There is no department of man’s life
on which more labor is spent.
—Pliny the Elder, Historia naturalis

In the spring of 1993 I joined experts from
nearly a dozen disciplines at the Robert Mondavi Winery to discuss the origins and ancient
history of wine. California’s Napa Valley was in
its glory, with Cabernet Sauvignon, Pinot Noir and other
varietal grapes just setting on the vine. And the surrounding foothills could almost have passed for the Caucasus or Zagros mountains of the Middle East, where some of the world’s first wines were thought to have been produced. As two Mondavi wines flowed at every lunch and four at every dinner, our discussions took on the spirit of a Greek symposium. The grapes around us may not have been ripe, but the study of ancient wine clearly was in full ferment.

In the winery’s Vineyard Room a display of ancient artifacts bore testimony to the importance of wine in world cultures. There were early Bronze Age sherds from Greece with grape leaf impressions; wine dregs from Roman amphorae discovered in the hull of a ship sunk off the coast of France; and fragments of an inscribed wine amphora from New Kingdom Egypt. But the guest of honor, the true inspiration for the symposium, was a more substantial specimen. For its flight to California from Toronto, it had been deemed too fragile for storage, too fat for coach. The flight attendants, having strapped it snugly into a first-class, bulkhead seat, had declared it the most undemanding passenger they had ever served: it refused meals, ignored the movie and never bothered its seatmates.

True, it was only a wine jar, but for one of the world’s oldest symbols of indulgence it was a model of abstinence.

Five years earlier, when Virginia R. Badler had asked me to see if the jar once contained wine, I had been skeptical. Badler was a graduate student in Near Eastern archaeology at the University of Toronto in Canada, and she had studied the jar at the Royal Ontario Museum. It had been excavated at a 5,000-year-old site called Godin Tepe, in the central Zagros mountains of north-central Iran. Although sherds from the jar had a deep burgundy deposit on their inner surfaces, I thought the deposit was probably an inorganic pigment, rich in iron or manganese.

Joining with the chemist Rudolph H. Michel, a research associate at the University of Pennsylvania in Philadelphia, I set out to test my theory. When our first results came out negative, we checked further for organic compounds, comparing the residue with a wine deposit from an ancient Nubian jar. In a standard Feigl spot test, both residues emitted a green fluorescence—a sign that they contained tannic acid, a compound specific to grapes—and other, more sophisticated analyses were even more compelling. Here then was the world’s earliest chemical evidence for wine, a finding that pushed the history of winemaking back several hundred years, to a time predating the earliest written evidence from Egypt (a hieroglyph showing a grape vine growing from a pot onto a trellis). Even before the rise of great Near Eastern civilizations, it seemed, wine had been an important commodity.

The Godin Tepe jar (or J. Badler, as the name on its airline ticket read) had inspired me to organize the Napa Valley symposium. The time was right, I thought, to test the adage in vino veritas. Where, when and why was wine first made? I asked, along with other wine experts. How did winemakers domesticate the wild domestic grape? Why has wine so long been associated with luxury? If some of our discussions were headier than usual, the reasons were clear: The jar and its dating confirmed that archaeological chemistry has grown sophisticated enough to open up new chapters of human and environmental prehistory. Dyes, drugs, resins and
lipids, perfume ingredients, antibodies and nucleic acids can now be extracted from ancient materials, then identified and dated. They can resolve archaeological conundrums about ethnicity and genetic development, about diet, disease and technology. They can answer even some vintage questions about wine.

This summer that promise was dramatically reaffirmed. By applying a battery of chemical tests, my colleague and I were able to identify wine residue in a specimen more venerable than J. Badler [see the image on the preceding page]: a Neolithic jar from Hajji Firuz Tepe, a 7,000-year-old site 200 miles north of Godin Tepe, in the Zagros Mountains. The world’s oldest wine, it seems, just got older.

How Grapes First Became Wine is not hard to imagine. The earliest remains of wild Eurasian grapes (Vitis vinifera L. subsp. sylvestris) are some 50 million years old. Colorful and relatively sweet, they would have been an obvious enticement for hunters and gatherers. And unlike most alcoholic beverages, wine can easily be made by accident. To brew beer, early farmers had to sprout barley, dry it out to make malt, add it to warm water, and hope that airborne yeasts would ferment it. To make wine, on the other hand, a Paleolithic cave man or woman would simply have had to squash a few grapes in a rock crevice or a primitive container. Within a few days, the juice would have naturally fermented, as grapes have a bloom of natural yeasts on their skins. If passersby happened to dab their fingers in for a taste, they would have been pleasantly surprised. Any number of variations on the same story might have transpired wherever wild grapes grew, though organic residues may never be found to confirm them.

Some 10,000 years ago people in the Near East first began to grow cereal crops. No one knows when the first vineyards were planted there, but the art and technology that went into making the jar from Godin Tepe and the wine it contained were quite sophisticated. Earlier Near Eastern peoples must have spent centuries breeding, selecting and hybridizing plants, designing airtight clay containers and perfecting their winemaking techniques. The earliest evidence of winemaking comes from the Neolithic period (between 10,000 and 6,000 years ago). But some wine experts think the mitochondrial and nuclear DNA of wild and domesticated grapes encode an even more ancient history. Because domesticated grapes used in modern wines are overwhelmingly descended from V. vinifera, it seems, grapes may have been domesticated in a single place at a single time. That so-called Noah hypothesis was named for the biblical patriarch and “first vintner,” who is said to have planted a vineyard on Mount Ararat after the flood, with dire consequences for his son Ham’s descendants. Variations on the flood story, in turn, date back to the epic of Gilgamesh.

As appealing as it is, the Noah hypothesis is probably impossible to prove: wild and domesticated grapes have been cross-pollinated throughout their ranges, and so their DNA has been inextricably mingled. Given the prevalence of wild grapes and the ease of making wine, in any case, grapes could have been domesticated more than once. By 2700 B.C., certainly, vine cuttings from domesticated species had been transplanted to the Nile Delta—where wild grapes never grew. Ironically, one of the last regions to host domesticated grapes is among the richest in wild grape species: North America, or Vinland, as the Vikings called it. Thomas Jefferson tried valiantly to produce wines from wild American grapes, but they simply proved too sour and “foxy” for the purpose.

The Story of Winemaking is in some ways the story of civilization. During the Neolithic period, domesticated plants and animals supported the first permanent human settlements, and grapes were probably cultivated in the Zagros Mountains and other upland regions. As food gradually became more abundant, Neolithic people had more time to experiment with soaking, heating, spicing and fermenting foods, launching a kind of culinary revolution. Fermentation, in particular, helped preserve foods and make them more nutritious. It yielded alcohol and other powerful antimicrobial agents, including chemical compounds such as polyphenolics, which have since been shown to prevent heart disease and other ailments. As long as Neolithic wine enthusiasts practiced more moderation than Noah, they were better nourished and less prone to sickness than those people who abstained.

Vineyards need years of careful tending before they bear fruit in quantity, but people who settled in permanent villages could afford to wait. As community life grew increasingly complex, wine may have helped ease tensions among people who had exchanged their hunting and gathering ways for a more sedate, settled life. At the end of a hard day, according to that theory, ancient farmers or temple functionaries might have sublimated their wilder proclivities by quaffing a cup or two. Wine, in any case, became a social and religious drink, its value heightened by its subtle flavors, mind-altering effects, limited availability and tendency to improve with age. (Fermentation itself, which converts grape juice to wine and is accompanied by a near-frenzied evolution of gases, may have only added to the magical aura of the beverage.)

Over time, ancient cultures learned to exploit the grape’s full potential. In the southern Zagros Mountains, where grapes were probably transplanted at an early date, winemaking flourished under the Persians, and the fine Shiraz wines later inspired Bacchic poets such as Omar Khayyam. In Egypt, wine production soon spread up the Nile and out to western oases. During the Byzantine period in Nubia, a region of the Nile that straddles southern Egypt and northern Sudan, wine was imported in such quantity that whole villages were largely made up of taverns. All around them, one could find heaps of empty amphorae such as the one used as a comparison with the Godin Tepe jar. At the
same time, wine from Gaza, in the Holy Land, was exported to Europe as the premier Eucharistic wine. And all those wines, with their infinite varietal range of tastes and bouquets, came from a single cultivar transplanted again and again—the same cultivar that now bears grapes from New Zealand to Europe and from New York to Japan.

In the years since I analyzed the jar from Godin Tepe, ancient wine has become my consuming—some might say intoxicating—interest. My laboratory in the Applied Science Center for Archaeology at the University of Pennsylvania Museum has become a kind of repository of ancient wine samples: from jars unearthed in the tomb of one of Egypt's first pharaohs to thousand-year-old vessels imported from the Rhineland into one of Scandinavia's first "towns," the Viking settlement of Birka. Some of the most promising samples come from the museum itself, which has one of the finest collections of well-documented excavated artifacts in the world.

Two years ago I asked the archaeologist Mary M. Voigt if she had ever noted intriguing residues on any Neolithic pottery she had excavated. In 1968 she had directed an expedition to Hajji Firuz Tepe, and the artifacts she recovered had been divided between the government of Iran and my museum. Now a professor of anthropology at the College of William and Mary in Williamsburg, Virginia, Voigt said she did remember such residues on several sherds from Hajji Firuz. At the time, she had thought the residue might be from some dairy product, but an analysis had come up negative.

After I questioned Voigt, she "re-excavated" one of the sherds from the museum's basement, and our investigation began in earnest. About four inches long and two inches wide, the sherd was covered with a thin yellowish deposit. According to Voigt, the deposit had covered the lower half of the vessel, where precipitates from liquids accumulate. Six such jars, each with a volume of about two and a half gallons, had been set into the floor of what appeared to be a kitchen in a mud-brick building at Hajji Firuz.

Organic materials tend to survive best in dry or waterlogged environments, where microorganisms and oxidants cannot get at them. Until recent decades, however, even the best-preserved samples revealed only a few of their secrets to archaeologists. Some excellent work was done in
the late nineteenth and early twentieth centuries on ancient wine and on dyes such as Royal Purple (used by the Phoenicians, among others), but the chemical tests of the time were too crude to identify many compounds. A few sizable liquid samples were lost to what were essentially "taste tests." As recently as the 1950s, when wet chemical tests were still heavily relied on, the German chemist H. J. Eichoff analyzed a rare liquid sample from a Roman site and wrote, memorably, "Ergebnis: Der "Wein von Niš' ist Wasser" (result: the 'wine from Niš' is water).

Chemistry has grown a great deal more subtle in the intervening decades. Infrared spectrometry enables me to screen as little as a milligram of material for compounds that absorb light at specific frequencies. Yet organic remains rarely offer easy answers. Archaeologists, archaeobotanists or other specialists often help to explain the significance of a material identified in an ancient context. Is a compound or the relative amounts of several compounds specific to a given plant or animal? (Royal Purple, for example, can be derived only from a glandular liquid found in certain marine mollusks.) Was the material processed in some way? How was it used? The more questions one asks about the chemistry, the further one drifts into the uncharted waters of ancient technology, economic exchange systems and cultural dynamics.

Wine is made to order for such interdisciplinary studies. It is an unusually complex blend of organic compounds: acids, alcohols, aldehydes, carbohydrates, esters, proteins and vitamins, as well as the polyphenolics that give wine much of its color and taste. Some of those compounds—tartaric acid for one—occur in large amounts only in grapes. Moreover, potassium bitartrate, a salt derived from tartaric acid, often settles out of wine, forming the lees, or wine dregs. Depending on where wine is made, other salts can also form: in Iran's limestone foothills and mountains, for instance, calcium tartrate often forms from the lees. As polyphenolics degrade, they yield carboxylic acids. Those acids also distinguish wine from other popular ancient liquids such as beer and olive oil. Best of all, both polyphenolics and their acids are relatively stable, and so they are more likely than other compounds to survive.

Even if a compound such as tartaric acid can be identified, it might have come from grape juice, grape syrup or another fruit juice adulterated with grape juice, as well as from wine. Sometimes an inscription on a vessel or some other drawing or writing will resolve the mystery. But some sites offer only a mute archaeological record, leaving investigators to infer the nature of a residue from other clues. Workers at Godin Tepe, for instance, guessed that jars discovered there might have contained wine because the workers had also discovered a large funnel and a kind of pressing tool nearby. At later winemaking sites, such devices had been used to strain grape must.

Like the jar from Godin Tepe, the one from Hajji Firuz had a long neck and a narrow mouth, and clay stoppers that would have fit it were found close by. Such stoppers could have absorbed liquid as cork does, expanding to give a jar an airtight seal—a sensible precaution if the jar was intended to contain wine. In the Middle Eastern heat, juice slowly pressed from grapes would have begun to ferment before the jar was filled. Oxygen, which sustains wild yeasts in grapes, enabling them to convert sugar to alcohol, also fuels bacteria that convert alcohol to acetic acid. For winemakers past and present, the trick has been to let the juice ferment long enough to become wine but not so long that it turns to vinegar. (In Historia naturalis the Roman encyclopedist Pliny the Elder devotes much of chapter fourteen to the problem.) In the Near East jars were left open until a wine was almost completely fermented, then they were stoppered with clay. Sometimes the stopper was punctured, enabling secondary fermentation gases to escape, and only then was the jar fully sealed off.

Aided by Donald L. Glusker and Lawrence J. Exner (respectively, a research associate and a volunteer at my museum), I subjected the Hajji Firuz jar to a number of tests. Traces of tartaric acid and calcium tartrate that we found showed that Voigl's residue came from grapes. But another, less common component proved the residue came from wine. In high-performance liquid chromatographic tests, a compound in the residue absorbed ultraviolet light at telltale frequencies. One material we knew was most likely to give that result: terebinth tree resin, the "the best and most elegant" of resins, in Pliny's words.

In the Middle East, where terebinth trees have long been
abundant and live even in desert areas, the trees can grow forty feet tall and more than six feet in diameter, yielding half a gallon of the resin in late summer or fall. According to Pliny, the Romans preserved their wines by adding terebith resin, or with resins from pine, cedar, frankincense or myrrh. Columella, another first-century Roman writer, describes a *medicamentum* made of myrrh, terebith resin, pitch and various spices. What was good for a wound, people evidently thought, was good for wine. And they were right: resins have been shown to kill bacteria such as *Acetobacter*, which causes the dreaded “wine disease,” turning wine into vinegar. In Greece today, village winemakers preserve their wine with pine and sandalac resins. The resultant retsina, like wine made with terebith resin, is mildly redolent of turpentine.

The people of Hajji Firuz probably knew that tree resins had some value as medicines and preservatives. Certainly the pharmacopoeia of later cultures in Egypt and the Near East is dominated by wines and resins. At Hajji Firuz, where grapes and terebith trees could be harvested at about the same time, juice and resin might have been mixed accidentally or on a whim. Pollen cores from nearby Lake Urmia have shown that wild grapes did grow around Hajji Firuz. But the wine in the jar might well have come from an early domesticated variety—an ancestor of the modern grape. Because the residue we found had a yellowish color, we speculated it came from a white wine.

The Hajji Firuz discovery was a seminal event, pushing the history of wine back another 2,000 years beyond Godin Tepe. After the story broke this summer, I sometimes felt like an ancient city under siege, as telephone calls, faxes, E-mail messages and photographers streamed in from around the world. In one case, however, the media attention was amply repaid.

One morning this past June, as a London-based syndicator was photographing me with a reconstructed jar from Hajji Firuz, I took the opportunity to examine the object in detail. Unlike other jars we had analyzed, this one had been on display in one of the museum’s Near Eastern galleries, and I had never had a chance to see it up close. There, along the inner walls of the jar, I found patches of reddish residue. Tests later showed that the residue was also a combination of calcium tartrate and terebith tree resin, along with a bit more tartaric acid than had been found in the other jar. In coming months, we will analyze the residue for signs of oenoside and other polyphenolic pigments. And then, perhaps, we will have an ancient red wine to go with the world’s oldest white.

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