S. students; participants visited the Solar Energy Applications Lab at Colorado State University, the Sandia Lab in Alburquerque, New Mexico, the Jet Propulsion Laboratory and the Applied Solar Research Company in Pasadena, California, and the Rocky Flats Wind Turbine test facility in Rocky Flats, Montana.

Such areas may seem a long way from Saudi Arabia's solar villages and from 14 year-old 'Abd al-'Aziz in Wadi Hanifa, but in the future – the foreseeable future – all those places will be playing a role in the development of energy straight from the sun. ■

SAUDI ARABIA AND SOLAR ENERGY

A Solar Pond

WRITTEN BY ARTHUR CLARK ILLUSTRATIONS BY NEVILLE MARDELL



An artist's view of the Research Institute's experimental solar pond, one of the institute's efforts to harness solar energy.

At Saudi Arabia's University of Petroleum and Minerals, solar energy experts at the adjacent but autonomous Research Institute are investigating several phases of solar energy: photovoltaic cells, the effects of surface dust on collectors (which is a major problem affecting efficiency), and – an especially interesting aspect – collection of energy in what they're calling a "solar pond."

A "solar pond" is an attempt to solve one of the more difficult problems associated with solar energy: how to collect it. Though sunshine falls on the peninsula in massive quantities, no one has yet perfected a way of conserving it efficiently, and the Research Institute hopes that what they call a "salt gradient" solar pond, may provide a solution.

Essentially, a solar pond is, in the words of the solar program's acting director Bruce Nimmo, "just water, salt, a hole and a liner." The hole is scooped out of "sabkhas," the salt flats which abound the eastern coastal region of Saudi Arabia, then lined with plastic and filled with salt water, found, usually, just below the surface.

What happens then, however, isn't at all as simple. Based on certain principles concerning the loss of heat from liquids and gasses, the water in a solar pond gets hotter and hotter and can be stored without loss of the heat.

Normally, in ponds, lakes or seas, the water, when it is heated by the sun, loses the heat at the surface through convection – roughly defined as movement in the water caused by temperature, density and gravity factors. But if the water is heavily salted, the movement of the heated water at the bottom of the pond or lake is restricted by the high density caused by the high salinity. As a result, the convection principle – i.e. the loss of heat at the surface caused by movement – no longer operates effectively; to the contrary, the water in the bottom half of the pond gets hotter and hotter; in the solar pond temperatures can go as high as 212 degrees F, enough to boil an egg or, more practically, provide hot water for dishwashers, showers, and washing machines in homes.

For researchers interested in that principle, Saudi Arabia's "sabkhas" are perfect; they are exposed to enormous quantities of sunlight and they usually have a bountiful supply of salt water a meter or two beneath the surface.

Solar ponds are also cheap to establish. Instead of constructing elaborate structures of metal and glass, the Research Institute can simply dig into a "sabkha" with a bulldozer, line it, wait until it fills up or fill it and, in some cases, increase the salt content.

So far, the institute's modest experiments – with a prototype pond built at the institute's solar lab last fall – have been successful; a meter and a half deep (five feet) and saturated with salt in its bottom half, the pond, built above ground, registered a temperature of 129 degrees F in its "lower convecting zone" or salt-saturated region just two weeks after start-up. In sufficient volume, water at that temperature could be pumped out of the pond's lower half and piped to homes and buildings for heat, or to factories, for such industrial purposes as washing bottles in a bottling plant.

The Research Institute, however, has more ambitious goals. Its scientists want to use solar ponds to generate electricity – by heating water to about 200 degrees F in the pond – pumping it out and transferring the heat in the water to a fluid with a lower boiling temperature (a Freon, for example) which, as it vaporizes, could drive a turbine.

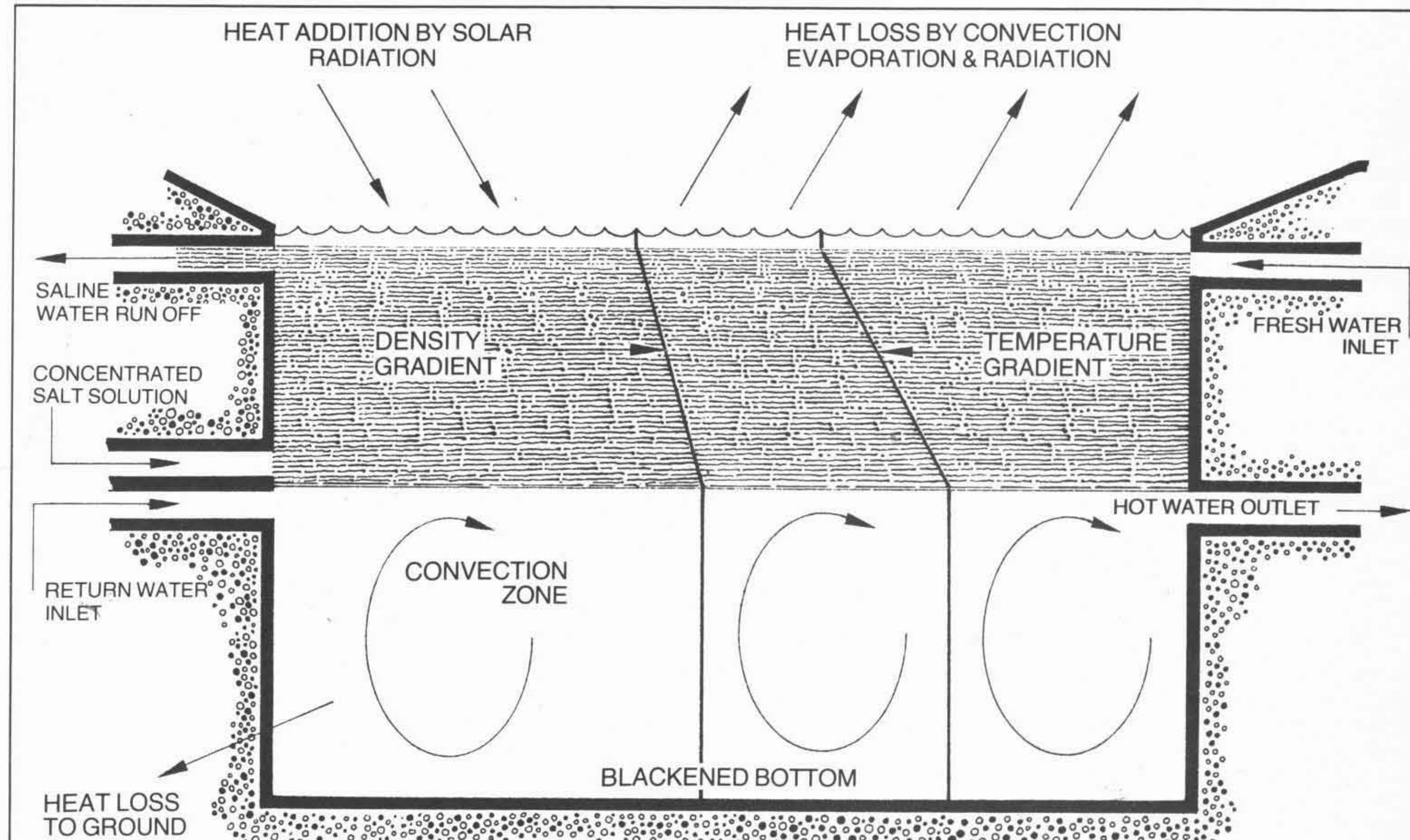
For now, though, the institute's program is focused on simply generating enough electricity to light up a nearby laboratory at night. The power supplied by the hot water from a single test pond should, according to researchers, be enough to light 15 one hundred-watt bulbs 24 hours a day and three ponds – totalling 2,000 square meters (21,528 square feet) – are to be built in 1982 on a beach near UPM, two of them in "sabkhas."

In their research, the institute team is not neglecting the element of cost. They say, for example, that the cost of a solar pond built in a "sabkha" is about $10 a square meter – about 10 to 20 percent of the cost of conventional solar thermal collectors (in which water is heated as it circulates through pipes beneath glass in the sunshine). And although conventional solar thermal collectors make about 35 percent of sunlight that falls on them available as heat – compared to 25 percent from solar ponds – the ponds offer other advantages.

Most thermal solar collectors, for example, require separate storage areas to hold heated water for use when the sun is not shining, whereas a solar pond has built-in hot water storage, down in the high-salinity layers. A solar pond, moreover, is not affected by dust which, accumulating on other types of solar collectors, cuts efficiency. The dust simply sinks into the ponds.

Last, there is the fact that the price per BTU (British Thermal Unit – a measure of thermal energy) received from a solar pond is now close to the price per BTU of a barrel of oil delivered to a user, according to Dr. Nimmo. That fact, undoubtedly, is spurring solar pond research.

What all that means, say researchers, is that solar ponds could add enormously to the already impressive potential for solar energy in Saudi Arabia. Though there are no plans now for a large-scale effort, Dr. Nimmo says the institute experiments suggest that solar ponds could provide five percent of Saudi Arabia's energy needs by the end of the century. ■



A schematic diagram of the Saudi Arabia Research Institute's "salt gradient solar pond" shows how the pond collects heat at the bottom, and can store it without any loss.

A Solar School

WRITTEN AND PHOTOGRAPHED BY AILEEN VINCENT-BARWOOD

A unique mosque in Tabuk, site of a solar heated complex.

At a formal ceremony last year, Saudi Arabia proved decisively that its commitment to solar energy is real: government officials dedicated, and opened, the largest solar heated complex in the world – the King 'Abd al-'Aziz training school in Tabuk.

The choice of Tabuk for the experiment – one of several now under way in Saudi Arabia – was anything but arbitrary. The site was chosen because Tabuk, in the northwest corner of Saudi Arabia, is perfect for solar energy: the sky is almost always clear and blue, and the prevailing breezes quickly sweep away dust that, in some areas, accumulate on solar collectors and reduces efficiency.

The Tabuk area, in fact, has the highest solar heating potential in the world – a persuasive factor when the Saudi Arabian Ministry of Defense and Aviation was weighing the pros and cons of a solar energy system in planning its new physical training school for the kingdom's Air Force.

Beautiful and ultra-modern, the new school, built by the U.S. Corps of Engineers, will depend on the sun to provide 70 percent of its total heat load, including 40 percent of the building heat and 100 percent of the domestic hot water needs – 36,000 gallons a day, enough to supply about 400 American homes.

In designing the school, Sverdrup and Parcel Associates, Inc. of St. Louis, Missouri, included in the 14 buildings a number of features known as "passive" solar energy, i.e. features that make it easier to heat – or cool – a given structure. To help minimize heat loss in winter, for example, but also to help cool the buildings from May to November – when peak temperatures have climbed to 117 degrees F – the lower levels of some of the buildings were built below the ground.

In addition, glass has been kept to a minimum, all windows are recessed and double paned – with a highly reflective bronze glazing – all large windows face north, and built-in heat exchangers expel excess heat. Because it can also get pretty cold in the desert – between December and March temperatures can go down to freezing – the designers also provided extras affecting the heating; extra insulation was added to the roofs and walls of the buildings – as well as to water storage tanks and heat exchangers. They also installed added protection for the collector plates; when temperatures drop a pump circulates hot water to the collector circuits.

The heart of the system, however, consists of the solar collector plates installed on the roof of the Field House; they cover an area about the size of three football fields and are attached to 12 roof panels. These plates trap the heat of the sun and transfer it to a liquid flowing through them – much the way a garden hose left lying in the sun for an afternoon will produce warm water at the end of the day.

From the rooftop, a piping system – well insulated – distributes the hot water, along with a heated solution of water and ethylene glycol, through a unique system of upright steel tanks in the support columns of the Field House. This design, according to Sverdrup and Parcel Associates, provides flexibility; collected energy can be transferred to where it is needed most and the temperatures can be controlled to provide maximum capacity. Furthermore, they say, simplicity of design and the use of conventional components guarantee easy maintenance, fuel conservation and efficient functioning for an estimated 35 years. Including the replacement of parts, the system is expected to pay for itself in 20 years. ■

Aileen Vincent-Barwood was once a freelance correspondent for CBC and has written articles and fiction for U.S. periodicals.

SAUDI ARABIA AND SOLAR ENERGY

The Spokesmen

WRITTEN BY ARTHUR CLARK AND AILEEN VINCENT-BARWOOD
PHOTOGRAPHED BY AILEEN VINCENT-BARWOOD AND M. J. ISAAC

Dr. Bruce Nimmo and Dr. 'Abd Allah Dabbagh of the Research Institute.

Behind all important enterprises, there are always special men, and with regard to Saudi Arabia's Solar Energy program the list is long. Among them is 35-year-old Dr. 'Abd Allah Dabbagh, director of the Research Institute at the University of Petroleum and Minerals.

The Research Institute, independent of UPM, was established in 1977 to carry out research "to solve problems that relate to the application of technology in the Kingdom of Saudi Arabia," explained Dabbagh in, ironically, an office carefully shielded from the brilliant sunshine outside. "There was a realization at the time of the kingdom's Second Five Year Plan (1975-1980) that petroleum is a non-renewable resource for energy and solar energy seemed to be the most reasonable alternative."

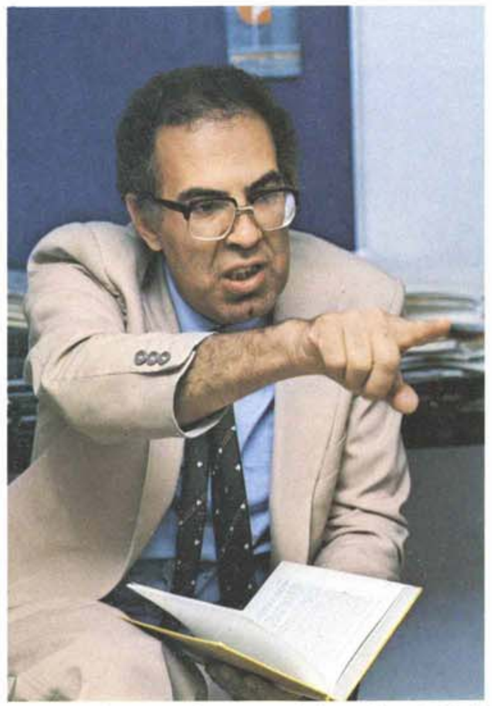
Dabbagh came to the Research Institute in 1976 with a B.Sc. degree in geology from the American University of Beirut and a Ph.D. degree in structural geology from the University of North Carolina, and was appointed assistant director of the institute in 1977. In 1978 he became director and since then he has been organizing such activities as the solar energy research taking place in the Division of Energy Resources, one of six divisions at the institute – and one of the most interesting. An American, Dr. Bruce Nimmo, 42, is acting head of the division as well as director of the solar program. Nimmo, who holds a Ph.D. degree from Stanford University, has been on the Dhahran campus since 1976. He came, originally, to teach for two years in the Mechanical Engineering Department while on leave from the University of Central Florida, but stayed on to establish the solar energy research program.

At the Research Institute, solar research has had a ranking importance from the very beginning. As early as 1969, scholars such as Dr. 'Ali Kettani had begun to think that solar energy could be of value to Saudi Arabia despite the kingdom's vast reserves of petroleum, and, not long after, UPM began to look into solar cooling, water heating, desalination and hydrogen production; it was the beginning of a serious commitment to the development of solar technology in – and by – Saudi Arabia.

Six years later, that commitment began to show results. At the 1975 conference of

An Immodest Proposal

Among the men now backing various solar energy projects in Saudi Arabia, Dr. 'Ali Kettani is one of the more outspoken proponents. Dr. Kettani doesn't mince words – nor proposals.



Dr. Kettani, sponsor of an unusual plan to dam the Gulf.

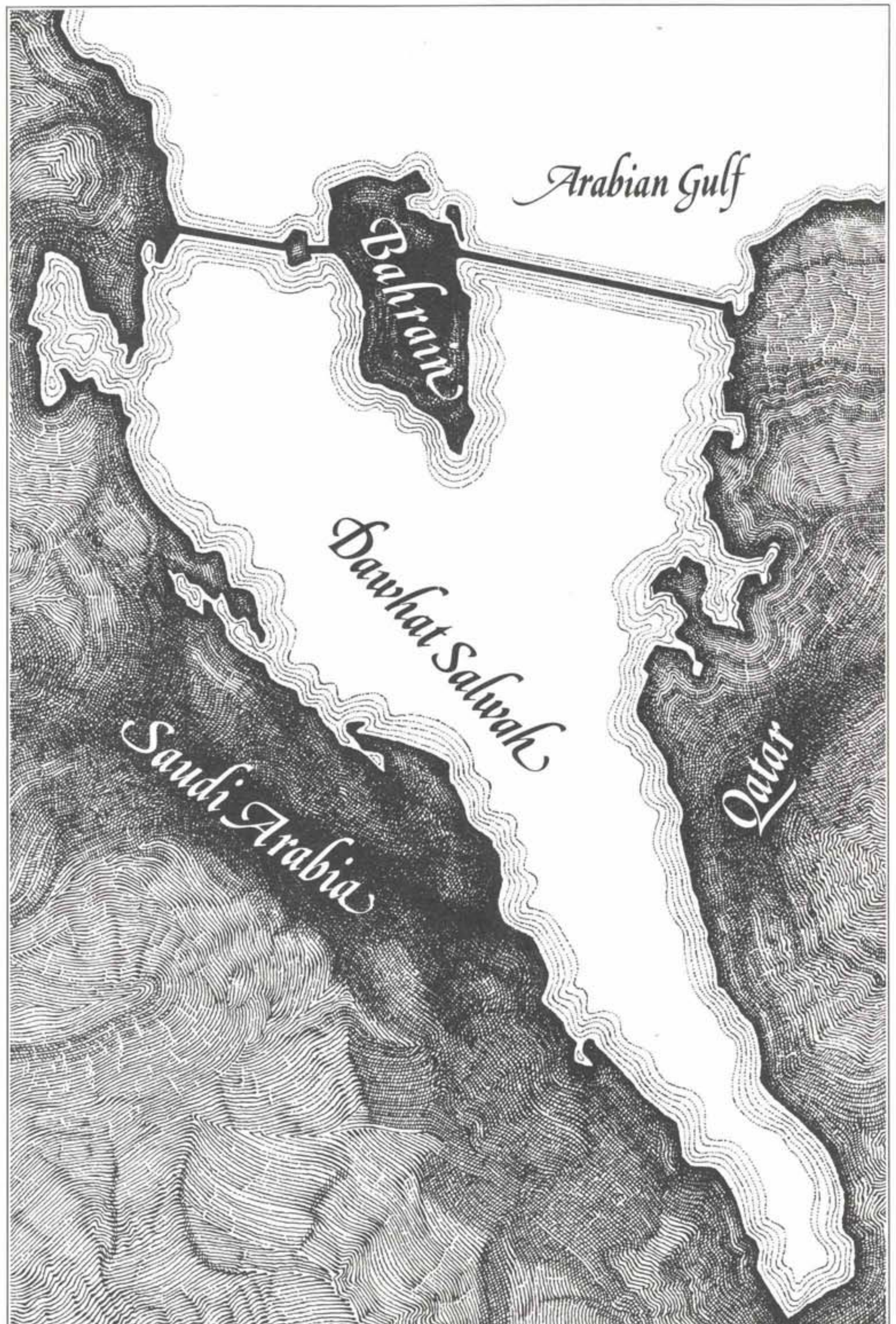
Moroccan by birth, Dr. Kettani, 39, studied at the Swiss Federal Institute of Technology in Lausanne, earned a Ph.D. degree in electrical engineering from the Carnegie Institute of Technology in Pittsburgh, and is now the head of the 42-nation Islamic Foundation for Science, Technology and Development.

Involved in solar energy ever since he joined the Electrical Engineering Department at the University of Petroleum and Minerals in Dhahran, Saudi Arabia, in 1969, he recently joined Lenine M. Gonsalves – on leave from Southeastern Massachusetts University – in presenting an astounding proposal on solar energy to Saudi Arabia.

The proposal is to close off 8,000 square kilometers (3,100 square miles) of the Arabian Gulf with dams, lower the surface of the water inside by 12 meters (40 feet) – through solar evaporation – and then generate electricity by letting the Gulf water pour into the dammed-off areas like a great waterfall.

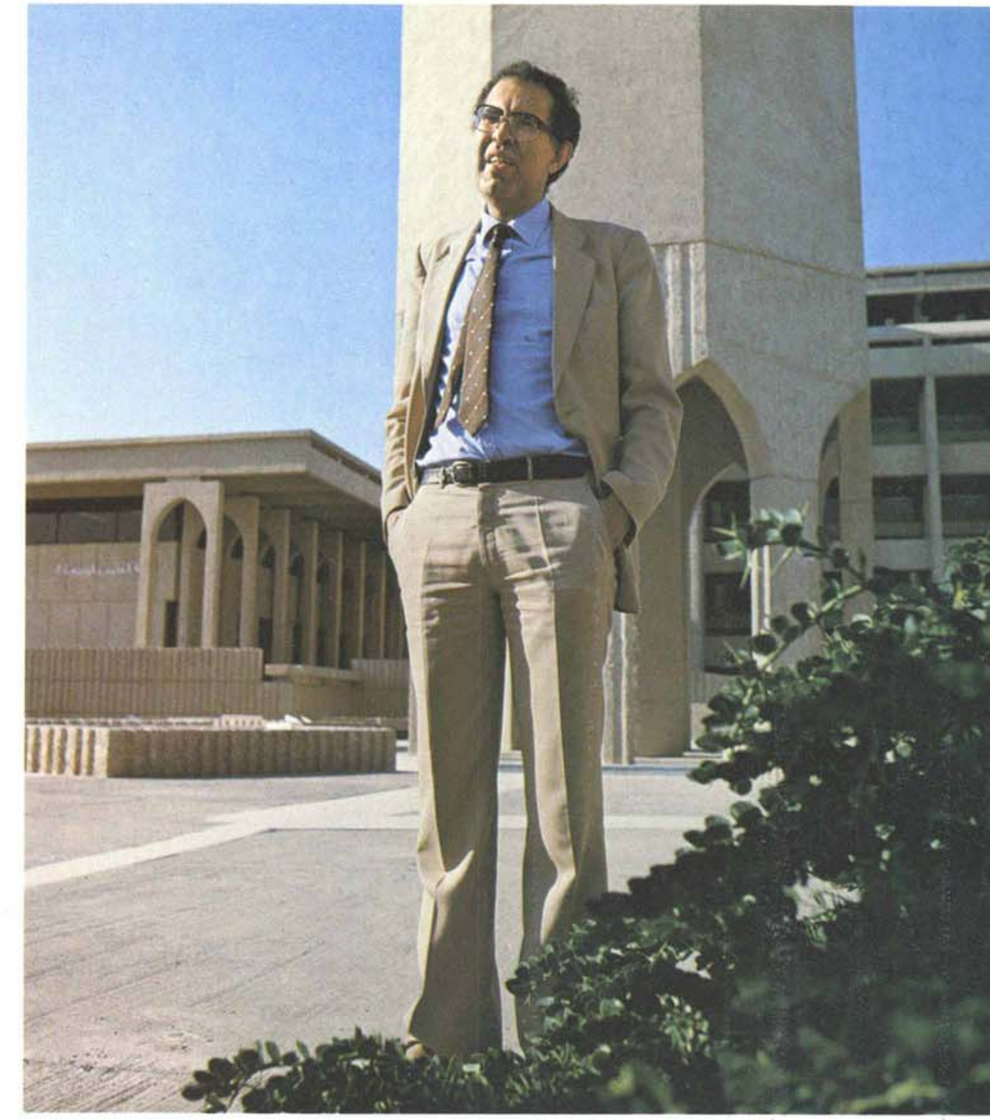
The dams would stretch some 58 kilometers (36 miles) in all, running from the Saudi Arabian shoreline to the Qatar shoreline in the finger of sea between the two countries, and meeting at the island of Bahrain, at the head of Dawhat Salwah, the long bay that would be dammed off.

It is not, obviously, a modest proposal. But, says Dr. Kettani, neither is it as fantastic as it first sounds. The process – called helio-hydraulics – could produce 300 million kilowatt hours per year. In addition, though, the dam could provide a second causeway to Bahrain – and generate tolls – and the dammed-off water could provide an enormous pond for raising shrimp, all of which, Kettani suggests, might make the cost feasible. ■



COMPLES (Cooperation Mediterrané pour l'Energie Solaire) at UPM, more than 200 delegates from around the world showed up to hear 120 papers on a variety of solar energy topics and Shaikh Ahmed Zaki Yamani, the Minister of Petroleum and Minerals, made it clear that Saudi Arabia's interest in solar energy was real.

"We all know that the known oil reserves, and what might be discovered in the future, won't be enough to satisfy all our energy demands, except for a few decades, and will be depleted by the mid-21st century," Yamani said. "In order to save our civilization there should be a substitute for this energy, and there is no answer to our demand except solar energy. Though we have a huge reserve of oil in this country, we very much encourage scientific research to establish and find other sources of energy supplies. We do this because we believe that humanity cannot be saved except through this route . . ."



Division head Bruce Nimmo totally agrees. Asked if he didn't see a degree of irony in his directing a solar energy program virtually on top of the world's key source of petroleum, he replied that he did not.

"It is to the credit of the Saudis that in spite of all the pressures of developing the country and all the difficulties that go with that they are willing to commit the resources to develop solar power," he said. "Oil is a finite resource. With the lesson of the industrial West in mind it is easy to recognize that. We saw this whole thing coming – the rate of oil consumption exceeding the rate of discovery of new resources in the U.S. It's a lesson that is abundantly clear."

With its present income, of course, Saudi Arabia could probably buy all the technology it will need to turn sunshine into energy, but as Dr. Kettani, one of the first solar advocates, is quick to point out, Saudi Arabia must produce its own skilled personnel or lose the chance to determine its energy future, and so has wisely chosen to work in close cooperation with the industrialized world.

As an example, Dr. Kettani points to a Saudi Arab-U.S. solar energy program called SOLERAS, in which Saudi scientists, at workshops in both Saudi Arabia and the U.S., share in the exchange of information among solar researchers. This sort of cooperation, he says, will allow Saudi Arabia "to grow with the technology."

Furthermore, Kettani goes on, Saudi Arabia must eschew wholesale importation of solar energy "gadgets" from abroad. "Solar energy is a raw material, but in its raw form it is useless," he says. "The cost of oil lies in producing and transporting it; the cost of solar energy is in the systems that will convert it into useful form. If we import the means to process solar energy, we are, in fact, importing energy. Unless Saudi Arabia develops its own solar energy industry and uses its own local talent for that purpose, it has not solved the problem whatsoever. The same is true for developing countries."

Dr. Kettani also thinks that to develop indigenous solar energy programs, cooperation among all Arab and Islamic states is vital. In a study he carried out with M.A.S. Malik, former director of the Solar Energy Program at the Kuwait Institute of Scientific Research, for the first Arab Energy Conference in Abu Dhabi in 1979, he urged the establishment of an Arab Solar Energy Commission to create an inter-Arab "solar energy plan of action." Published later, in a book entitled "Solar Energy in the Arab World: Policies and Programs", the study was commissioned by the Organization of Arab Petroleum Exporting Countries (OAPEC).

Kettani has high hopes for the Arab solar energy program. Saudi Arabia, he says optimistically, could get 25 percent of its energy needs from solar energy within 25 years – if there is cooperation. "If we don't pool our efforts to develop solar energy, other people will. This world is not waiting for us; the world is aware of the problem of more and more scarcity of fossil fuels. If we don't do something now, we'll be high and dry. There will be no more oil and we will have nothing for our future. For solar power, the time is now . . ."

Other spokesmen, though restricting their comments to technology, are equally optimistic. One is Dr. 'Abd al-Khalik Muhammad Zakzuk, in the Electrical Engineering Department of the University of Riyadh.

A man who refers to himself as "strictly a technology man," Dr. Zakzuk is a graduate of Liverpool University – where, for four years, he did research in integrated circuit technology

On rooftop of Riyadh University Dr. Hammad Safrata displays experimental photovoltaic circuitry being tried there.

and semi-conductor devices – and is now in his fourth year at the University of Riyadh, a specialist in micro-electronics as it applies to solar technology – i.e. photovoltaic cells which convert sunlight into electricity.

Though there are presently three small companies in the kingdom manufacturing solar cells – one in Riyadh and two in Jiddah – Dr. Zakzuk would like to see more, partly because he is seeking a product low in cost and high in efficiency. "There are two ways this can be done," he explains, his manner as precise and exact as his work. "By design and technical processes to reduce the cost, and by the choice of material. At present, semi-conductor grade silicon is being used to make solar cells. This is expensive. There is now a solar-cell grade silicon which is cheaper and we hope that within two years or so we can produce silicon solar cells and thin-film solar cells of low cost here at the college."

And Saudi Arabia, he goes on, is the ideal place to test solar technology because of its high summertime temperatures, intense sun and all-pervasive dust, all of which affect its efficiency. Since all three conditions are variables which can significantly increase or reduce the efficiency of a system, and drastically change its performance, Dr. Zakzuk will be recording that data when he performs tests on arrays made of silicon cells.

To Dr. Zakzuk, photovoltaic research is by no means new. "In the field I'm in – micro-electronics – we have heard about photovoltaic electricity for at least 50 years. But it didn't really become important until after 1973 and the energy crisis, and now solar technology is in the vanguard of scientific research. We in Saudi Arabia want to teach our students what is new, what is just beginning, what will be useful to them and their country in the future."

Another spokesman from the University of Riyadh is Dr. 'Ali Sayegh, chairman of the Arab Section of the International Solar Energy Society (ISES), a man who believes that wise men develop sophistication out of simplicity. This, he says, is the story of progress.

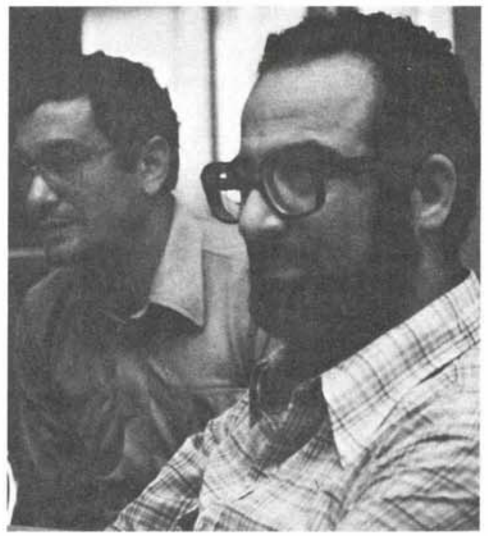
Dr. Sayegh firmly believes solar energy can and should replace the burning of petroleum. Oil, he says, should be put to better use: as petrochemical feedstock to manufacture much-needed materials – things like fertilizers, pharmaceuticals and plastics of all kinds.

Seated in his office in the University of Riyadh's old College of Engineering building – where he has been conducting experiments in solar energy research since 1969 – Dr. Sayegh likes to compare the present state of the art with Thomas Edison's beginning years. "His work was considered impractical and too costly then, too."

Dr. Sayegh also likes to point out that solar research really didn't get under way until 20 years ago, that "the amount spent on it so far is one billionth of that expended on nuclear research," and that "it has taken the industrialized nations 50 years of research and billions of dollars to reach their present imperfect stage of nuclear use, and it still has the disadvantage of producing dangerous wastes which we have not yet found a way to dispose of."

"To get involved in nuclear power," he goes on, "would be a mistake for my country. For one thing it would make us dependent on uranium, which we do not have, whereas we do have sunlight – plenty of it. Besides, nuclear technology is even more costly and highly sophisticated than solar."

Like Dr. Kettani, Dr. Sayegh is an optimist. He expects to see solar technology "leap ahead" within the next 10 years. "It's now a priority rather than a toy," he says, "and more money, more people and more good brains than ever are involved. I fully expect a major breakthrough within a decade."



Dr. Muhammad Ghazi works in solar desalination.

Where this will occur can't be predicted, of course, but Dr. Sayegh wouldn't be at all surprised if the University of Riyadh experiments play a part in the breakthrough. Funded totally by the university, the solar experiments have included measuring and mapping of the sun's radiation in the area, solar heating and cooling, studies of simple but selective absorptive coating materials, thermal storage, passive building design, and the comparative testing of various flat plate collectors.

According to Dr. Sayegh, the Riyadh experiments already surpass solar research he has seen in Europe and Canada – and the future may hold some startling developments. He predicts, for example, that Saudi Arabia will be able to make hydrogen – by electrolysis using photovoltaic cells – store it in batteries, and export it. And he, himself, hopes to investigate heat storage in a variety of substances such as rocks, water, tar, calcium chloride, water and paraffin wax. Another avenue is the possibility of building greenhouses with roofs made of radiating material which is transparent to infra-red light and which employs night radiation to cool rather than to heat. Still another is the possibility of using buildings and streets to store Saudi Arabia's burning summer heat for later use.

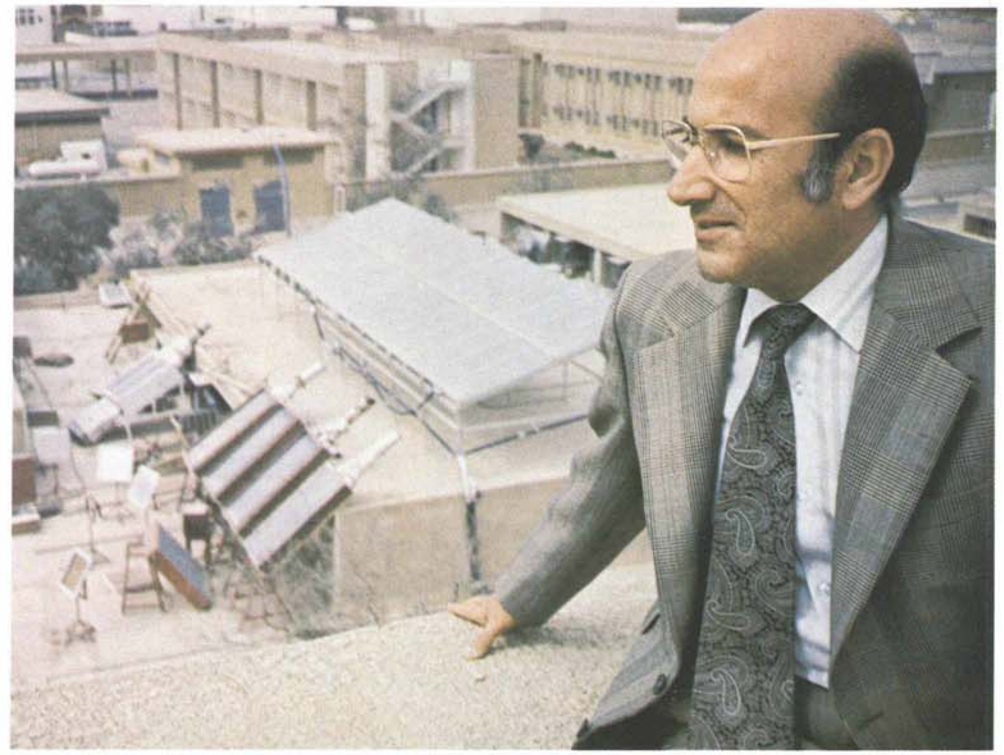
The possibilities, in fact, seem endless. In his third floor laboratory at the University of Riyadh's College of Science and Engineering, for example, Dr. Hammad Safrata has already spent four years testing, experimenting and expanding his knowledge of heat transfer systems and air conditioning, and – with a $2 million grant from SANCST – plans to expand and speed investigations into seven projects. One involves a solar air conditioning laboratory funded by SOLERAS, and the others range from an easily assembled and portable reflector type of solar picnic cooker to a small refrigerator made of entirely local materials, a prototype of a thermal electric system. This fridge uses only solar energy and, having no compressors or fans, requires no maintenance and makes no noise. "It's a practical enough idea," Dr. Safrata says, "but not until photovoltaic cells are cheaper – perhaps in 20 years." Another project is to explore a way to use the available absorption systems of a normal gas refrigerator two different ways – either with electricity or by direct solar heating.

Dr. Safrata's teams are also trying to measure the performance of solar equipment, and trying to find a reliable method of removing dust from collectors, a vital factor in developing solar energy since dust, in a desert climate, coats all equipment daily and reduces efficiency. Dr. Safrata and his colleagues would like to find units of measurement for that dust and design an instrument to measure it accurately. "It would be an entirely new term of measurement," he says, nodding thoughtfully, "and something which up till now has had little international attention."

Dr. Safrata believes that Saudi Arabia, by working to develop solar technology, is at least helping to create the breakthrough which, he predicts, is not far off. Furthermore, he says, Saudi Arabia is in an opportune position to learn about solar technology from the beginning. "We must make use of this opportunity and join with the research from the start. No one will give you his know-how. You must get it yourself."

The University of Riyadh, obviously, is playing a key role in solar experiments. But there are spokesmen elsewhere as well. At King 'Abd al-'Aziz University in Jiddah, for example, there are Dr. Mehmet Akyurt, 'Abd Allah al-Mahdi, Dr. Samir 'Ali, Dr. 'Abd Allah Nasif, the university president, Dr. Muhammad Jamjun, the dean, and – one of the pioneers of solar research in Saudi Arabia – Dr. Jaffar Sabbagh.

Years ago, with Dr. 'Ali Sayegh at Riyadh University and Dr. 'Ali Kettani of UPM, Dr. Sabbagh pioneered the kingdom's first solar research; at a UNESCO conference in 1972 they submitted papers on solar research from Saudi Arabia. And today he feels as strongly as ever about its importance. "In many fields of research," he says, "Saudi Arabia cannot be said to be very advanced, but in solar we're starting even with everyone else."



Dr. 'Ali Sayegh on roof at Riyadh University Engineering College where he has led solar research for some 12 years.

Since King 'Abd al-'Aziz University was not founded until 1975 – and is still awaiting completion of needed laboratories – "starting even" may be a shade optimistic. Yet it is undeniable, as Dr. Salah Gahin, chairman of the Mechanical Engineering Department, is quick to say, that the university does have some impressive projects underway: Dr. Akyurt's work with solar collectors and heat pipes; Dr. Muhammad 'Abd Allah Ghazi's solar desalination; and work by Dr. Ibrahim Taha, Dr. Mustafa Elsayed and 'Umar al-Rabghi on solar absorption systems which are part of a solar cooling project involving both absorption systems and vapor compressor systems.

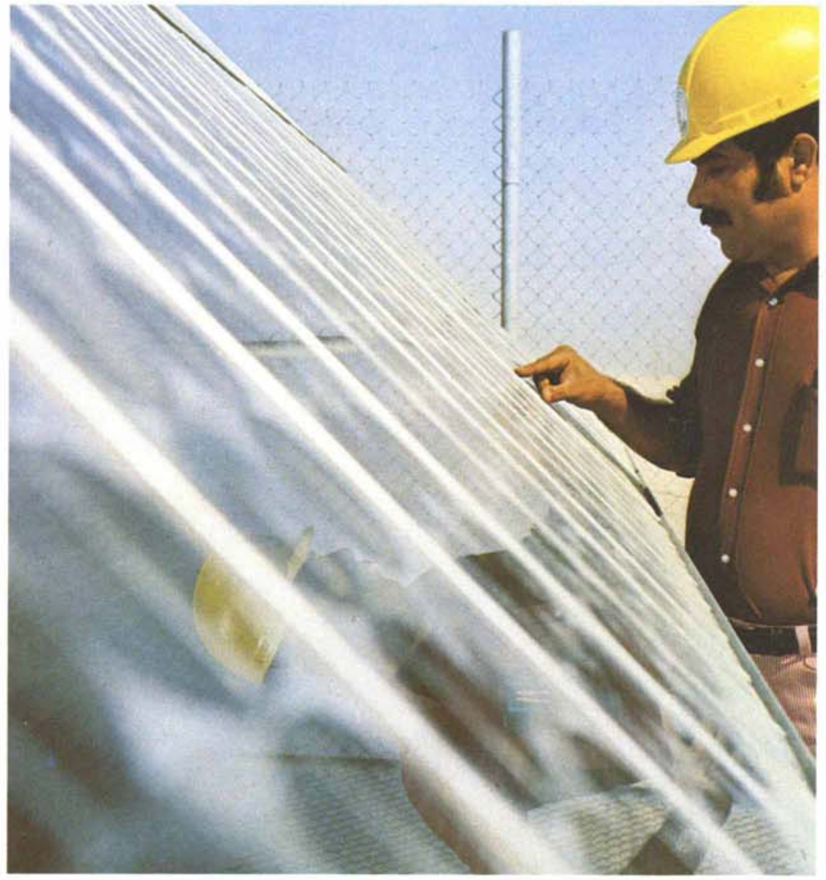
As he describes the projects, Dr. Gahin is careful to mention all researchers, meticulously including Dr. Talib Allah, of the Department of Applied Science, who is doing research on selective coating for flat plate collectors, and Dr. Fawaz Alamy, dean of Meteorology and Arid Land Institute, a part of the College of Meteorology. He also wants it known that he is expecting another $1.9 million for his research and that he expects his laboratories, when fully equipped and operating, to be the first of their kind in the world. Indeed the Middle East – particularly since the start-up of Saudi Arabia's $16.5 million solar village project – is fast becoming a focal point of world solar development. It is estimated that there are 150 or more solar research projects now under way in over 30 universities and 20 government research centers – as well as in several national oil companies.

The reason is not hard to find: the sunshine falling on the Arab East produces a minimum of three million megawatts of electricity – the equivalent of the output from 3,000 large power stations. In addition, many of the Arab oil countries have both the funds and the foresight necessary to tackle what might be the world's next technological revolution. ■

SAUDI ARABIA AND SOLAR ENERGY

A Solar Shield

WRITTEN BY ARTHUR CLARK
PHOTOGRAPHED BY M. J. ISAAC



Ahmad Abu Isa, superintendent of Aramco's Cathodic Protection Division, checks a solar panel.

The calculations are complicated, but what they boil down to is a decision to enlist the sun in Aramco's endless war against corrosion – through photovoltaic cells, the tiny devices developed for the space program which convert sunlight directly into electricity.

In effect, corrosion is an electro-chemical cancer that attacks buried petroleum pipelines and well casings, eventually, riddling them with microscopic holes or weakening their resistance to the high pressures of flowing petroleum. An enormous problem in industrial societies, corrosion is the movement of metal ions – electrically charged atoms – from one point on a pipeline, or a well casing, to another point.

What happens, engineers say, is that an electric current is set up when two dissimilar metals – or two areas of the same metal – come in contact via a bridge, or path, like soil or water; moving from a negatively charged area – the anode – the current carries ions away from the anode and flows to the cathode. In streaming from the anode the ions dissolve and corrosion results. Because steel alloys in well casings and pipelines contain enough dissimilarities, such "galvanic cells" are easily activated and corrosion – occurring at an anode, the point where the pipeline loses ions – eventually eats a hole through the metal pipe or casing, in weaker areas of the metal, and a leak results.

To fight corrosion, engineers long ago worked out a process called "cathodic protection" under which another source of metal – such as magnesium – is buried near the pipeline or well casing; it's a sort of sacrificial lamb used as a source of current sent to the pipeline rather than drawn from it. To put it another way, the pipeline, or casing becomes the cathode, and the sacrificial metal becomes the anode – thus giving rise to the "sacrificial mode" of cathodic protection.

In another mode, called "impressed currency," the key to cathodic protection is a reliable source of electricity. This mode requires a steady current flowing from an anode placed in the ground – usually graphite or high silicon iron which corrode slowly – to the cathode. Until recently this electricity was provided by power lines or generators. Now, however, Aramco has decided to use solar energy as a source of electricity for what is to be an expanded cathodic protection program.

According to Ahmad Abu Isa, superintendent of the Cathodic Protection Operations Division of Aramco Pipelines Department in Dhahran, Saudi Arabia, plans to use photovoltaic cells to provide power for numerous cathodic protection systems are based on the fact that photovoltaic equipment is virtually "maintenance free."

In addition, the cost of solar cells has plummeted in the past two years, while the cost of electricity from conventional sources has risen. With the company preparing to "electrify" some 1,330 well casings – about a third using solar power via photovoltaic cells – the savings could be important. The company also plans to install 14 photovoltaic units to protect some 250 kilometers (155 miles) of crude oil pipeline between Qatif and Qaisuma, the first leg of the Trans Arabian Pipeline – Tapline.

Aramco engineers have high hopes for the photovoltaic system – and solid reasons for their optimism. For two years, says Abu Isa, Aramco has been experimenting with a photovoltaic system set up to protect 5.6 kilometers of crude oil pipeline near Abqaiq (three and a half miles), the headquarters of Aramco's Southern Area Oil Operation. And so far, he says, there have been no problems at all.

A four-solar-panel "array," containing the photovoltaic cells and a battery that stores up to 200 hours of electrical power – to supply power at night or on overcast days – the Abqaiq unit produces 60 watts of power, enough to light a single average light bulb. Furthermore, engineers say, the unit is efficient. Because of the inland site, the dust that clings to the panels in other places – thus cutting the efficiency of the solar cells – is less of a problem; lacking the high humidity of the Gulf coast, thick dust does not accumulate.

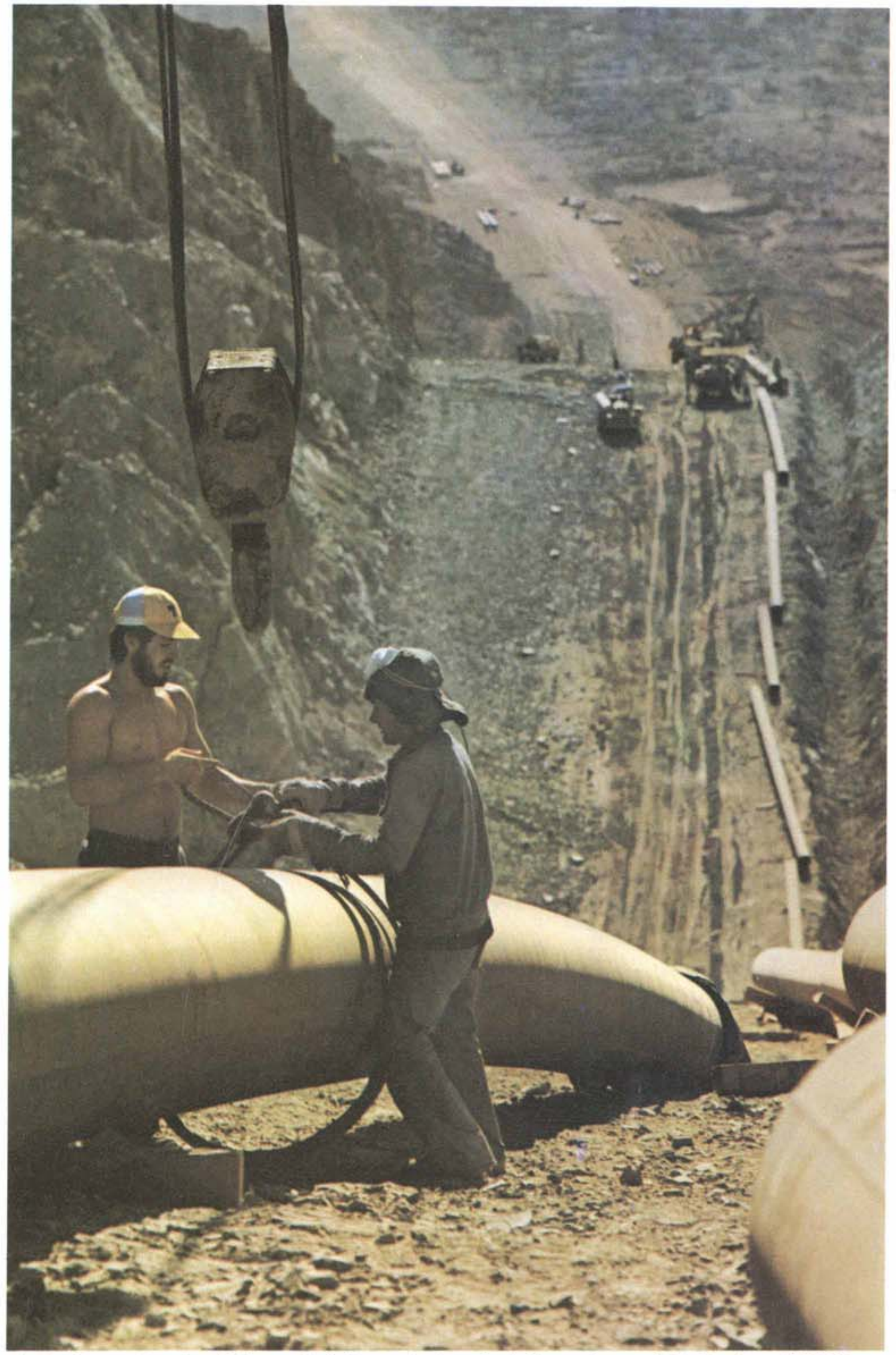
A second photovoltaic system, Abu Isa says, has been working since October, 1980 providing cathodic protection for some 10.4 kilometers (six and a half miles) of crude oil pipeline north of Dhahran, and is still functioning smoothly. This system produces 108 watts of power.

According to Troy Stilley, senior project engineer with the Cathodic Protection Unit of Aramco's Central Area Project Design and Construction Department, a typical Aramco well casing requires 240 watts of power to protect it – enough to run two portable color television sets. But since power is also required whether the sky is overcast, or night has fallen, a panel capacity of some 1,500 watts must be built into the system.

Engineers say the price of a typical photovoltaic cathodic protection power supply is approximately $50,000 including the photovoltaic cells, the panel packaging, the unit's storage batteries and a regulator. Two years ago, that same typical photovoltaic power supply would have cost about $80,000.

A complete system, including anode, fencing, platform and installation, runs to about $250,000. This may seem expensive for a few hundred watts of power but with each mile of power line strung to such outlying areas costing $100,000, plus fuel for the plant, solar energy, streaming freely down from the sky every day, offers cost advantages that are obvious. ■

Arthur Clark is a writer for Aramco Public Relations Department in Dhahran Saudi Arabia.



In the future, solar cells might be used to fight corrosion in such pipelines as the recently built east-west NGL Line.

On a simple loom, an ancient craft

WARPS, WEFTS & WADIS

WRITTEN AND PHOTOGRAPHED BY VIRGINIA McCONNELL SIMMONS

Sunset bathed the acacia-studded wadi with a peach-colored light as we jostled down a sandy track toward the Bedouin camp where we had been invited for supper. A young girl was herding her flock toward the same destination, a black tent nestled in the lee of a granite outcrop. Surely, it seemed, this scene was a mirage, spun from romantic scenes of the past.

Rounding a boulder, we came into camp. The men of the family greeted us and led us to a handsome wool rug beside the fire pit outside the tent, where coffee was soon served. Seated on our fine rug – conspicuously the place of honor, since the other rugs around the fire were of ordinary India cotton – I took in a few details of the camp, with its modern acquisitions juxtaposed on the traditional scene. On one side of the tent was a shiny wire enclosure filled with sheep and goats; next to it a new pick-up truck was parked. On the other side of the tent a long, narrow loom of the ancient Bedouin type was stretched on the ground.

With the men's attention occupied by the host's new portable radio, I walked over to the tent, where Sarah, our hostess, was preparing food. When I showed an interest in the nearby loom, Sarah proudly pointed out the pieces of her weaving equipment – an acacia stick wound with gray yarn, a few iron tent stakes pinning the apparatus to the ground, a carved piece of wood for beating the yarn into place, and an animal horn.

To my delight, Sarah then demonstrated the loom. Kneeling near the heddle, from which was suspended the longitudinal warp yarn, she leaned forward and beat the heavy strands of warp with her fist. Like most Bedouin women, Sarah was not large, and all the strength in her slim arm was required to force down those threads while she tugged at others, pulling them up to form a passage for her shuttle. When this opening was formed, she inserted her carved sword beater – the name refers to its shape – to hold the opening while she inserted her shuttle – the shuttle being simply the acacia stick – and so drew the weft yarn – the crosswise yarn – through the warp, or longitudinal yarn. Then came a vigorous pulling against the weft with the sword beater to bring the new row in snugly. Next, with the horn, she caught a few warp yarns and yanked them again and again to drive the weft down even more tightly. After repeating this step across all the warp, she resumed the original pounding on it to form a new opening for the weft. Sarah's strenuous methods are the standard techniques used with a horizontal loom.

Whatever the type of loom, its function is basically the same – to hold the warp taut while the weft is interlaced through it. Sarah's horizontal loom is man's oldest type of weaving equipment, with the exception, perhaps, of sticks hung between trees. Apparently first used in ancient Egypt, the horizontal loom is still the most common type used by Bedouins in the Middle East. The essential difference between this loom and most others is that it has a fixed heddle, so alternate sets of warp threads cannot be moved up and down mechanically to form passages for the weft: that has to be done by sheer muscle. Warp is wrapped in a continuous length back and forth between the front beam and back beam, alternate warp threads passing through loops of string, called the leash, which are attached to the heddle. This type of loom has two advantages over more sophisticated types: applying the warp is a simple matter of winding yarn back and forth from front to back; and the nomads can unpeg the loom, bundle it up and move it with their camp – regardless of what stage the weaving on it may have reached.

Disadvantages also are twofold: openings for the weft are difficult to make, and only a few patterns of weaving can be worked.

Like the loom itself, Sarah's simple tools are typical, although her combing horn is a possession especially prized by a weaver lucky enough to own one. It is a gazelle horn, from an animal once common in the Arabian Peninsula but now nearly extinct. Instead of a horn, many weavers use an iron hook – its end sometimes wrapped with yarn to provide a soft handle.

Before the loom is set up, the weaver must know the length of the finished piece of cloth. If a strip of tent material is to be woven, perhaps as long as 12 or 15 meters (40 or 50 feet), the beams must be pegged at least that far apart. Then the warp is wrapped, its alternate threads are leashed and weaving begins at the front beam. As the cloth grows, the heddle is moved back, a few feet at a time, and the front beam is occasionally unpegged and the finished cloth rolled up on it, both to keep it out of the dirt and to keep the edge of the woven area within the weaver's reach. Then the beam is re-pegged. A strip is rarely wider than 63 to 76 centimeters (25 to 30 inches), this being the limit of most weavers' reach. If a wider piece is needed, separate strips are sewn together, or a pair of weavers may work side by side on the left and right sides of the loom; often mothers and daughters, one generation learning from the other.

Sarah's daughter, who was learning through just such an apprenticeship, was eager to help with her mother's demonstration to me. After a few rows of weaving, Sarah rocked back on her heels and looked up at me, her gestures and expressive eyes asking if I understood. Yes, I understood the techniques. What I didn't understand was how this small woman could sustain the back-breaking labor long enough to produce anything. But over our heads was the very tent which she had made and to which she would add the new strip now on the loom. A dividing wall inside the tent, and even the intricately patterned rug on which I sipped my coffee had also been made by Sarah and her daughter. I wondered how much longer the Sarahs of the desert and their daughters would be able to continue this skilled and time-consuming craft when they can now so easily and cheaply buy imported textiles.

For centuries, Bedouin weaving has gone hand in hand with the pastoral culture of the Arabian nomads. Their livestock has provided milk and meat, utensils made of skins, fuel from dung, transportation, occasionally some trade goods and, of course, wool for weaving.

Nowadays, the Bedouins belong to a money economy in which many of these traditional uses are not as important as they were. Yet Arabian sheep and goats still total over four million, and there are about one million camels, plus uncounted donkeys, oxen and cattle. Thus, the raw material for weaving is at least available.

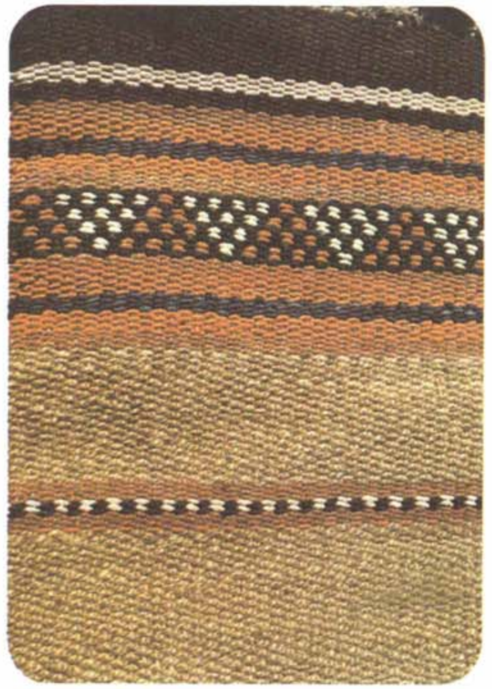
Although a man will occasionally shear a sheep or goat for the wool, the women usually pluck the hair after the animal has been slaughtered and skinned. Most of the hair for weaving comes from goats and sheep, with additional raw material from camels and cattle. Both goat and sheep hair are fairly coarse, and since the native fat-tailed sheep are long-haired, there is no fleecy wool. Camel hair, being very soft and fine, but also comparatively scarce for weaving, is the most highly prized. Goat and sheep hair is usually black or white with some rich brown from goats and gray from sheep, while camel hair ranges from ecru through dark brown.

Producing spun yarn from these fibers is a seemingly never-ending task for women and girls, and one seldom sees a shepherdess without a spindle in flashing motion as she follows her flock over the desert. First, the wool is washed and picked over with the fingers to remove twigs, thorns and other foreign matter, but it is not carded. During this cleaning process, the fibers are worked into a loosely twisted thread, called a rove, which is wound into a skein. The spinner then can carry the skein on her wrist, and, with the thread hooked to the upper end of her spindle, twist the fibers into yarn. Twisting techniques vary: sometimes the spinner drops the spindle yo-yo-fashion in the air, holding it by the yarn already spun. More often, in Arabia, the spinner uses the palm of her hand to roll the shaft of the spindle upward along the outside of the thigh. As spinning progresses, a ball of yarn is wound onto the end of the shaft or around the crossed bars which are sometimes attached to the end of the spindle.

Still, the yarn is not finished, for this single strand or ply of spun yarn is not heavy enough for most uses. Instead, two balls of single-ply yarn are twisted together into two-ply yarn. To keep it from unraveling, the plying twist must be in the opposite direction of the twist that spun the yarn. Large as they are, these balls of very coarse yarn will be too short for most weaving purposes, so the weaver will then splice the yarn by wrapping strands together with thread or even ribbon, lending a rather disconcerting effect to the finished product.

Most Bedouin yarn is used in its natural color, such as the black goat hair used for tents, which are decorated with only an occasional band of natural white or gray, but some is dyed. The dyed wools, and the scarcer natural browns, are usually saved for such items as dividing walls inside the tent, rugs, bags or animal trappings. Until World War II, most dyes used in Arabia were natural ones – madder, henna, or cochineal for red; kermes for reddish brown; saffron or fermented lemons for yellow; lichens treated with ammonia for purple and indigo for blue.

In some towns like Jiddah, where a dye trade flourished, strips of indigo cloth drying on lines were a common sight and in Taif or Hofuf today you can still find dye sheds filled with hanks of yarn in handsome shades of red, purple or rust. Some of the natural dyes are still imported from India, but most dyeing today, whether done by commercial dyers or Bedouin weavers, is done with commercial aniline dyes. From Europe, consequently, the rich colors of older dyes are often replaced by untraditional splashes of pink, purple, orange or green – especially in products which are made for sale rather than for the weaver's own use.



Most goods woven on a horizontal loom have weaves which differ markedly from those worked on other types of looms. Many materials, such as those for tents, are warp-faced rather than weft-faced. That means that the threads that show most on the surface of the cloth are the "long" warp threads instead of the "crossways" weft threads.

The heavy "beating in" which each weft thread receives forces the warp threads into prominence, and the patterns or contrasting stripes are produced by using different colors in the warp rather than in the weft, as in weaving in the West or other Middle Eastern countries. When patterns are worked into a warp-faced weave, the weaver selects the warp threads she wants from the different colors of thread which have been strung on the loom; the unused colors "float" at the back of the cloth until they are needed for the design. Because of these floating threads, Bedouin warp-faced patterns are not reversible, unlike weft-faced rugs such as those woven by Indians of the southwestern United States.

Occasionally, however, Bedouin designs may be weft-faced. A *kelim* rug is much like Navajo weaving in technique, with different weft colors being worked back and forth with the fingers. Another finger-woven weft weave is *sumak*, which may be introduced as an embellishment or as the basic weave of an entire piece such as a prayer rug. This type of weave, characteristic of Bedouin fancy work, is shared with craftsmen of many times and places: *sumak* has appeared in primitive weaving in Egypt, Peru, Sweden, Japan and Guiana, among other places, and archeologists have found *sumak* weave fragments dating from 2000 B.C. at a site in a Swiss lake.

Although most designs in Bedouin weaving are simply colored stripes, an adventurous weaver may attempt borders, triangles, diamonds and zigzags, but intricate designs are rare. In keeping with orthodox Muslim traditions, there are few depictions of human figures or animals in Bedouin weaving.

No one knows how long Bedouin women, using only simple tools, techniques and designs, have been manufacturing their families' shelters, rugs, containers, cushions and clothing. For that matter, no one knows how long people anywhere have been weaving; cloth is so perishable that only extraordinary circumstances – acid mud, for example – preserve it for the archeologists. It seems likely though that Arabia's prehistoric populations knew how to weave, as Egyptians of the time did. But historical accounts from the 10th century to recent times all

indicate that the demand for woven materials was greater than the local supply. Although most Bedouin women wove the woolen cloaks worn by their people, those worn in the Hijaz region came from Egypt in the early 19th century, according to Burckhardt's *Travels in Arabia* (1829). Even the tents, which seem to be the hallmark of Bedouin culture, were once not so abundant. Karsten Niebuhr's *Travels in Arabia* (1792) informs us that only the shaikhs enjoyed the luxury of living in tents.

Thus, it appears that Bedouin weaving in Arabia may have reached its greatest productivity only *after* the early 19th century, when the craft could provide most of the textiles used in Bedouin daily life – including what became the principal type of shelter used: the tent. A conspicuous advantage of the *bait sha'ar*, or "house of hair", was the readily available construction material; it involved no cash outlay. Furthermore, women could make it, set it up, and take it down for seasonal migrations. The oily hair provided insulation and resisted moisture, and the original roof could be enlarged or repaired at any time with a new strip. Within the tent a more colorful dividing curtain usually separated the women's household and sleeping quarters from the men's gathering place. This curtain was often woven of sheep's wool, sometimes dyed, and decorated with strips or geometrical patterns. When it was not needed for privacy, the curtain might be used as a rug for seating guests.

Today, in many parts of the Arabian desert, this curtain now seems to have fallen into disuse, even where the traditional goat-hair tent remains, and decorative rugs are also scarce; the Bedouins themselves seem inclined to buy inexpensive imports such as plastic mats from Japan. Some rather garish, warp-faced carpets turn up in markets, but most of these are made by town weavers in Abha or Khamis Mushait or Yemen.

Similarly, hand-woven storage bags and saddlebags are being replaced in Bedouin camps by cotton sacks or even suitcases, while bags sold in the markets are the colorful products of village craftsmen. Traditional storage bags, some large enough to be made from two strips of cloth sewn together, were stuffed with household belongings and hung inside the tent, placed on the ground as cushions or, when moving, slung on the side of a donkey or camel. Saddlebags were also made, with one compartment hanging on each side of the animal. Along with the bags, Bedouins also wove brightly colored bridles, bands, and other animal trappings decked with tassels and beads. Few of these are made today – though elaborate trappings still are sold for special occasions like annual camel races.

Today, wool is rarely woven for cloaks except in a few oasis towns, such as Hofuf, where treadle looms rather than Bedouin ground looms are employed. Here, one might see the fine camel-hair cloth, which will be sewn into a *bisht* and trimmed with gold ribbon for a person of high rank.

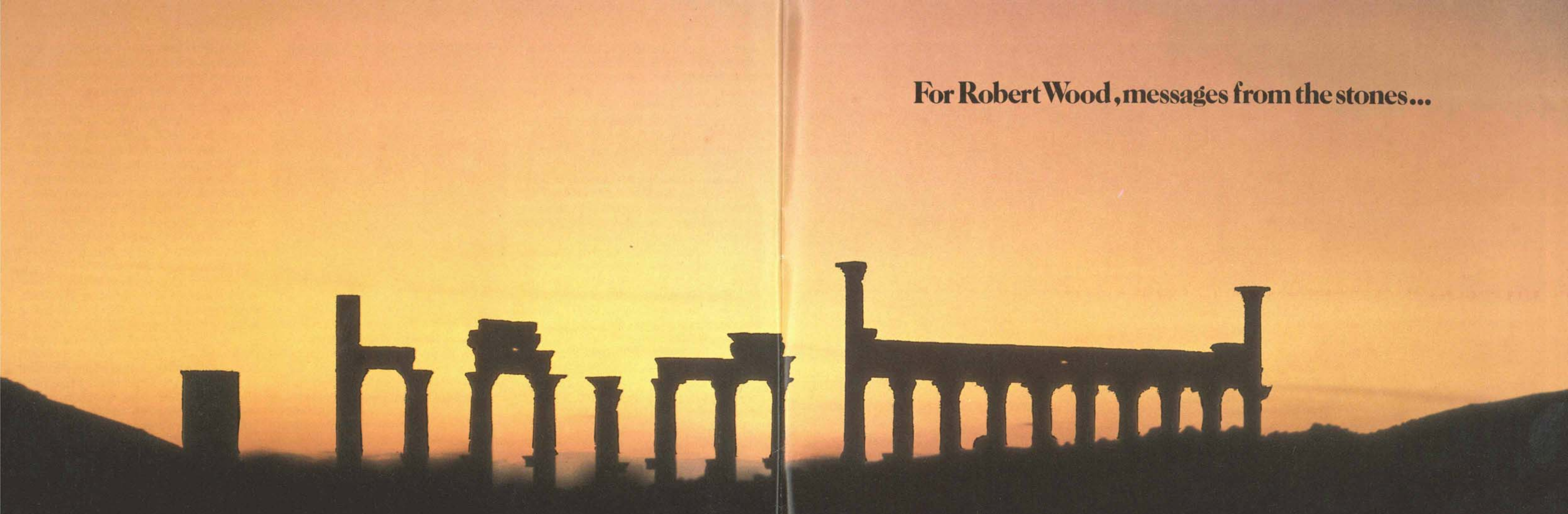
Although craftsmen of towns and villages weave chiefly for urban markets, their merchandise also includes Bedouin-style weaving to be sold to Bedouins. Nomads, who lack the time or the skill to weave what they need, frequently buy tent strips or even balls of spun yarn at the country *suqs*. But as the Bedouins' needs and tastes have changed in the past 30 years, handweaving in the towns has declined too.

This is natural. Mass produced articles are cheaper and just as good as handmade ones. But they cannot provide the user with the pride which comes from the performance of a skill with the hands, a fact that other societies learned only after machinery had replaced almost all of the traditional handcrafts.

The loss is felt, though unconsciously. Two out of every five Americans, for example, engage in some sort of craft as a hobby, vocation or therapy – an attempt to regain what Sarah still has: a vital role in the welfare of her family and a tangible link with the heritage of her people. Her weaving is a symbol, unconscious though it may be, of the importance of her own life and her society. As Saudi Arabia takes steps to collect and preserve its traditional heritage, perhaps an increasing recognition will accrue to the value of the kingdom's folk art, present as well as past. In the craftsmanship from Bedouin looms is a key to recalling and understanding the old ways of the Arabian desert.

Virginia McConnell Simmons, an American, has lived and worked in Saudi Arabia.

For Robert Wood, messages from the stones...



It requires no effort to recapture Palmyra's splendor. The ruins of graceful, colonnaded streets and a magnificent monumental arch, the crumbling remains of a theater and a temple dedicated to Bel, all testify to its glorious past. Isolated in a desert setting dominated by the looming presence of an old Arab castle on a nearby hill, Palmyra, a romantic vision in the clear, sunlit air, inevitably stirs the imagination; even seasoned tourists can instantly visualize the great caravans that, centuries ago, brought silks and spices and precious stones from Arabia and distant Cathay.

Palmyra -A Portent?

BY JOHN MUNRO

PHOTOGRAPHED BY KATRINA THOMAS, BRIAN SMITH AND JAMIE SIMPSON

It was because of the caravan trade that Palmyra flourished during the third and second centuries B.C. Already prosperous, Palmyra became a Roman client state in the time of Mark Antony; about 60 years later, in the reign of Tiberius, it became a tributary and then, in A.D. 212, a colony. Eventually, Palmyra also became a valuable ally and Odenathus II, Palmyra's king, was appointed commander of the Roman armies in Syria, under whose charge they were able to recapture Mesopotamia from the Sassanians and extend their authority across the Euphrates as far as Ctesiphon.

It was not Odenathus, however, but his widow Zenobia who assured Palmyra its prominent place in ancient history. Unhappy under the authority of Rome, she took the title "Augusta" and sent her armies to occupy Egypt and parts of Asia Minor while Emperor Claudius Gothicus was preoccupied with problems closer to home: the invading Goths, then attacking Rome from the north.

Initially successful, Zenobia and her son Vaballathus then went too far. Vaballathus assumed the title of Augustus, and had coins struck with his own image and that of his mother – an affront that Claudius' successor, Aurelian, could not accept. The Roman armies swept into the city, ransacked it, captured Zenobia and brought her to Rome, where, bound in golden chains, she was made to march behind the Emperor's triumphal chariot through the streets of the city.

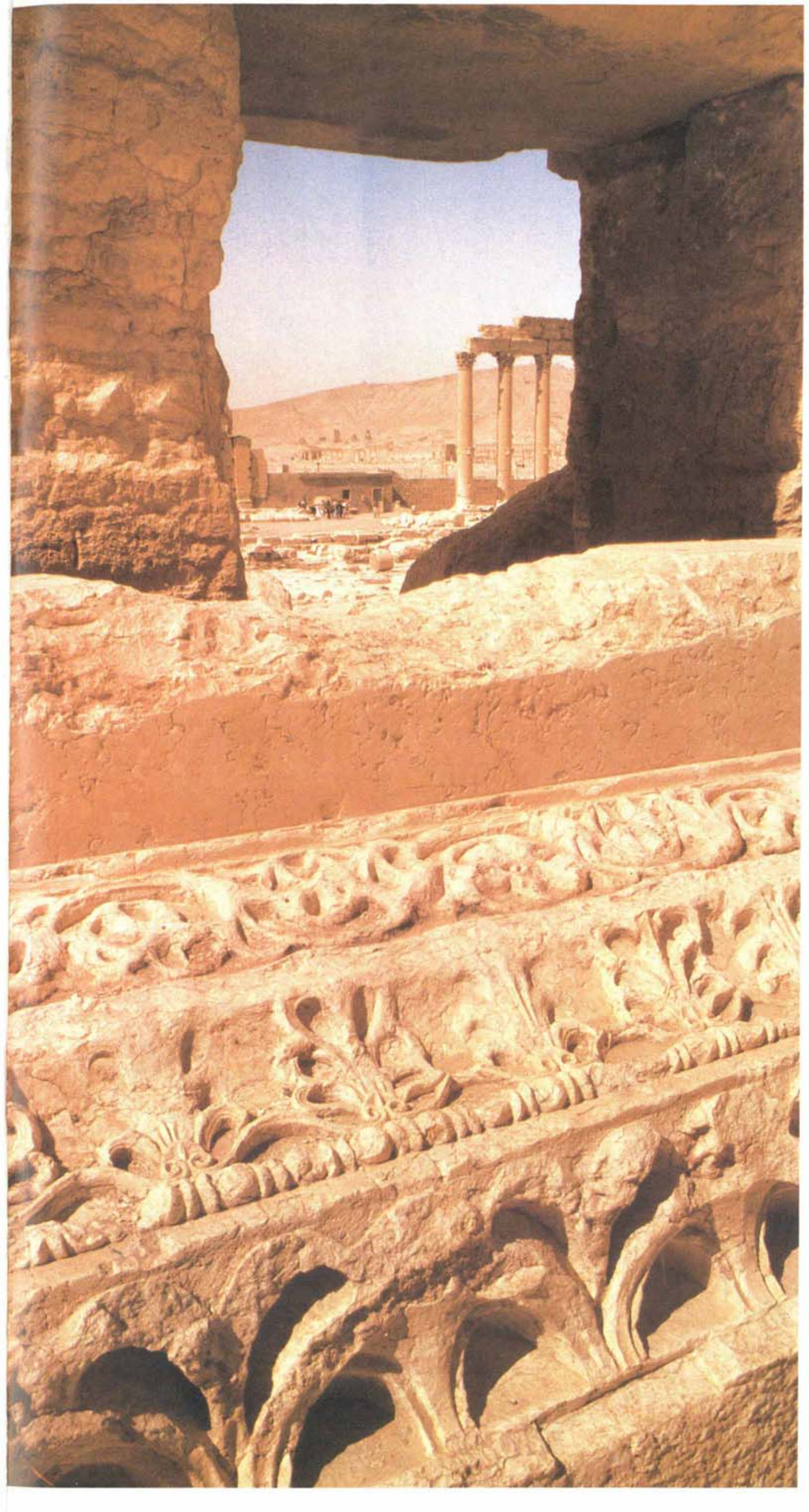
In the history of Palmyra, that was a turning point. With Zenobia in Rome – where she married a Roman senator – Palmyra's fortunes declined rapidly. And although it enjoyed a brief revival under the Abbasid caliphate, Palmyra never again attained anything like that splendor that characterized it during the time of Odenathus and Zenobia.

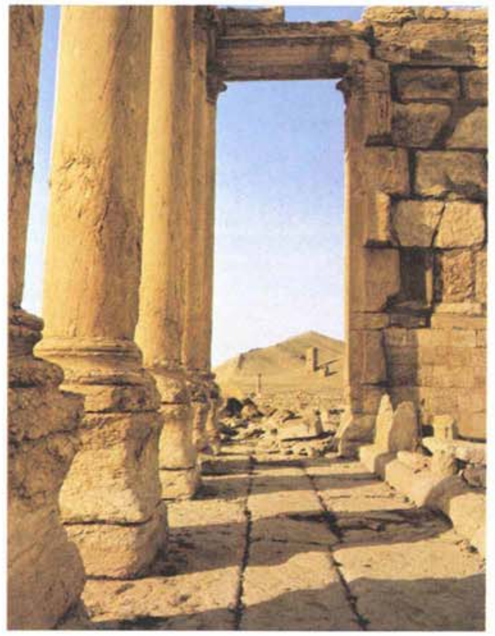
Not surprisingly, Palmyra's rise and fall have attracted the attention of many historians and amateur philosophers, who have contemplated the city's dramatic reversal of fortune, and sought moral lessons among its still impressive ruins. Among them was Robert Wood – or "Palmyra" Wood as he came to be known – an Englishman born in 1717, who visited Palmyra in 1751.

Best known as a politician, Wood served as under secretary to Prime Minister William Pitt from 1756 until 1763 and was also secretary to the Treasury during the administration of Lord Bute. But Wood was also a student of ancient history, sharing with his more famous contemporary Edward Gibbon an interest in the rise and fall of great nations. And to Wood the story of Palmyra was a portent of the future of Great Britain.

According to Wood, who published *The Ruins of Palmyra* in 1753, it was the traveler's duty to analyze the forces which led to the rise and fall of past civilizations, rather than simply describe the splendor of their monuments. Despite its splendid engravings, therefore, Wood's book is less significant for its description of Palmyra's ruins than for its brief, but now eerie prophecies with regard to Britain.

A cultivated, 18th-century Englishman, Wood, in an essay on Homer published in 1765, said that true knowledge can come only after one has had an opportunity to evaluate one's own society in relation to others. Homer is great, Wood observed, partly because he was a traveler, and therefore able to place knowledge of his own culture in its proper perspective.

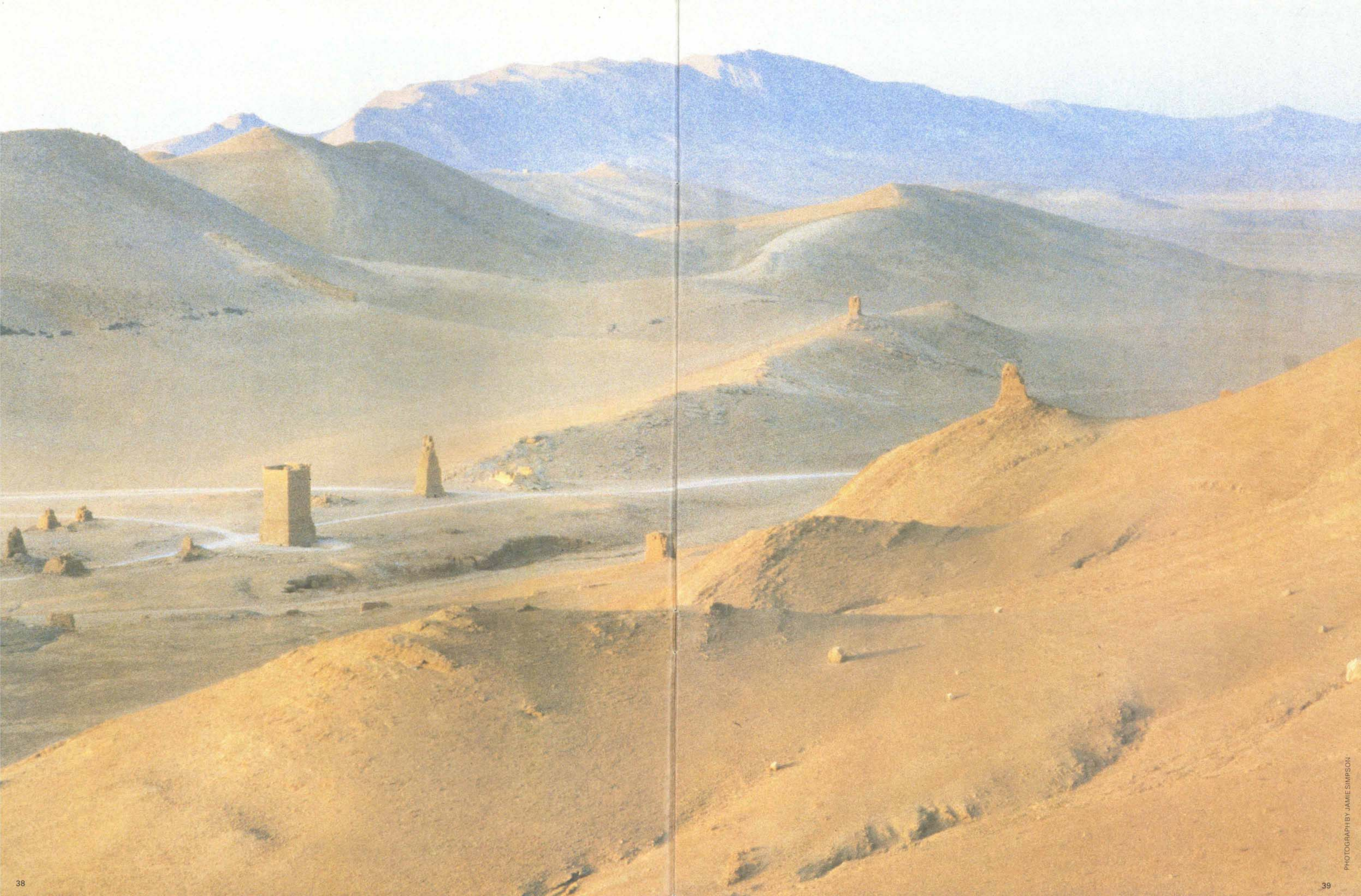




It was in this spirit that Wood, accompanied by two Oxford scholars, James Dawkins and John Bouverie, and an Italian artist, Borra, journeyed to Palmyra, and then to Baalbek, – which led to publication of *The Ruins of Baalbec* in 1757. He hoped that his investigations might lead him to a better understanding of his own country. To Wood, Palmyra achieved a high level of civilization as a result of its own unaided efforts – as did England – rather than through contact with supposedly superior cultures.

Although it was widely supposed, he wrote, that Palmyra's splendor came about as a result of Rome's beneficence rather than by the enterprise and industry of the city's own inhabitants, this, in fact, was entirely wrong. The city rose to prominence, he went on, by capitalizing on its advantages as an important stopping place on the trade routes from the East. It declined only *after* it had become a tributary of Rome.

Suggesting other similarities between Palmyra's situation and that of Great Britain, Wood noted that just as the sea contributed to Britain's "riches and



PHOTOGRAPH BY JAMIE SIMPSON

defense," so the desert contributed to Palmyra's: both states profited from their strategic position in terms of commerce and their ability to ward off potential invaders.

Like Great Britain, Wood argued, Palmyra had been able to prosper as a result of its independence from surrounding nations. After it was absorbed by Rome, the Palmyrans were reduced to living "idly on as much as Aurelian had spared," a situation which sapped their morale and weakened their resolve. There was a lesson here for his own country, Wood thought.

In Wood's eyes, another factor in Palmyra's success was its natural environment, a climate not unlike that of classical Greece. True, one could not explain Britain's cultural heritage in terms of similar climatic conditions, but some argue that the energies of Western Europe do stem from a brisk climate. Besides, there were other parallels. Like Palmyra during the time of its greatness, Britain was blessed with a form of government that was essentially sound.

In particular, Britain had a constitution which, in the words of Wood's Scottish contemporary, philosopher David Hume, was the envy of her neighbors, "a noble fabric" that had been raised "by the labor of so many Centuries, repaired at the expense of so many Millions, and cemented by such a profusion of Blood." Nevertheless, Wood argued, if Britain fell victim to the dissensions of the age, it might suffer the fate of Palmyra, and he warned his fellow countrymen that they should not allow the pressure of the moment to pervert the noble simplicity of their constitution.

What perhaps prompted Wood to issue his warning was his fear that the complacency of his age might lull his countrymen into a state of pliant acquiescence, and so Britain might suffer the same fate as Palmyra.

The years between the War of the Austrian Succession (1740-1748) and the Seven Years War of 1756 to 1763 have been called the most placid of the century, a time when Britain felt powerful and secure. But, as Wood realized, and as his investigation of Palmyra seemed to confirm, such periods of glory could be short-lived, and the British should be wary of the misfortunes that frequently attended nations that became too self-confident.

On the other hand, Wood believed that once a great civilization had established itself, it was unlikely to die. Palmyra, he believed, could still regain its past glory, since the basic conditions that had promoted its rise to power were still present: the caravan trade and the desert. Such optimistic predictions were, of course, never realized; today most of the traffic flowing toward Palmyra is composed of busloads of tourists who come to view its ruins.

To Robert Wood, today's tourists, plodding resignedly among the stones with the same quiet veneration that visitors accord museums, would be an affront. To Wood, Palmyra was much more than a museum. It was evidence of a past civilization, and its stones bore messages of value to all mankind. Wood believed that the true traveler inspected the ruins of other civilizations in order to assess the forces that influenced their development and to learn something of value in relation to his own. To Wood, ancient ruins were the tangible remains of the past way of life and it was the duty of the interested observer to examine them for clues which might account for their greatness and subsequent decline. Like most modern archeologists, Wood realized that the stones themselves were less important than what they signified.

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