

Chapter 10

On the Authenticity of the James Ossuary and its Possible Link to the Jesus Family Tomb

The results of an archaeometric analysis of the James Ossuary strengthen the contention that the ossuary and its inscription are authentic. Patination consists mainly of the weathering product of the source rock (Early Senonian, Mount Scopus Group) and the *in situ* accreted, variable, environmental and anthropogenic components. The ossuary stone is enriched in phosphors due to leaching from the original bones it contained. The composition of the patina is mainly 93% CaCO_3 and contains the following elements: Si, Al, Fe, P, and Mg. It contains no modern elements and adheres firmly to the stone. The beige-to-gray patina's morphology can be observed on the surface of the ossuary, gradationally continuing into the engraved inscription, despite the fact that the ossuary was cleaned unprofessionally with a sharp implement and unidentified cleansers. The engraving clearly does not cut the patina. Ultra-violet illumination does not indicate any new engraving marks. Thin striations, over which the patina has accreted, about 0.5 mm wide and several centimeters in length, are found on the outer sides of the walls. Some vertical to diagonal ($\approx 45^\circ$) patinated striations that continuously transect the letters appear to be from the friction of falling roof rocks induced by earthquake, floods, and landslides during long burial in the cave. Many dissolution pits are superimposed on several of the letters. In addition to calcite and quartz the patina contains the following minerals: apatite (calcium phosphate), whewellite (hydrated calcium oxide), and weddelite (calcium oxalate). These minerals result from the biogenic

activity of microorganisms such as microcolonial fungi, yeasts, lichens and bacteria that require a period of at least 50–100 years (if not longer) to form the bio-patina.

Lately, the “James Son of Joseph Brother of Jesus” ossuary was discarded as “fake” on the ground of an oxygen isotopic investigation (Ayalon et al. 2004) even though there have been no studies of the oxygen isotope values of patinas from archaeological artifacts not only in Israel, but worldwide. Moreover, due to variable environmental anthropogenic conditions over the centuries, as well as the episodic development of the patina in ancient unprovenanced artifacts, oxygen fractionation values are an unreliable tool for authentication.

Dust is a significant, albeit under-recognized, component of patinas that accumulates on exposed surfaces of artifacts and in soil. Storm dusts that contribute up to 50% of the soil are ubiquitous in the Levant; however, often-unnoticed key substances such as minerals, microfossils, and pollen can be found within the patina of an artifact, preserving its geological signature. We have identified microfossils (nannofossils and foraminiferans) and quartz grains from sites in the patina that are consistent with what is expected of deposition of wind-blown particles in the Jerusalem area. The exposed rock belongs to the Judea and Mount Scopus groups and contains within its sediments microfossils that are light enough to become airborne. The heterogeneous existence of wind-blown microfossils, quartz and other airborne minerals that characterize the patina of the ossuary including the lettering zone, reinforces the authenticity of the ossuary. The chemical fingerprint of the patina and soil of the James Ossuary agree well with the surface of the cave walls and the patina analyses of the ossuaries found in the Talpiot cave (Pellegrino, this volume 2008) indicating that the James Ossuary might originate from the surroundings area of the Talpiot cave complex.

Introduction

An ossuary made of chalk and covered by a beige-to-gray patina was brought to the Geological Survey of Israel in August 2002 in order to study its archaeometry. The following Aramaic inscription appears on one of the long outer walls of the ossuary (Lemaire, 2002, 2003):

יעקב בר יוסף אחי ישוע

= *Ya'akob Son of Yoseph Brother of Yeshua (James Son of Joseph Brother of Jesus)*

Rosenfeld and Ilani (2002) were the first scientific team to investigate the archaeometry of the James Ossuary. They concluded that the patina indicates a burial in a cave and that the surficial patina is found also within some of the letters. The inscription was cleaned and the patina covering some of letters was absent. Rosenfeld and Ilani (2002) reported a high concentration of phosphorous (P) both within the stone and the patina. This is indicative of a dissolution process in which the bones (high in phosphorous) that were originally in the ossuary dissolved and the phosphorous was incorporated into the stone of the ossuary as well as into the patina, a process that takes time.

Keall (2003) led a team at the Royal Ontario Museum (ROM) in Toronto that investigated the ossuary and its patina after it was cracked during transportation from Israel to Canada. The team found the following: (1) a high phosphate content in the stone wall of the ossuary as well as in the patina, (2) thin layering in the patina (with phosphate), and (3) prominent veins of calcite crystals (due to differential weathering) running consistently across the surface of the ossuary and through the incised letters of the inscription. Keall (2003) also refuted the so-called “two-hand” theory that maintains that the last two words of the ossuary, “brother of Jesus,” were added by a second hand to an already-existing inscription that read “James, son of Joseph.” They recognized that the first part of the inscription was vigorously cleaned by a sharp tool but maintained that they could observe signs of natural aging of the inscription. It was clear to them that the inscription is not a modern forgery.

Goren (2003), in his report to the Israel Antiquities Authority (IAA) “Material Committee,” concluded that the inscription was forged. But he also noted that the ossuary might have been cleaned. He provided no explanation as to why he did not consider that the cleaning process could have been consistent with his observations.

Ayalon (2003) and Ayalon et al. (2004) described a new method using oxygen isotopes to authenticate patinas in archaeological artifacts. They concluded that the forger prepared the patina of the James Ossuary artificially by applying powdered chalk immersed in boiling water over the freshly cut inscription. They claimed that microfossils were found only in the inscription indicating additional evidence that the ossuary was forged.

Harrell (2004) reviewed the work of the “IAA Material Committee” (Goren 2003; Ayalon 2003 and Ayalon et al. 2004) and concluded that their evidence does not support their conclusion that the inscription is a forgery. In addition, their interpretation that the James Ossuary inscription is a modern fake is biased and based on flawed geochemistry.

We would like to emphasize that the knowledge of patinas on archaeological artifacts is still scarce and needs additional research, especially in Israel where unprovenanced artifacts are very common. About 80–90% of Israel's archaeological artifacts come from the antiquities market and are unprovenanced. These artifacts should definitely not be overlooked/discarded by archaeologists. It is evident that authentication of the ossuary requires a wide, interdisciplinary approach. The interaction between rocks, environment (soil, dust water, climate, etc.), anthropogenic activity, and cleaning processes should always be considered when examining archaeological artifacts.

Methods and Materials

The mineralogical composition of the ossuary and the patina was determined by using a petrographic microscope and a Philips X-ray diffractometer. Samples were removed from the ossuary and from the patina by peeling with a sharp steel blade. The samples were studied at the Geological Survey of Israel. A scanning electron microscope (SEM, JEOL-840), equipped with an energy dispersive spectrometer (EDS; Oxford-Link-Isis) was employed for a detailed inspection of the physical properties and structural features of the samples, as well as for chemical analysis. A Hitachi S-3200N SEM with low vacuum was used for further analyses of microorganism content within the patina layers. In addition, we used the ICBM electron microscopy unit at the Soil Science Department of Carl von Ossietzky Universität Oldenburg, as well as the Institute of Crystallography of the Würzburg University for microscopy and X-ray diffractometry determination. The stone ossuary and the patina were examined by magnifying lens and binocular (magnification up to X40). The following samples were examined: remnants of the soil found attached to the cavities found in the lower part of the outer sides of the ossuary, six samples of the chalk and six samples of the patina.

The location sampling from the ossuary is as follows: sample 1 and sample 2 represent chalk of the ossuary, sample 3 and sample 4 represent brown patina. All four samples were taken from the fragment that was broken in the lower right corner of the inscription face. Sample 5 and sample 6 are from the patina near the letters. Sample 7 represents soil from the pits from the lower part of the ossuary (zone 1; see below for locations of the zones). Sample 8 represents soil from the lower right corner of the inscription face. Sample 9 is from the patina above the letter “Samekh” (of

Yoseph). And sample 10 and sample 11 represent the original chalk from inside the ossuary.

Description of the Ossuary

The length of the ossuary is 50.5 cm at the base and flairs out to almost 56 cm at the top. When viewing the inscription, one of the short sides is 100° from the base and the other is slanted at 110°, giving the box a “trapezoidal shape.” The maximum width of the ossuary is 26 cm and the maximum height is 30 cm. Based on its dimensions, it is clear that this ossuary was used to store the bones of an adult. A flat lid, also made of chalk, rests on a small ledge, 0.6 cm wide, running inside the rim of the long sides of the ossuary. A groove forming a frame about 1.2 cm wide is found along the outer edges. A faded decoration of two rosettes, engraved and encompassed by weak outlines of three circles, is found on the long wall opposite to that of the inscription. A sub-horizontal welded crack 12 cm in length on the long wall, crossing the right corner and continuing to the slanted short side of the ossuary, is found about 9 cm beneath the inscription. The lid and the opposite wall of the inscription display faint spots of red iron-oxide paint, a common feature in many ossuaries (Porat and Ilani 1993).

The long wall with the inscription on it contains dense oval solution cavities, or pits, that form three distinct zones from left to right that dip, or tilt, at an angle of about 20°. Pits are small indentations or depressions on the surface of a rock as a result of some eroding or corrosive processes, such as differential solution (Jackson, 1997) and biopitting that takes a long time to form (Krumbein, 2005). The lowermost zone (zone 1) extends from the bottom of the ossuary along the left side for about a maximum width of 13 cm. Zone 1 consists of large pits up to 10 mm in size and depth. Above is the middle zone (zone 2) that extends for another 12 cm in maximum width along the left side of the ossuary. Zone 2 consists of numerous smaller pits about 2–5 mm in diameter. A third and uppermost zone (zone 3) extends to the top of the left side of the ossuary for 5.5 cm and contains randomly scattered pits, each about 1–3 mm in diameter.

Thin striations, up to 0.5 mm wide and up to several centimeters in length are found on the outer sides of the walls. These marks are mostly vertical, but there are also diagonal striations (45°). Falling stones probably made the striations from the ceilings and walls of the cave due to earthquakes, floods, and landslides. Most of the striations and the pits are coated with the beige patina.

Archaeometric Analysis

Rock

The Ossuary is made of chalk and was mined from the Cretaceous (Senonian) Menuah Formation in the lower Mount Scopus Group (Flexer 1964, Flexer et al. 1990). This rock unit attains a 10-m thickness in the Jerusalem area. The properties of this formation and the microfossil content are well known (e.g., Flexer 1964; Mimran et al. 1996; Reiss et al. 1985). Chalk is a sedimentary deposit comprised mainly of marine microorganism skeletons made of calcium carbonate (calcite). The use of this chalk in Jerusalem was extensive during the Second Temple period (2,000 years BP) mainly for the manufacture of stone vessels and ossuaries (Magen 1984, 1988, 1994, 2002; Flexer et al. 1990). Ossuaries were used for storing the bones in a cave tomb. The production of chalk vessels and Jewish ossuaries around Jerusalem during the first century (both BC and BCE) were related to the Jewish customs of purity. Several chalk stone quarries were discovered from that period in the Jerusalem area (Magen, 1984, 1988, 1994, 2002). The destruction of the Second Temple in 70 CE explains the cessation of the production of the stone vessels and the ossuaries in Jerusalem.

The rock from which the ossuary was carved is not homogeneous; it was partially converted to a *nari*. A *nari* is a variety of caliche that forms by surface or near-surface alteration of permeable calcareous rocks and that occurs in the drier parts of the Mediterranean region (Jackson 1997). Due to intensive weathering and the narization process the ossuary is extremely fragile. In fact, Keall (2003) reported that the ossuary broke on its way from Israel to Toronto for exhibit at the Royal Ontario Museum (ROM). It arrived in a cardboard carton encased only in layers of bubble wrap which, when removed, revealed a soft limestone bone box that had broken into five pieces. The lack of homogeneity of the rock can explain the fact that the letters seems to be engraved at different depths and, that furthermore explains the “different hands” hypothesis suggested by some epigraphers.

Patina

The patina of an archaeological artifact is the outer weathered layer consisting mainly of the weathered source rock that, due to physical, chemical, and biological (e.g., microorganisms) factors began to disintegrate over the years. Another component of the patina is the accretion of material from

the environment and its interaction with soil and dust, including anthropogenic material as well as water that sometimes deposits calcite. A patina rich in phosphate is typical of burial places where there is an abundant supply of bones. Thus, the patina is heterogeneous in its character.

In the James Ossuary, we observed two layers of patina, a thin (film-like) beige layer above a white-gray layer. A similar, double-layered (gray below and yellow above) patina is found on the Acropolis monument at Athens, Greece (Krumbein 2003). The patina is about 1 mm thick and is discontinuous in places; deposition is episodic. This suggests that the patina on the ossuary was not developed continuously at a constant rate over a 2,000-year period.

The beige patina can be found inside the letters, accreting gradationally into the inscription. The patina can be observed on the surface of the ossuary continuing into the engraving. The engraving clearly does not cut the patina. This phenomenon can be seen almost in every letter of the inscription despite cleaning with a sharp tool. The last letters of the inscription were not cleaned, and the entire patina can be observed in these letters.

There are numerous fine striations crossing almost every letter. These striations were probably caused by falling roof rocks in the cave during the past 2,000 years. They occur on the surface of the ossuary, moving into the letters and are aligned in at least three sets dipping from upper left to lower right, upper right to lower left, and vertically. Not only are the letters patinated, but so are some of the striations.

The striations can be seen in other letters of the inscription, including the letters “Shin” and “Ayin” of the word “Yeshua” at the end of the inscription. The striations are filled with the same patina that is found within the letters. They are another strong proof for authenticity.

Zone 2 contains pits that are also superimposed on the engraved letters. The following letters have superimposed pits: “Ayin,” “Kuf,” “Beth” (Yaacov), “Resh” (Bar), “Samekh” (Yoseph), “Aleph” (Akhui), “Dalet” (two pits), “Shin,” and “Ayin” (Yeshua).

The fact that the pit zones and striations are at varying angles suggests that the ossuary shifted from its original horizontal position over the years and was at times partially submerged in water. Thus, the top of each pitted zone represents the height at which the water reached. The lowermost zone (zone 1) was immersed for the longest time evidenced by the larger pits in that zone. Some of the lineaments can also be attributed to plant roots or climbing plants on the lower part of the ossuary.

In addition to calcium carbonate, the patina on the ossuary is also composed of the following minerals in descending order of volume: apatite

(calcium phosphate), whewellite (hydrated calcium oxalate), weddelite (calcium oxalate), and quartz (silicon dioxide) (Krumbein 2005). These minerals within the thin layers (films) of the beige-to-gray patina are the product of subaerial biofilm geomicrobiogenic activity that covers all surfaces of the ossuary (Gorbushina 2007). The presence of microcolonial long-living, black yeast-like fungi forming pitted embedded circular structures indicates slow growth over many years. Microcolonial fungi (MCF), known to concentrate and deposit manganese and iron, play a key role in the alteration and biological weathering of rocks and minerals (Staley et al. 1982; Gorbushina 2003; Gorbushina and Krumbein 2004). They are microorganisms of high survivability, inhabiting rocks in extreme conditions, and are also known to survive in subsurface and subaerial environments. Long-living black yeast-like fungi form pitted embedded circular structures (Krumbein 2003; Krumbein and Jens 1981; Sterflinger and Krumbein 1997; Krumbein 2003). These microcolonial fungi (MCF) structures and minerals were found on the surface of the ossuary and, more importantly, within the letters.

The patina on the long wall of the inscription is more condensed and darker to the right side, where the first four words, including the letter “Aleph” of the word “Akhui”, reflect the intense cleaning. On the opposite long wall (with the rosettes), the patina is darker in the upper half. The same gray-to-beige patina is also found within some of the letters. The inscription was cleaned (Rosenfeld and Ilani 2002; Keall 2003) and the patina is therefore less prominent in several letters. The patina in several localities, mainly on the upper parts of the external walls, has numerous “cauliflower shapes” known to develop in a cave environment. The margins of the letters are weathered, sometimes even heavily weathered.

The so-called “James Bond” patina that was described by Goren (2003; Silberman and Goren 2003) as a “grainy” gray material is actually the same beige patina that covers the rest of the ossuary. This so-called fake “James Bond” patina (op. cit.) actually represents the chipped flakes of the original patina that were exfoliated by a cleaning process. It was observed by Goren only in a few letters in the middle of the inscription (e.g., half of the “Het” and “Vav” letters of “Yoseph”) and was not found at the beginning or the end of the inscription. We believe that the few areas deep within the letters, in which the patina is found represents fragmental remnants of an original, “real” patina. If a forger had done this, we should have found this patina scattered all over the inscription rather than just in a few recesses of some letters. The forger would have tried to disguise his work by applying the patina more completely. We maintain that the inscription was cleaned and

Goren's (2003) "grainy" patina is the remnant of the genuine cleaned patina that remains in a few letters found in the middle of the inscription and can only be seen with special illumination.

We are unable to observe the "James Bond" patina because of the careless treatment by the IAA and the Israeli police. They extracted the remnants of the patina by using a red plastic/silicone waxy (?) mold used to replicate footprints at a crime scene. We maintain that in science when an examination cannot be repeated, the original results are suspect. Thus, the oxygen isotope results of Ayalon et al. (2004) are not valid; they cannot be verified since the original surface no longer exists. In other words, their results are not falsifiable.

The ossuary and its inscription were tested at the ROM in 2002 with UV illumination, and they show no suspicious glowing that, according to Newman (1990), is a strong indication for the authenticity of an inscription.

Geochemistry

Based on energy dispersive spectrometer (EDS) analysis of the scanning electron microscope (SEM) laboratory of X-ray microanalysis, we found that the ossuary is composed mainly of CaCO_3 (97%) and contains Si (1.5%), Al (0.7%), Fe (0.4%), P (0.3%), and Mg (0.2%). The accreted patina shows similar composition, consisting mainly of CaCO_3 (93%) and contains Si (5.0%), Al (0.7%), Fe (0.3%), P (0.4%), and Mg (0.2%). The soil is composed mainly of CaCO_3 (85%) and contains Si (−7.4%), Al (−2.5%), Fe (−1.7%), P (−1.0%), Mg (−0.7%), and Ti (−1.0%). Note that there is a discrepancy between the total amounts in the various samples due to the nature of EDS-SEM analysis.

The patina is enriched with silica (about 5.0%) relative to the original stone (about 1.5%) over the ossuary surface, as well as in its inscription. The calculated enriched phosphate in the patina is 1.3%, and the enriched phosphate in the soil is about 3%. All of it probably originated from the dissolution of the bones. The patina does not contain any traces of modern tools and it adheres firmly to the stone. No evidence that might detract from the authenticity of the patina and the inscription was found.

Dust

Dust is an important component in soil and patina formation in the Middle East. Storm dusts that contribute about 50% of material to the soil are

ubiquitous in the area; however, often-unnoticed key substances such as minerals, microfossils and pollen can be found within the patina of an artifact, preserving its geological signature. The microfossil and mineral constituents in a patina could serve as a tool to authenticate unprovenanced artifacts (Ganor et al. 2007).

Ayalon et al. (2004) reported that only the letters patina from the James Ossuary contains microfossils of marine origin. This constituted an indication of forgery according to them (Goren 2003; Ayalon et al. 2004). However, we found microfossils embedded within the entire patina, as well as on and within all other surfaces not only on the letters. We find it odd that Ayalon et al. (2004) did not observe the presence of these microfossils. Calcareous nannoplankton (about 5–10 microns) and foraminifera (about 100–200 microns) are elements that are commonly found in the dust of the Jerusalem area (Ganor 1975; Ganor et al. 2007). Ayalon et al. (2004) suggest that the microfossils were artificially deposited by grinding marine carbonate sediments (possibly chalk from the same burial box) and dissolving them in warm water.

The microfossils are not recent, but range from the Cretaceous age to the Tertiary age, similar in age to the marine carbonate rocks that are widely exposed over most of Israel. The obvious source of this dust component is from mechanical erosion of the prevalent outcrops of limestones and chalks. They should be as plentiful in the historical past as they are today. Indeed, their absence within a patina purportedly coming from Jerusalem would be suspicious; the entire city is situated upon marine carbonate exposures of the Judea and Mount Scopus groups (of limestones) containing microfossils.

In addition, the fact that the foraminifera are well preserved and have empty chambers (empty of sediment infilling) precludes the possibility that the patina was artificially deposited by the grinding of marine carbonate sediments, as proposed by Ayalon et al. (2004). Grinding the limestone along with its microfossil content would not have enabled the grinder to extract the sediment that fill the chambers. The sediment could only have been removed by a natural, slow erosional process.

Oxygen Isotopes

Recently, the oxygen isotopic composition of the patina's carbonate was analyzed, and the results used to suggest that the James Ossuary was not authentic (Ayalon 2003; Ayalon et al. 2004). This conclusion was based

on the assumption that the presence of oxygen in the carbonate could be explained by precipitation from meteoric groundwater in the Jerusalem area. The data contains seven analyses of the patina. Six of these analyses reported that $\delta^{18}\text{O}$ values are depleted relative to the expected stalagmite/stalactite range carbonate formation data (-4‰ to -6‰ $\delta^{18}\text{O}$ ‰ PDB) (Bar-Matthews and Ayalon 1997).

The six samples were more negative compared to the samples taken from the surface of the ossuary. However, Ilani and Rosenfeld (2002) reported that the inscription was intensively cleaned chemically as well as by a sharp tool. The lettering was enhanced, and contamination of the patina can surely be expected. Thus, the comparison between the oxygen isotopes from the letters and the surfaces (op. cit.) is irrelevant because of contamination and definitely cannot indicate a forgery.

Harrell (2004) notes that very negative $\delta^{18}\text{O}\text{‰}_{\text{PDB}}$ values for six samples from the “letters patina” imply that the material within the patina formed at a high temperature, perhaps at $40\text{--}50^\circ\text{C}$ as they (Ayalon 2003; Ayalon et al. 2004) suggest. He further states that this is only true if the patina consists of pure calcite, a qualification that the authors fail to make. The authors claim that the patina covering the letters was artificially prepared, most probably by grinding marine sediments, dissolving them in hot water, and depositing them onto the underlying modern engraved letters (Ayalon et al. 2004). As Harrell (2004) states, ground calcite will not dissolve in hot water. There is an inverse ratio of calcite solubility such that solubility increases as water temperature decreases. Thus, the contention of Ayalon et al. (2004) that the patina was artificially deposited, after it was made by grinding marine carbonate sediments and dissolving them in warm water, is suspicious and based on flawed geochemistry.

The letter “Ayin” from “Yeshua” was found by Ayalon et al. (2004) to have values of ($\delta^{13}\text{C}\text{‰}_{\text{PDB}} = -5.14$; $\delta^{18}\text{O}\text{‰}_{\text{PDB}} = -5.82$). Another letter (“Het” from “Akhui” [“brother of” in Aramaic]) yielded expected oxygen isotope ratios of cave deposition ($\delta^{13}\text{C}\text{‰}_{\text{PDB}} = -2.41$; $\delta^{18}\text{O}\text{‰}_{\text{PDB}} = -4.65$) and surprisingly was not reported in Ayalon et al. 2004. However, in the Geological Survey of Israel Carbonate Analysis log of April 22, 2003, the data from their analysis (Line 9) are clearly listed. Two samples yielded the expected oxygen composition values, according to the examination of Dr. Ayalon, and were not taken into their consideration of authenticity (Ayalon et al. 2004). We propose that discrepancies in the isotope ratios were caused by the cleaning and enhancing processes and the small quantity of the so-called “James Bond” ossuary is a mixture of the real patina and the chemical cleaning substance. The two expected values are probably the

remains of the calcitic patina that was sampled. In fact, Pellegrino (2008) found extensive contamination by micro-shreds of paper-and-“rag”-based fibers overlying the patina. He noted that the paper yielded high phosphorous and chlorine peaks consistent with phosphate-based detergents of the late 1970s and early 1980s, and suggestive of amateurish cleaning of the ossuary about that time, with detergent-soaked towels, presumably in preparation for the antiquities market.

The compositions of oxygen isotopes were measured in patinas on several artifacts from officially sanctioned excavations and exhibit a wide range of values (Professor Aldo Shemesh, Weitzmann Institute, personal communication). The values of the oxygen isotopes not only vary between different geographic locations but also vary in the same location, as well as in the same artifact. Discrepancies from stalagmite deposition range up to $\delta^{18}\text{O}$ -8‰ PDB. The kinetic processes of the oxygen isotopes clearly indicate that there are more variables than water composition and temperature (as assumed incorrectly by Ayalon et al. 2004). Thus, it is clear that oxygen isotopes are not a reliable method for the authentication of any archaeological artifacts.

The various patina layers may have different isotopic compositions both, laterally and vertically. Thus, when Ayalon et al. (2004) measured the isotopic values of the patina layer on the James Ossuary that resulted in different readings, they concluded that the ossuary was forged. However, the readings may have been correct, and the variability of the readings could have been accurate. This is a line of investigation that should be explored.

The development of the patina was compared to the development of a (cave) stalagmite by Ayalon et al. (2004). In a stalagmite cave, one can clearly observe the annual growth rings representative of calcium carbonate deposition. This growth is indicative of a constant supply of water over the years. However, the formation of a patina on archaeological artifacts is produced in a few sporadic events. The patina on archaeological artifacts is not comparable to continuous growth of stalagmite rings. Thus, it is inaccurate to assume that patina formation is comparable to the formation of stalagmites in a closed system ignoring all interactions with the environment, including anthropogenic ones.

Bar-Matthews and Ayalon (1997) developed a climatic ruler based on the averages of stable isotopes (oxygen and carbon) from the Bet-Shemesh stalagmite cave measured every two hundred years over several millennia. However, we maintain that patination is not a continuous, average process but forms under extreme conditions of episodic seasonal events probably in years of high rainfall and warm temperatures.

Thus, their climatic ruler determined by stalagmites and stalactites is not applicable in studying the formation of archaeological patinas with a restricted water supply.

Within the accreted patina, particles of the dust and soil (e.g., microfossils, sand, and clays) were observed. In addition, one must take into account the effect of microbiogenic activity when studying patina formation. Most importantly, since the artifact is unprovenanced, its geographic location is not known, yet the geographic location is very important in determining the oxygen isotope results. Oxygen isotope, as a method of authentication, is not used and was not approved to be an authentication in no lab in the world. There is no archaeological database for comparing oxygen isotopes from artifacts found in known excavated sites.

The Connection of the James Ossuary to the Jesus Family Tomb

In 1980, a burial tomb was unearthed in Talpiot, east Jerusalem, containing ten ossuaries, six of which bear inscriptions such as “Yeshua bar (son of) Yehosef,” “Mariya,” “Mariamne (also known as) Mara,” “Yose,” “Yehuda bar (son of) Yeshua,” and “Mattya (Matthews)” —names that match those of the New Testament, but were commonly used during the first century CE (Kloner, 1996; Tabor 2006). The Talpiot cave has six niches (Kloner, 1996). The *Golal* (Rolling stone) that was used to seal the tomb was not found.

The niches (two eastern, two western, and one northeastern; *kochim*) contained the ten ossuaries. The two-meter-long northwestern niche was empty of ossuaries when discovered in 1980. One meter of soil from the floor of the cave covered the ossuaries when it was first explored and was removed in a salvage excavation.

Pellegrino (2008; Rosenfeld et al. 2011) examined fourteen caves in the Jerusalem area (including the Talpiot cave) and discovered that each of the patinas bears its own chemical signature. He based his analysis on fourteen separate elements. These quantitative elemental “fingerprints” match the patina on the ossuaries found in each cave. In other words, each ossuary can be matched to the cave in which it was buried. Elemental variability between the ossuary and its cave ranges up to 5%. Even caves in close proximity to one another, within the same rock formation, exhibit different elemental fingerprints. This makes it easier to match the ossuaries to the host cave and is a powerful tool for linking unprovenanced artifacts to their cave of origin.

The James Ossuary has the same elemental fingerprints as are found in the Talpiot cave (Jesus family tomb) and its ossuaries (Pellegrino 2008); it

has equivalent peaks of phosphorous, titanium, iron, and aluminum. The phosphorous peak originates from the dissolution of the bones, whereas the titanium and aluminum peaks can be linked to clay particles, and the silica peak originates from quartz grains that come from atmospheric exposure to dust and soil.

The James Ossuary is very similar in size to the missing tenth ossuary (Kloner 1996). The measurements of the width and the height are identical, but the length falls short by 3–4 cm. Based on similar size and the elemental fingerprints, it is possible to conclude that the James Ossuary from the Talpiot cave is the missing tenth ossuary (Pellegrino 2008). However, we suggest that the James Ossuary could in fact be the missing eleventh ossuary. The fact that the James Ossuary was “caliched,” intensively weathered, and cracked suggests that this cave was breached a long time ago, and another adjacent niche of the Talpiot cave (possibly the empty northeastern niche) with the same chemical history held the eleventh ossuary. The Talpiot cave could have very well been looted before it was discovered in 1980 because it was exposed to atmospheric conditions by a partial collapse and the penetration of soil and water for at least two hundred years (Krumbein 2005). The massive pitting and striations as well as the intense weathering of the James Ossuary are not found in the other nine ossuaries.

Only the Mattya Ossuary exhibits sporadic pitting; the diameter of the pits is between 1–3 mm, but they are very shallow. No ossuary was affected as much from climatic conditions as the James Ossuary, and it could possibly be considered the eleventh ossuary because of it.

The fact that the James Ossuary exhibits the same geochemical fingerprints as the Talpiot cave and its ossuaries is a very important observation in regard to the Jesus family tomb. Adding this ossuary with the inscription “Ya’akob Bar Yoseph Akhui d’Yeshua” to the cluster of the names found in this tomb has a great statistical weight. It raises the calculated odds (Feuerverger, 2008) in a combined probability equation that it does not belonging to the New Testament Jesus family from one chance in 1,600 to a compelling level of certainty that it is really the historic holy family tomb. This completes the last piece in the jigsaw puzzle of the holy family.

Conclusions

1. A natural beige patina can be found inside the letters, accreting gradationally into the inscription. The patina can be observed on the surface of the ossuary continuing into the engraving. The engraving clearly does not cut the patina. Deposition of the patina

is episodic, suggesting that it was not developed continuously at a constant rate over a 2,000-year period.

2. Ancient patinated striations probably caused by falling cave-roof rocks transect the letters and the surface of the ossuary in the same direction.
3. Massive pitting developed under atmospheric conditions after the engraving of the inscription on the ossuary is also superimposed on several letters.
4. In addition to calcium carbonate, the patina on the ossuary is also composed of minerals (apatite, whewellite, and weddellite) that are the product of geo-microbiogenic activity. The presence of microcolonial long-living black yeast-like fungi forming pitted embedded circular structures indicates slow growth over many years.
5. The so-called “James Bond” patina that was described by Goren (2003; Silberman and Goren, 2003) as a “grainy” gray material is actually the same beige patina that covers the rest of the ossuary.
6. The patina is enriched with silica (about 5.0%) relative to the original stone (about 1.5%) and extends over the ossuary surface as well as in its inscription. The calculated enriched phosphate in the patina is 1.3%, and in the soil, it is about 3%; all of this probably originated from the dissolution of the bones. The presence of phosphate (from bones) that is incorporated into the patina is another indication of slow growth. This heterogeneous patina does not contain any traces of modern tools and it adheres firmly to the stone.
7. The microfossils in the patina are not recent, but range from the Cretaceous period to the Tertiary period in age, similar in age to the marine carbonate rocks that are widely exposed over most of Israel. The obvious source of this dust component is from mechanical erosion of the numerous outcrops of limestones and chalks as well as minor quartz. They should be as plentiful in the historical past as they are today. Indeed, their absence within a patina purportedly coming from Jerusalem would be suspicious; the entire city is situated upon marine carbonate exposures of the Judea and Mount Scopus groups (of limestones) containing microfossils.

8. The fact that the foraminifera are well preserved and have empty chambers precludes the possibility that the patina was artificially deposited by the grinding of marine carbonate sediments as proposed by Ayalon et al. (2004). Grinding the limestone along with its microfossil content would not have enabled the grinder to extract the sediment that infilled the chambers. The sediment could only have been removed by a natural, slow erosional process.
9. The contention of Ayalon et al. (2004) that the patina was artificially deposited, after it was made by grinding marine carbonate sediments and dissolving them in warm water, is suspicious and based on flawed geochemistry.
10. It is inaccurate to assume that patina formation is comparable to the formation of stalagmites in a closed system ignoring all interactions with the environment, including anthropogenic ones.
11. Oxygen isotopes were not found to be a reliable method for the authentication of archaeological artifacts.
12. The fact that the James Ossuary exhibits the same geochemical fingerprints as the Talpiot cave and its ossuaries is a very important observation in regard to the Jesus family tomb. Adding this ossuary with the inscription “Ya’akob Bar Yoseph Akhui d’Yeshua” to the cluster of the names found in this tomb has a great statistical weight. It raises the calculated odds (Feuerverger 2008) in a combined probability equation that it does not belong to the New Testament Jesus family from one chance in 1,600 to a compelling level of certainty that it is really the historic holy family tomb.

Glossary

Al = aluminum

Ca = calcium

CaCO₃ = calcium carbonate; the mineral calcite

$\delta^{18}\text{O} \text{‰}_{\text{PDB}}$ = measurement value of oxygen isotopes $\delta^{13}\text{C} \text{‰}_{\text{PDB}}$ = measurement value of carbon isotopes

Delta value = the difference between the isotope ratio in a sample and that in a standard, divided by the ratio in the standard, and expressed as parts per thousand per mil.

Fe = iron

Foraminifera = a protozoan characterized by the presence of a test (shell) usually composed of calcite or agglutinated particles

Isotope = one of two or more species of the same chemical element

Mg = magnesium

Nannoplankton = passively floating unicellular organisms

P = phosphorous

PDB standard = used as a standard of comparison in determining the isotopic composition of carbon and oxygen

Si = silicon, an element

Silica = a mineral composed of silicon and oxygen; a chemically resistant dioxide of silicon, SiO_2

Ti = titanium

UV = ultraviolet

References

- Ayalon, A. 2003. "Examination of Authenticity: James Brother of Jesus Ossuary and Yehoash King of Yehuda Inscription. A Report in Israel Antiquities Authority." *The Bible and Interpretation*. http://www.bibleinterp.com/articles/Goren_report.htm.
- Ayalon, A., M. Bar-Matthews, and Y. Goren. 2004. "Authenticity Examination of the Inscription on the Ossuary Attributed to James, Brother of Jesus." *Journal of Archaeological Science* 31:1185–89.
- Bar-Matthews, M. and A. Ayalon. 1997. "Late Quaternary Paleoclimate in the Eastern Mediterranean Region from Stable Isotope Analysis of Speleothems at Soreq Cave, Israel." *Quaternary Research* 47:155–68.
- Feuerverger, A. 2008. "Statistical Analysis of an Archaeological Find." *Annals of Applied Statistics* 2:3–54.
- Flexer, A. 1964. *Paleogeography of the Senonian and Maestrichtian in Northern Israel*. Unpublished PhD Theses [in Hebrew; English abstract]. Jerusalem: Hebrew University, Jerusalem.
- Flexer, A., A. Honigstein, A. Rosenfeld, and B. Polishook. 1990. "Geology, Geotechnical Properties and Exploitation of Chalk in Israel: An Overview." In *Chalk: Chalk Symposium in Brighton Polytechnic, 1989*. London: Thomas Telford, 63–70.
- Ganor, E. 1975. *Atmospheric Dust in Israel: Sedimentological and Meteorological Analysis of Dust Deposition*. Unpublished Doctoral Dissertation. Hebrew University, Jerusalem.
- Ganor, E., S. Ilani, J. Kronfeld, A. Rosenfeld, and H. R. Feldman. 2007. "Environmental Dust as a Tool to Study the Archaeometry of Patinas on Ancient Artifacts in the Levant." *Geological Society of America Annual Meeting* 39. Denver: Geological Society of America, 574.
- Goren, Y. 2003. "Examination of Authenticity: James Brother of Jesus Ossuary and Yehoash King of Yehuda Inscription. A Report in Israel Antiquities Authority." *The Bible and Interpretation*. http://www.bibleinterp.com/articles/Goren_report.htm.
- Gorbushina, A. 2003. "Microcolonial Fungi: Survival Potential of Terrestrial Vegetative Structures." *Astrobiology* 3:543–54.

- Gorbushina, A. A. 2007. "Life on the Rocks (Mini-Review)." *Environmental Microbiology* 9 (7):1613–31.
- Gorbushina, A. A. and W. E. Krumbein. 2004. "Role of Organisms in Wear Down of Rocks and Minerals." In *Microorganisms in Soils: Roles in Genetics and Functions*, ed. F. Buscot and A. Varma. Berlin: Springer Verlag, 59–84.
- Harrell, J. A. 2004. "Flawed Geochemistry Used to Condemn James Inscription." *Biblical Archaeology Review* 30:38–41.
- Jackson, J. (ed.). 2007. *Glossary of Geology*. Alexandria: American Geological Institute.
- Keall, E. J. 2003. "New Tests Bolster Case for Authenticity." *Biblical Archaeology Review* 26 (4):52–55.
- Kloner, A. 1996. "A Tomb with Inscribed Ossuaries in East Talpiyot, Jerusalem." *Atiqot* (Jerusalem) 29:15–22.
- Krumbein, W. E. 2003. "Patina and Cultural Heritage: A Geomicrobiologist's Perspective." In *Proceedings of the 5th European Common Conference "Cultural Heritage Research: A Pan-European Challenge"*, ed. R. Kozłowski. Cracow: Polish Academy of Sciences, 39–47.
- Krumbein, W. E. 2005. "Preliminary Report: External Expert Opinion on Three Stone Items, n.p." *Biblical Archaeology Review*. "Finds or Fakes." Biblical Archaeology Society web-site.
- Krumbein W. E. and K. Jens. 1981. "Biogenic Rock Varnishes of the Negev Desert (Israel): An Ecological Study of Iron and Manganese Transformation by Cyanobacteria and Fungi." *Oecologia* 50 (1): 25–38.
- Lemaire, A. 2002. "Burial Box of James the Brother of Jesus." *Biblical Archaeology Review* 28 (6):24–33.
- Lemaire, M. A. 2003. "Ossuaire de Jacob/Jacque fils de Joseph, le frere de Jesus-Trois Inscriptions Arameennes sur Ossuaire et leur Interet." *Comptes Rendus de L'Academie des Inscription & Belles-Lettres*. (Jan.–Mar.):301–19.
- Magen, Y. 1984. "Jerusalem as the Center for Stone-Ware Production during Herodian Times." *Qadmoniot* 17:124–27.
- Magen, Y. 1988. *The Stone Ware Industry in Jerusalem of the Second Temple Period* [In Hebrew]. Society of Nature Conservation.
- Magen, Y. 1994. "The Stone Vessel Industry during the Second Temple Period." In *Purity Broke Out in Israel*, ed. O. Rimon. Haifa: The Reuven and Edith Hecht Museum, 7–27.
- Magen, Y. 2002. "The Stone Vessel Industry in the Second Temple Period. Excavations at Hizma and the Jerusalem Temple Mount." Jerusalem: Israel Exploration Society and Staff Officer of Archaeology.
- Mimran, Y., A. Honigstein, Y. Arkin, A. Rosenfeld, L. Michaeli, and Y. Hatzor. 1996. "The Use of Ostracod Biostratigraphy in Geotechnical Evaluation of the Santonian Chalk for the Proposed Mount Scopus Tunnel." *Israel Geological Survey, Current Research* 10:138–42.
- Newman, R. 1990. "Weathering Layers and the Authentification of Marble Objects." In *Art Historical and Scientific Perspectives on Ancient Sculpture*, eds. M. True and J. Podany. Malibu, California: J. Paul Getty Museum, 263–82.
- Pellegrino, C. 2008. "Methods Paper: The Potential Role of Patina History in Discerning the Removal of Specific Artifacts from Specific Tombs." In *Proceedings of the 3rd Princeton Symposium on Judaism and Christian Origins, "Jewish Views of the After Life and Burial Practices in Second Temple Judaism, Evaluating the Talpiot Tomb in Context,"* ed. J. H. Charlesworth. Jerusalem, 13–16 January 2008.

- Porat, N. and S. Ilani. 1993. "Pigments Derived from Minerals." In *Colours from Nature: Natural Colors in Ancient Times*, eds. C. Sorek and E. Ayalon. Tel Aviv: Eretz Israel Museum, 9–12, 16–38.
- Reiss, Z., A. Almogi-Rabin, A. Honigstein, Z. Lewy, S. Lipson, S. Moshkovitz, and Y. Zaks. 1985. "Late Cretaceous Multiple Sytratigraphic Framework of Israel." *Israel Journal of Earth Science* 34(4):147–66.
- Rosenfeld, A. and S. Ilani. 2002. "SEM-EDS Analyses of Patina Samples from an Ossuary of 'Yaakov Son of Yossef Brother of Yeshua.'" *Biblical Archaeology Review* 28 (6):29.
- Silberman, N. A. and Y. Goren 2003. "Faking Biblical History." *Archaeology* (September/October): 20–29.
- Staley, J. T., F. E. Palmer, and J. B. Adams. 1982. "Microcolonial Fungi: Common Inhabitants on Desert Rocks?" *Science* 215:1093–95.
- Sterflinger, K. and W. E. Krumbein. 1997. "Dematiaceous Fungi as the Main Agent of Biopitting on Mediterranean Marbles and Limestones." *Geomicrobiology Journal* 14:219–231.
- Tabor, J. 2006. "Testing a Hypothesis." *Near Eastern Archaeology* 69:132–36.

Chapter 11

Implications of the “Forgery Trial” Verdict on the Authenticity of the James Ossuary

The James Ossuary was labeled a forged artifact in 2003 by the Israel Antiquities Authority. The “not guilty” verdict (case 482/04) handed down by the Honorable Judge Aharon Farkash of the Jerusalem District Court in March 2012 resulted in Oded Golan’s acquittal of charges that he forged the James Ossuary Inscription and the Jehoash Inscription tablet. The “Forgery Trial” sparked a fruitful and important debate on the issue of unprovenanced artifacts among top scientists from all over the world. The conclusions of the judge regarding the inscription of the James Ossuary contributed much to the forgery debate. By casting doubts on the accusations, the judge accepted some crucial facts: 1) the inscription was cleaned by a sharp object; 2) there is a real patina covering some letters in the words “Achui d’Yeshua”; 3) statistically the few samples analyzed by the prosecution experts are not sufficient for conviction; 4) the oxygen isotope “expected range” cannot determine forgeries; 5) oxygen isotopic examination of patinas on artifacts is as yet not perfected and cannot be used to determine whether the artifact is authentic; 6) the photos of the ossuary from the 1970s presented to the court are authentic; 7) the casting of the red silicone by the Israel Antiquities Authority (IAA) forensic examiners changed the physical condition of the inscription of the ossuary, so much so

that Golan’s defense was affected adversely; 8) the judge accepted Professor Krumbein’s statement that “the patina on the ossuary evolved over centuries if not thousands of years, and that the patina within the inscription and the patina on the ossuary were created during the same time period”; 9) the IAA material committee’s conclusions were based on unverified climatic data, incorrect chemistry, ignoring the possible effects of the cleaning, conservation and enhancement of the inscription; 10) the judge accepts that disqualifying the “Het” sample or any other sample, based only on the outcome of its isotopic composition is a “scientific bias or a circular argument”; 11) the ability of the experts from the Royal Ontario Museum, Canada, to distinguish between a genuine or pseudo-patina was valid even though Professor Goren claimed otherwise; and 12) the IAA material committee came to incorrect and misleading conclusions regarding the discovery of microfossils in the patina. Judge Aharon Farkash’s verdict in the alleged forgery of the James Ossuary inscription clearly contributes more than ever to the strengthening of the contention that the inscription is genuine.

Introduction

The discovery in 2002 of a limestone burial box bearing the Hebrew [Aramaic] inscription “James son of Joseph brother of Jesus” tantalized the world of archaeology. If genuine, the ossuary would be the only archaeological artifact yet found with a possible direct link to Jesus of Nazareth. The ossuary that was found in Israel went on display at Toronto’s Royal Ontario Museum and swiftly thereafter a scholarly debate ensued that resulted in many studies, several documentary movies, and at least four books.

However, experts at the Israel Antiquities Authority (IAA) declared it a modern-day forgery. Israeli police seized the ossuary and arrested its owner, Tel Aviv collector Oded Golan. In December 2004, he was charged with faking the ossuary and dozens of other items, including an inscribed tablet linked to King Jehoash, which, if authentic, would be the only physical evidence from the Temple of Solomon.

This article is based on the testimony of expert witnesses who testified in the “Forgery Trial” and on the 475 pages of the meticulous verdict of Judge Aharon Farkash, District (Criminal) Court in Jerusalem, Israel. The verdict was delivered on March 14, 2012 (case number 482/04), the State of Israel (IAA) versus Oded Golan and four others who were accused of

forging very important antiquities. We discuss the scientific problems in lieu of the verdict concerning the James Ossuary inscription (JO; count No. 1). The Jehoash Inscription tablet (JI; count No. 2) and the decorations of the stone oil lamp (count No. 7) will be discussed in a later publication. The verdict in case 482/04 by Judge Farkash came about because proof that the artifact was forged beyond a reasonable doubt was not presented in the court. The prosecution experts could not agree among themselves about whether these artifacts were fakes. We have investigated, published, and testified about these three artifacts (Ilani et al. 2002; Ilani et al. 2008; Krumbein 2005; Rosenfeld and Feldman 2008; Rosenfeld et al. 2009; Rosenfeld et al. 2010a, b; Rosenfeld et al. 2011; and Rosenfeld et al. 2012) and our conclusions are summarized in what follows.

The forgery trial was very thorough, lasting seven years, and containing about 13,000 protocol pages, with hundreds of exhibits, reports, and books. It expanded to more than 120 sessions that lasted more than eight hours per day, some even continuing into the late evening hours. The 74 prosecution witnesses and the 54 for the defendant (a total of 128 witnesses) represented a number of different fields and came from Israel, the United States, Canada, France, and Germany. The court had to rule on the forging of certain antiquities, most of which came from the antiquities market (unprovenanced), and heard testimonies and lectures from experts in various scientific fields: geology, chemistry, geochemistry, and microbiology. Scholars from archaeology, philology, epigraphy, paleography, biblical studies, and other areas of the humanities, were also called. The scope of the questions dealt with during the trial revealed many scientific as well as juristic issues.

We must praise the work of the Honorable Judge Farkash and his assistant attorney Inbal Moshe. They worked faithfully and with great skill to produce such an important verdict. Judge Farkash praised all the experts who appeared in the trial and said that his impression was that the experts were loyal to their fields and worked according to their skills, ability, experience, and honesty in order to seek scientific truth. Judge Farkash said that he believed that in the future new scientific methods would be developed, enabling the identification of fake or genuine antiquities. The judge expressed his regret that both sides did not succeed in negotiating an agreement between them without the need to come to the “end of the road”—the verdict. A few times during the lengthy trial Judge Farkash suggested that the prosecution should drop the charges (Kalman 2008). Judge Farkash scolded the IAA in his verdict, stating that there was a long distance from a suspicion of forgery to finding Golan guilty beyond any reasonable doubt.

The judge emphasized that while he found no proof of forgery it was not the task of the judge to determine whether the artifacts are genuine. Although Judge Farkash expressed his own views on some key questions, we have only translated scientifically relevant points from his verdict and the expert testimonies. Brackets [...] are used by the authors for clarification. The numbers next to the subheadings are the paragraph numbers in the judge’s verdict.

We should emphasize that in our peer-reviewed publications, we found nothing suspicious that would indicate that the James Ossuary inscription is not authentic (Rosenfeld and Ilani 2002; Rosenfeld and Feldman 2008; Rosenfeld et al. 2011; Rosenfeld et al. 2012). We came to the conclusion, regarding the JI, that our analysis strongly supports the antiquity of the patina, which in turn strengthens the contention that the inscription is authentic (Ilani et al. 2002; Ilani et al. 2008; Rosenfeld et al. 2009). With regard to the stone oil lamp with the menorah and the seven species, we concluded that the multilayered silicified calcitic patina attached to the lamp’s surfaces is indicative of natural long-term development in a burial setting. We can say with a high level of confidence that the oil lamp, including its ornamentations, was produced many centuries ago (Rosenfeld et al. 2010; Rosenfeld et al. 2011). The verdict on the Jehoash Inscription tablet and the stone oil lamp will be discussed in a future publication.

The James Ossuary Inscription

Results of Our Team’s Analysis

The inscription on this ossuary says “Ya’akov son of Yosef brothers of Yeshua.” Rosenfeld and Ilani (2002), Krumbein (2005), and Rosenfeld and Feldman (2008) observed that the inscription was unprofessionally cleaned but that, nevertheless, a genuine patina was found covering some of the engraved letters. The composition of the patina on the surface of the ossuary was the same as within some of the letters of the inscription. Namely, the beige patina on the surface of the ossuary continued into and through the engraving incisions. Thus, the engraving of the letters clearly does not cut the patina, a strong proof for authenticity. No evidence of modern engraving tools was found there. In addition to calcium carbonate, the patina on the ossuary is also composed of minerals (apatite, whewellite, weddellite) that are the product of geomicrobiogenic

activity. The presence of microcolonial, long-living black yeast-like fungi forming pitted embedded circular structures indicates slow growth over many decades (Krumbein 2005). We observed in some of the letters of the inscription genuine beige biopatina or “varnish.”

Dust, a significant component of patinas, accumulates on exposed surfaces of artifacts and in soil. We have identified numerous examples of embedded microfossils (nannoplankton and foraminifers) and quartz grains that are consistent with windblown particles in the Jerusalem area (Ganor et al. 2009). The microfossils in the patina are similar in age (Cretaceous–Tertiary) to the marine carbonate rocks that are widely exposed over most of Israel.

The patina is enriched with phosphate up to 1.3% that probably originated from the dissolution of the bones (Keall 2003). The presence of phosphate (from bones) that is incorporated into the patina is another indication of slow growth that supports the authenticity of the inscription. The patina does not contain any traces of modern tools and adheres firmly to the stone. Moreover, the formation of a patina on archaeological artifacts is probably produced through a series of sporadic events and is not comparable to continuous growth of stalagmite rings as suggested by Ayalon et al. (2004). Thus, it is inaccurate to assume that patina formation is comparable to the formation of stalagmites in a closed system. Interactions with the environment and microorganisms, as well as anthropogenic interventions like war, destruction, and fire during ancient times are crucial factors. See the conclusions of Professor Shemesh about the isotopic examination in the verdict below.

The results of the archaeometric analysis of the James Ossuary, and the heterogeneous existence of windblown microfossils, quartz, and other biogeochemical minerals that characterize the patina of the ossuary including the lettering engravings, does not indicate a forged inscription. On the contrary, it supports the contention that the inscription of the ossuary is authentic.

The Israel Antiquities Authority Results

The IAA material committee (IAA 2003) came to the conclusion that the exceptional oxygen isotope composition of the “letter patina” above and below the expected oxygen isotopes -4‰ to -6‰ [PDB] could not have been formed under natural temperature and oxygen isotope composition that prevailed in Judea during the last 3,000 years. Samples from the

inscription yielded negative anomaly values for oxygen isotopes between -7.5‰ to -10.2‰ [PDB]. These numbers suggest that ground carbonate was dissolved in hot water and heated to ensure the good adhesion of the new, artificial patina.

The ossuary and its beige patina are authentic but the inscription coating the “letter patina,” or “James Bond” as Silberman and Goren (2003) named it, is very soft and can easily be removed by a toothpick. Microfossils (foraminifers and coccoliths) were found only in the “letter patina” and were not observed in other sites of the ossuary. The entire inscription cuts into the beige (real, biological) “varnish” patina. “The inscription was engraved or at least completely cleaned in modern times” (IAA 2003). All samples from the patina of the James Ossuary and two samples from other ossuaries yielded the expected oxygen isotope -4‰ to -6‰ [PDB]. Only the last letter “Ain” of the inscription in the word “Yeshua” yielded a value within the expected range (-5.8‰).

Professor Goren (2005), a member of the material IAA committee, accused us of being infected with the “Jerusalem syndrome.” All the authors of this study are experienced geologists/archaeometrists with numerous publications. Unfortunately, psychology is not within our purview and as “innocent victims,” we are unable to react to such a sweeping accusation.

Discoveries during the Trial

In the summer of 2004, the Israeli police, with the permission of the IAA, made a red silicone mold of the inscription, thereby destroying both the “letter patina” and the evidence. Consequently, the alleged small amount of “letter patina” is absent now and cannot be studied further. In science, an observation and/or an experiment that is not reproducible should be ignored. When we first examined the JO inscription, we paid attention only to the patina that occurred in the margins of the letters, since we noticed that the inscription was unprofessionally cleaned and probably handled by an antiquities dealer. The microfossils (foraminifers and nannoplankton) were found by us all over the ossuary (Krumbein 2005) and not only in the faked “letter patina” as described by Ayalon et al. (2004). The obvious source of this microfossil component carried by ambient dust is from mechanical erosion of outcrops of limestone and chalk. The fact that the foraminifera are well preserved precludes the possibility that the patina was artificially deposited by the grinding of marine carbonate sediments

as proposed by Ayalon et al. (2004). According to Ayalon et al. (2004), the “letter patina” is composed of ground chalk dissolved in hot water. This is in contrast to basic chemistry: carbonate dissolves better in cold water and precipitates in hot water. The defense expert witnesses (Professors Marcus, Kronfeld, and Harrell) strongly rejected the IAA’s hypothesis that the patina was faked with ground calcium carbonate patina dissolved in hot water (see also Harrell 2004a, b; 2005).

Not only did the “Ain” yield the expected oxygen isotopes, but also the “Het” in the word “Achui” (brother of) was measured for oxygen isotopes. Ayalon et al. (2004) found that it yielded a value within the expected range. However, this value was discarded and was not presented in the IAA’s report. This omission was discovered during the trial. The isotope experts explained this omission by claiming that the sample was likely contaminated due to its occurrence within 2 cm of the fissure that was mended in the Royal Ontario Museum. We should stress that the samples are very minute and were taken with the aid of a microscope and that the “Het” sample was most probably omitted deliberately.

The Patina and the Oxygen Isotopic Contradictions

The compositions of oxygen isotopes were measured in patinas on several artifacts from officially sanctioned excavations and exhibit a wide range of values (Shemesh 2007). The judge accepted Shemesh’s report that rejected the “expected range” and the forgery theory of Ayalon and Bar-Matthews. The values of the oxygen isotopes vary so much that the discrepancies from stalagmite deposition range up to -8‰ [PDB]. It is clear that the use of the oxygen isotope method for the authentication of archaeological artifacts is premature and unreliable (Shemesh 2007). To our knowledge, this method of authentication is not used in any laboratory in the world today.

The expected oxygen isotopes of an archaeological patina during the last 3,000 years according to Ayalon et al. (2004) must be similar to the stalagmite from the Bet-Shemesh cave (near Jerusalem) and ranging between -4‰ to -6‰ delta O18 [PDB], which matches the annual rainfall of 500 mm in a sub-arid climate with a temperature range of 18–19 degrees Celsius. Deviations from -4 to -6‰ are strictly considered by Ayalon et al. (2004) to be a faked patina.

Surprisingly, Ayalon and Bar-Mathews contradict this expected “normal” range of oxygen isotopes in Orland et al. (2009). There, they examined the same stalagmite from the Bet-Shemesh cave using a very new and exact isotopic method yielding different values for the composition of the oxygen isotope range between -6.5‰ to -8‰ [PDB]. This new oxygen isotope analysis matches the annual rainfall range between 800–1,200 mm during the Roman and Byzantine periods (about six hundred years; Orland et al. 2009, Figure 6). This is twice as much as their former annual estimate of 500 mm rain. These new data of oxygen isotopes averages -6.5‰ to -8‰ delta O18 produced by Ayalon and Bar-Mathews severely contradict their former expected oxygen isotopic range of -4‰ to -6‰ [PDB] (Kalman 2009). The alleged faked patinas of the JI and the JO revealed by the oxygen isotopes are now within the new range proposed by Ayalon and Bar-Mathews, thus undermining their own determination of forgery. After Ayalon and Goren’s “carbonate dissolution in hot water concept” was rejected in the trial by many chemists, Ayalon, in his rebuttal testimony, changed his forgery method and suggested to the court that warm soda water was used by the forger to dissolve the carbonate (instead of hot water alone). Ayalon and Goren, in a desperate attempt to save their “forgery theory,” demonstrated some uncontrolled soda water experiments (one was even performed in the courtroom). The ground powder and the soda were poured into an engraving in modern limestone. But after the defense attorney Hagai Sitton puffed into it, all the material was blown away. This demonstration eliminated this method of creating a fake patina.

Moreover, the compositions of oxygen isotopes were measured in patinas on fifty-six artifacts from officially sanctioned excavations and exhibit a wide range of values (Shemesh 2007). The values of the oxygen isotopes not only vary between different geographic locations but vary also in the same location and in the same artifact. About 30% of the oxygen isotope patina samples exhibited more negative values compared to Ayalon’s and Goren’s “expected range” (-4‰ to -6‰ [PDB]) values, with discrepancies ranging up to -8‰ . According to Shemesh (2007), the deposition of patina is in a disequilibrium state and the oxygen isotopic equation cannot be applied for archaeological patinas (see the isotopic chapter of the verdict below).

Judge Farkash's Verdict of The James Inscription: "Not Guilty of Forgery"

Reasons for the Acquittal

Below are some translations of the scientific summaries and citations of the experts' testimonies written by Judge Farkash:

The Epigraphy and the Content Aspect Prosecution Experts

Dr. Esther Eshel (Bar-Ilan University) testified that she had a "feeling" that the inscription is a fake. Paleography "is not an exact science." "It is not 100% science." "It is not unequivocal." "The worst I can be is wrong and thank God nobody will die if it turned out that I did a mistake."

Professor Ronnie Reich (Haifa University; excavations in Ir David) testified: "There is nothing to point out in the inscription... that could indicate of any kind of a forgery." "All these characteristics... indicate an authentic inscription from the late Second Temple period (mainly the first CE)." The impression of the judge was that Reich still maintained the opinion that the script and the content of the inscription is authentic and that "there is no typological or content-related sign that might indicate a forgery." The professor was forced to change his mind to forgery, according to the IAA material committee, in 2003. All the words of the inscription were written by one hand and Professor Reich did not think that there is a difference between the two parts of the inscription, which is written in a uniformly straight line. It was unreasonable to assume that before us there were two parts of the inscription, because in a cave it would be difficult to keep a straight line with the first half of the inscription.

Judge Farkash's Remarks (71)

It is hard not to be impressed by the fact that different experts were influenced, some more, some less, by other experts' conclusions. For example, Dr. Eshel wrote in her report about the different widths and depths of the engravings and noted explicitly that these differences were reported to her by the material committee. Her conclusion was that two different chisels were used. In her testimony, Dr. Eshel said that "there are accumulations of evidences from all kind of directions that cast suspicion on the inscription." The influence of one expert on another can be seen quite clearly in

the case of Professor Reich, who independently wrote in his report that the inscription is authentic before he heard the opinions of other members of the committee. But after he heard the conclusion of the other members of the committee he changed his mind.

Dr. Ada Yardeni (Hebrew University, Jerusalem) testified: "I did not see anything that can prove something is not genuine... all the discussions on this matter did not convince me. I still think that this inscription [of the James Ossuary] is authentic, and that's it! Until someone steps forward and says, 'I did it.'" Dr. Yardeni stood by her opinion during her cross-examination and confirmed that her testimony as stated above was accurate. She said that if it became clear that it was a forgery she would leave the profession [paleography-epigraphy].

Dr. Hagai Misgav (Hebrew University, Jerusalem) testified: "I know many ossuaries that were written and someone after a few years added [some words] to the original inscription... from the paleographical aspect the inscription is absolutely correct." Dr. Misgav said that, in general, ossuaries were written by family members and not by professionals. He said that "some of them were written in the darkness of the tomb, the variability of the letters is huge, the script could be [engraved] in a terrible way or in a professional, formal way."

Judge Farkash's Remarks (78)

To sum up till now, we can say that the prosecution witnesses on the script, the content, and the archaeological aspects of the inscription indicate no unequivocally clear and satisfactory conclusion about the forgery of the inscription of the ossuary. Moreover, some of them (Professor Reich and Dr. Yardeni) support the opposite conclusion, in other words, that the entire inscription is authentic (at least from the epigraphy and content perspectives). I should mention that some of the witnesses (like Professor Kloner and Dr. Eshel) testified that they are not experts in the precisely required field, and that they are experts in other general archaeological fields that are close to the present subject, but it cannot be said that their testimonies are absolutely not relevant.... On the contrary, Dr. Yardeni is an expert in paleography, with many years' experience, and she actually thinks with an absolute certainty that the inscription is authentic, and that it was written by one man. Dr. Misgav also thinks in this manner and that he is a "specialist in this field."

The Defendant's Experts

Professor Gavriel Barkay (Bar-Ilan University) testified that he saw the JO and his impression was that the inscription was engraved by the “same hand.” He was asked to compare the two letters of the “Ain” in “Yaakov” and in “Yeshua.” Like other experts, he maintained that there was no reason that the same form of “Ain” would appear in the same inscription, even it was engraved by one hand, because this is “hand” work and not “machine” work. We should not look for a perfect uniformity because this was not done by a professional engraver, but in the dark conditions of a cave, by a member of the family, and that writing would not have been his daily occupation.

Professor André Lemaire is a Sorbonne Institute expert in Semitic epigraphy and has over forty years' experience in the field. He is a Hebrew and Aramaic philologist, and has published ten books and 400 scientific articles on the epigraphy and the history of Israel in the Levant; he has participated in twenty official excavations in Israel. He expressed his opinion that the inscription was written continuously by the same hand, and that there was no reason to doubt its originality. The combination of formal and cursive script was routine and normal, because this was only the deceased's name for identification needs. He rejected the claim of the prosecution that the letter “Dalet” was copied from another ossuary and he maintained that the letter “Dalet” [in the JO] was different.

Judge Farkash's Remarks (88–89)

The testimonies of the defendant's experts in their epigraphy and paleographical conclusions also supported the authenticity of the inscription on the ossuary, exactly as assumed by some of the prosecution experts. Judge Farkash writes: “My conclusion from the above is that, in these aspects, it was not proved beyond reasonable doubt that the inscription has two parts and was written by two different people. And even if it was so, there are logical and reasonable explanations that are accepted by many experts, mostly by the accuser's experts.”

The Material Aspect

Prosecution Experts

Dr. Elisabetta Boaretto (Weizmann Institute) testified that she did not have enough material from the patina of the JO for her laboratory carbon-14

dating. Without sampling or, obviously, without carbon dating, she signed the report of the IAA material committee that the inscription is forged. She admitted that the other members of the material committee convinced her to sign for forgery even though it is not her specialty.

Mr. Jacques Neguer (IAA, chief art conservator) testified: "The Ossuary is authentic, the inscription on it is forged because of several reasons: the scratches and the engravings are covered by artificial patina of round crystal grains occurring only on the side of the inscription; the engravings of the inscription cut the original patina; probably the inscription was written by two different people and with different tools." "I cannot tell if part of the inscription is fake or not fake." "It seems I am not sure if this is 100%, but at least two people wrote the inscription." "The differences between the depths of the engravings... originates from the kind of the material, as we are talking about engravings on a stone which is not homogenous material, and it is not [the differences in the depths of the engravings] from the methods of engraving the letters."

Superintendent Yehudah Novoslaski (deputy of signs and materials in the Forensic Department of the Israeli Police) testified that he produced a silicone [red] mold and photographed it. He reported the results of his examination: "I found differences in the engraving tools between the first part of the inscription 'Ya'akov Bar Yosef' and the second part 'brother of Yeshua.'" Because of this unprecedented examination by the police with the probable permission of the IAA [which retains custody of the antiquities], the inscription of JO was contaminated with red silicone. [The red silicone is a very sticky gummy-like material that remained inside the letters and the area around it.]

Professor Goren

Professor Yuval Goren is an archaeologist, head of the Department of Archaeology and Ancient Near Eastern Cultures at Tel Aviv University. He considers himself a specialist in the application of different geological methods to determine whether archaeological artifacts are forged. His methods include microscopy, mineralogical and chemical methods, including archaeological petrography. He mainly investigates ceramics. Professor Goren worked in the IAA from 1988 to 1996 and was in charge of the laboratory examining ceramics. Professor Goren also found that, within the inscription on the ossuary, an additional coating material appears as a grayish color, a unique material that was not found on this ossuary or on the

other ossuaries he examined from the collections of the state. This coating is very soft on the inscription (easily grooved with a wooden toothpick), sometimes grainy, often homogeneous, and it fills the lower sections of the inscription. This material covers the varnish in the areas adjacent to the inscription. Also, the grooves and the engravings (working marks) in the region of the inscription are coated with a layer of varnish. The entire length of the inscription is cut into the varnish and interrupts it. Microscopic examination reveals that the coating of the inscription is composed of calcite and common coccoliths (marine microfossils).

Professor Goren's conclusion was that the ossuary itself is authentic both in typology and patina, which is coated with a varnish. Goren's conclusion was that "the engraved inscription was produced (or at least was cleaned in the entire length) in modern times... the coating of the inscription is not natural. It was probably done by powdering and dissolving chalk (maybe the engraving powder) with hot water and pouring the suspension on the inscription area for blurring the fresh engraving." The final conclusion of Professor Goren was that "the inscription is a modern forgery." The main findings of Professor Goren that led him to conclude that the inscription was forged are as follows:

1. There is a soft, patina-like material in the letters (the "patina letters"). In non-scientific publications, this material was jokingly called "James Bond" by Professor Goren.
2. The varnish on the ossuary surface is cut by the letters of the inscription. In addition, there is no varnish within the letters or on the margin of the letters.
3. The presence of marine microfossils (coccoliths, foraminifers) in the patina covering the letters is not found on the ossuary itself. Professor Goren's conclusion was that the material found in the letters is not a real patina: "It is a combination of natural substances that were artificially placed within the letters."

About the occurrence of marine microfossils, Professor Goren testified that he found a large number of marine microfossils in the patina letters, but that they do not appear in the patina on the surface of the ossuary. "Thus, it raised the possibility that the patina covering the letters was created by fragmentation and dissolution of the ossuary rock itself and artificial placement of it in the letters." Regarding the findings of the microfossils in the patina, Goren

testified to its forgery “because fossils cannot occur in secondary calcitic patina which crystallized below the surface [or] on the ground.” “With my microscopic examination, I did not find varnish in any place within the letters.” However, unlike the others [researchers], including the material committee members, (such as Ms. Orna Cohen, who saw the varnish in the word “Jesus”), “My conclusion is that the varnish is not serving us in any way and therefore the key point here is the ‘letters patina.’ If the letters patina is ok, it means that the inscription is ok. If the patina of the letter is problematic, we have a problem here.” “I think this inscription presents problems that contradict the ‘doubt,’ meaning that it creates a situation where we have a doubt, which is very reasonable for its authenticity, even a serious doubt about the fact that the inscription is authentic.” “The patina that covers the inscription is not an authentic patina, it is not a genuine patina, it was not formed under natural conditions, in contrast to other patina occurring on the ossuary.”

Judge Farkash's Remarks (110–120)

Professor Goren was cross-examined at length on his [forgery] opinion, for five days of sessions, usually lasting a whole day. Contrary to Professor Goren's initially clear-cut position that he did not find varnish in the letters, it seems that by the end of his testimony some doubts appeared, questions and indecision on this issue. Especially with regard to the “Het” letter of the word “Achui” and the letters “Shin” and “Ain” in the word “Yeshua” [Jesus]. He examined the ossuary in July 2003, but now he cannot see the “letters patina.” According to his hypothesis, [the “letter patina”] is a soft substance that can easily become detached from the letters, and the material probably fell away when the ossuary was reviewed by other investigators. **Also, the grains of the “letter patina” in the photos taken by the Royal [Ontario] Museum of Canada cannot be observed.** The fact that others did not see the “patina letters” [according to Goren] is because experts “do not always pay attention to details.”

The Letter “Het” in the Word “Achui”

Professor Goren agreed that it was possible to see the grainy substance [“letter patina”] covering the real patina only outside the letter “Het.” On the fourth day of his testimony, Professor Goren brought a microscope to the courtroom through which he examined the ossuary. The letters were

projected on the wall of the hall. First, he repeated his position that the varnish is not in the engraved “Het”; later he admitted that “maybe” there is varnish in the letter “Het.” Golan’s attorney argued in his summation that, when observing the letter “Het,” one can see clearly that the varnish goes into the upper part of the letter occurring in the groove of the letter. The prosecution also agreed that the court would need to determine what can be seen (pages 11 and 458).

“The rule is that the court may also... use the sense of sight. However, the rule of ‘seeing’ does not make the court an expert, and it does not obviate the testimony of an expert.... Nevertheless, Judge Farkash will add my impression when I viewed the projected letters on the wall using the microscope in the courtroom during the hearing: it seems that there is a real claim that the varnish enters into the top of the ‘Het’ letter. When it was projected in the courtroom, we were impressed by the original colors, which indicate, apparently, the existence of bio-patina in the letter ‘Het.’”

The Letter “Shin” in the Word “Yeshua”

Professor Goren admitted that if the defense was right about the form of the letter “Shin,” and he was not an epigraph expert, then the middle stake of the letter had a varnish stain (dot) (page 1197), and that such amount of varnish was enough to substantiate the claim that this was a real letter.

The Letter “Ain” in the Word “Yeshu”

In the beginning of the testimony of Professor Goren he stated that “it might be” that there was varnish inside the letter “Ain” (pp. 1197–98); and further in his testimony he reaffirmed that “There could be a spot [of varnish] in the letter ‘Ain.’” Professor Goren added that if we found within the letter “Ain” two spots with real patina, then “it could be that the letter ‘Ain’ is genuine,” but “this could [also] have very different and very strange explanations.”

After his testimony, Professor Goren asked the prosecution’s attorney to invite him to join further investigations. Professor Goren testified that the letter “Ain” caused him “many doubts,” and the many days in which he testified were for him “an opportunity to look inside me” that is, to see if the questions asked made him doubtful. In fact, the only one that caused him to waiver was the letter “Ain,” so much that after the hearing he asked the prosecution attorney to check the ossuary again without the pressure of being on the witness stand. He did: “I checked again the inscription

all along, I checked the letter ‘Ain’; I took better pictures, sharper than in the past and of the entire length of the inscription, and of the appropriate sections of the letter ‘Ain.’ And my conclusion from this examination was unequivocal; in the bottom line of the letter ‘Ain,’ there is varnish, a true biopatina. This conclusion is unequivocal” (p. 2014), “And today you can see it (the patina—A. F.) so much better.”

Professor Goren concluded his opinion thus: “So in the end, if you ask me to make any conclusion, the conclusion is that I was struggling, I have a dilemma. This silicone mold worked out for the better, because you could see the intervals of the inscription. Without the coverage of the ‘James Bond’ or the ‘letters patina’... so... you could also observe this area... cleaner, meaning it was clear to see what is the varnish how it went there into the bottom line of the letter ‘Ain,’ and other details.”

Defendant’s Experts

Ms. Orna Cohen is an archaeologist who specializes in preserving antiquities, has thirty years of experience in the field, and has worked for the conservation project of the IAA. She was not summoned to testify on behalf of the accuser; she testified for the defense.

Microscopic examination by her showed that in the second part of the inscription “Achui d’Yeshua” a yellowish patina in the letters can be seen, such as [occurs] on the ossuary. However in the first part of the inscription a similar patina cannot be found within the letters. Her conclusion was that there is fraud and deception. Even if some of the inscription “Achui d’Yeshua” is original, the whole inscription should be considered entirely false. Producing a superficial patina such as crushed stone in the ossuary [inscription] shows a simple forgery attempt. It was clearly revealed how only in the second part of the inscription the patina had been discovered within the letters. It is the same yellowish patina that appears over the entire ossuary. The patina goes inside the letters: “Het,” “Yod,” “Shin,” and in the “Ain” (in the words “Achui d’Yeshua”—A.F.) (p. 4716).

Ms. Orna Cohen testified that she examined the ossuary before the forensics tested it, and in her opinion, after the casting, the ossuary became contaminated by the silicone, because silicone sticks to everything and pulls out what adheres to it. Her estimation is that the patina she saw in the second part of the inscription comprises a combination of biopatina, minerals, and chemicals... dissolved salts, etc., and is the result of something ancient that stayed in ground. The ossuary was not engraved recently. Although she found the same patina in the letters of the ossuary, Ms. Orna Cohen’s

conclusion was: “And I would argue that the second part of the inscription is genuine due to the patina that enters inside [the letters], while the first part is probably late... has no patina at all.” The grainy material was added to contribute to the uniformity of the overall appearance of the inscription. She emphasized that she was aware that most experts were of the opinion that the second part is actually the fake, and yet she insisted that the second part was authentic (p. 4768). We should stress that her final conclusion was that even if some part of the inscription is genuine, the inscription should be regarded as an attempt to fake and mislead, and in this sense, her conclusion is consistent with other experts.

Dr. Dan Rahimi is an archaeologist who works at the Royal Ontario Museum, Canada. His testimony was given by video conference from Canada. According to the testimony, in October 2002, Shanks [the editor of *Biblical Archaeology Review*, BAR] offered to exhibit the ossuary at the museum in Canada. The museum asked for documentation of ownership of the ossuary and the export permit by the Israel Antiquities Authority was presented. When the ossuary arrived, he was surprised to see it was packed in soft cardboard: there is usually double packaging consisting of wood or metal. When he opened the box, he found the ossuary cracked. The Museum of Canada suggested a conservation proposal be sent to the collector through a lawyer. The collector agreed to the conservation proposal. Rahimi testified that the museum employees in Canada examined the ossuary before, during, and after conservation, and concluded: “We are convinced that the ossuary itself and its inscription are authentic.” “Under the microscope, we saw the signs of cleaning, and under these signs, we found in the long parts of the inscription evidence of patina... by microscopic observation... we concluded that the inscription in all its parts is authentic.”

Judge Farkash's Remarks (132)

“The accuser claims that the findings of the museum in Canada regarding the existence of patina in the inscription grooves are fully compatible with the description of the “letters patina” by Professor Goren, and therefore it is clear that the museum’s conclusion regarding the authenticity of the inscription is wrong. Another argument is that all experts agree today that the material described by Rahimi is not a natural patina. I found no basis for such claims, and therefore I cannot accept them. As mentioned, Rahimi was questioned on cross-examination and repeated that the museum

professionals in Canada found patina in the grooves of the inscription. Although this is not evidence with the weight of expert opinion, because the museum professionals themselves have not written a report, and they were not cross-examined, you cannot doubt their ability to distinguish between genuine patina and the pseudo-patina material that Professor Goren found.”

Professor Krumbein

Professor Wolfgang Krumbein is a German Professor of Geosciences specializing in Microbiology. He was invited as an expert witness for the defense in relation to various items including the ossuary. His opinion, in English and in Hebrew, was filed as N/189 and N/189a [Krumbein 2005]. Professor Krumbein is one of the most important experts in the various fields relevant to our case, including those pertaining to biopatina. Professor Krumbein carried out some investigations and analyses on the ossuary and its inscription especially on the patina on both of them. He set out to investigate them independently and to present his opinion on the conclusions of the material committee of the IAA and evaluate their scientific papers. The various tests that Professor Krumbein conducted clearly indicate that cleaning operations, sometimes rough, were performed several times especially in the area of the ossuary inscription.

Based on a comparison of the JO to other ossuaries, it seems that the cave where the ossuary was situated collapsed centuries ago, or alluvium deposits penetrated into the cell of the cave with water and buried the ossuary, fully or partially. Remains of roots and climbing ferns, as well as “biopitting,” confirm that the ossuary was placed for a long period of time in contact with soil or with alluvium, and exposed to atmospheric conditions other than those typical of a cave, for over a period of at least 200 years. Krumbein noted, “... and believe me it is a very hard work for the microorganisms, sized less than several millimeters to create such holes [biopitting] that can be observed by the eye, it takes a very long time.” Various tests conducted clearly indicate that cleaning was performed in a very rough manner. Based on the findings above, the isotope of the patina tests is not relevant to the question of the authenticity of the inscription. Professor Krumbein identified at least three places in the inscription of the ossuary (the first part and second part of it) where there remains a natural patina within the grooves of the inscription. Krumbein identified microfossils in the patina of the ossuary that are far from the inscription. The

ossuary was identified as an antiquity [and genuine] by the IAA. The IAA researchers identified microfossils in the patina inside the ossuary inscription and mistakenly thought it was a forgery indication. The presence of microfossil in patina, especially in items of stone from Jerusalem, was published in scientific journals over a hundred years ago. The presence of microfossil in the patina of the inscription area and on the entire ossuary, actually reinforces the probability of the authenticity of the inscription. In his testimony Krumbein said: “I say that the... the microfossil is not... evidence of forgery” (pp. 4886–89). It seems that the material sampled by researchers of the IAA is not the natural matter of the ossuary. This material [that the IAA sampled] may be a product of chemical reactions on natural patina from the use of detergent or as a result of reaction of the rock material with water at temperatures significantly above 24 degrees [in the cleaning process].

Professor Krumbein later in his opinion expressed criticism on the handling of the ossuary by the IAA, as well as the material committee’s erroneous assumptions, inadequate methods, damaged comparative techniques, conclusions presented as clear-cut even though they rely on assumptions that are not supported by controlled data, conclusions that are based on unverified climatic data, [conclusions] based on false chemistry, and for ignoring the possible effects of the cleaning, conservation, and enhancement [of the inscription]. [In their conclusions, the IAA material committee] showed poor interpretation or misleading information regarding discovery of microfossils in the patina, lacking foundation, and ignoring relevant information.

Judge Farkash's Remarks (139)

“I understand that Professor Krumbein is a professional man, and a world-renowned scientist with abundant experience. Therefore, there is no reason to suspect his report found patina that does not exist, or that he could not properly compare the photographs of the letters he observed under the microscope. Also, during his cross-examination, Professor Krumbein emphasized that he does not see evidence of human manipulation of the items examined, even if the tools used are not 100% reliable (p. 5007). We should mention that even Professor Goren was eventually forced to admit that he found varnish in some of the letters, in exactly the same locations Professor Krumbein indicated (such as the middle stake of the letter “Shin” and the bottom stake of the letter “Ain”).

Thus, this has to be enough to strengthen the findings of Professor Krumbein for the occurrence of the patina in some of the letters in the second part of the inscription. I will note also that Professor Krumbein admitted, due to his fairness, that he was wrong for not sampling the letters of the first part of the inscription, even though he knew the forgery charges were only on the second part of the inscription. However, he ruled out that Golan is the one who told him where to sample. This acknowledgment of his mistake [Professor Krumbein's] also strengthens his professional credibility in my eyes."

The Minimum Time for the Development of Patina, and the Option to Accelerate the Patina Growth

Professor Krumbein noted that under the examinations and comparisons he performed, he can safely say that it took at least fifty to 100 years to develop a patina of the particular composition whose remains were identified in the ossuary inscription, but this does not mean that the development [of the patina] did not occur over a much longer period of hundreds of years. In his opinion, if we consider also the existence of additional findings, such as the presence of biopitting, microfossils, microorganisms, and oxalate acids in the patina, it is clear that the ossuary patina developed over centuries, if not thousands of years. The patina sampled far from the inscription has the same composition as the samples taken from the inscription and is identical to the patina flowing from the surface into the inscription. There are no signs of adhesive use in the patina. The conclusion, in his opinion, was that the patina in the inscription and the patina on the ossuary were created in the same period of time.

Judge Farkash's Remarks (143)

According to Professor Krumbein, who is a world-renowned expert in the field of biopatina, and one of its founders, a period of many years is required for this patina growth; and in any case, his examinations brought him to the conclusion that **the patina on the ossuary evolved over centuries, if not thousands of years, and that the patina within the inscription and the patina on the ossuary were created during the same time period. The conclusion of Professor Krumbein in this matter is not hidden and I accept it.** It should determine that the existence of varnish in the

letter “Ain” in the second part of the inscription of the ossuary is a plausible option, and it has to establish reasonable doubt.

In summary of his findings, Professor Krumbein noted that he “reinforces the probability that the inscription itself is ancient and most of the original patina vigorously cleaned (using a sharp instrument and cleaning materials) and that the inscription was treated over the years more than once.” In his cross-examination, Professor Krumbein was asked if he can prove that the sharp object was used for cleaning the inscription and not for making the forgery, and he answered: “But I think the evidence is quite clear from the photographs of the inscription.”

The accuser’s attorney maintained that the claim in this issue [the cleaning] by Professor Krumbein was not proven by him. I do not share this assumption. Professor Krumbein testified that he found evidence of cleaning operations using primarily a sharp object in the inscription area, and pointed to the findings in photographs. It must be noted that other experts, including the prosecution experts, found evidence of cleaning operations by a sharp object. Recall that the final conclusion of Professor Goren in his opinion was that: “The inscription was engraved (or at least was cleaned in its entire length) in modern times.”

As mentioned, Professor Krumbein criticized the IAA committee in a number of ways, including various presentations by the IAA that completely ignored that cleaning and handling operations had been carried out on the inscription. These operations were diagnosed by microscopic examination carried out in Israel and Canada and included as part of the conclusion of Professor Goren. Thus, Professor Goren agrees that the inscription was likely be cleaned using a sharp instrument. Golan’s attorney sought to draw this conclusion himself, which is enough to place a reasonable doubt on the guilt attributed to Golan: because this cleaning of the ossuary, and particularly the cleaning of the inscription, are significant in another regard—the isotope tests of the material committee. I’ll decide on this argument later on.

Dr. Amnon Rosenfeld and Dr. Shimon Ilani

Dr. Amnon Rosenfeld has a PhD in geology and was a Geological Survey employee [now retired]. As he said of himself, he has forty years’ experience in the study of microfossils, is an expert in determining the age of the rock strata, and has expertise in archaeometry, a science that links the natural sciences of chemistry and geology with archaeology. Dr. Shimon Ilani also has a PhD in geology and is currently a Geological Survey employee.

His main research field is economic geology, and in his research he deals with petrography, geochemistry and the mineralogy of rocks, and he is also an expert in archaeometry. Together they were asked by Dr. Amos Bein, the Director of the Geological Survey of Israel, to examine several items, including the ossuary. They were brought to testify as experts for the defense. The conclusions of Dr. Ilani and Dr. Rosenfeld were that not only they did not find evidence of forgery in the artifacts examined, including the ossuary, but also found positive points that support the fact that the artifacts are authentic. Dr. Rosenfeld said at the beginning of his testimony that "we did not determine that the artifacts are 100% genuine, but most probably they are authentic.... In any case we... have published these studies on the three ancient artifacts, fearlessly, honestly, and truthfully, with faith in our tools that we've examined and published them."

"We found no signs of forgery and, believe us, we were examining the artifacts for more than three months, nearly a year in the case of the Jehoash inscription, and more than a year on the stone oil lamp, and we were looking for [evidences of] forgery, but found only positive points to support authenticity." "We worked without being biased toward one side or another; we aspired to seek scientific truth by using our tools, and according to our experience, regardless of the outcome."

These are the points recorded by Dr. Ilani and Dr. Rosenfeld in their testimony, supporting the authenticity of the ossuary inscription:

The natural patina (varnish) covers engraved letters of the ossuary at both the beginning (the letters: "Kof," "Bet," and "Bet") and at the end (the letters: "Het," "Yod," "Shin," and "Ain") of the inscription. A sample obtained from within the patina covering a groove (= letter) indicates that the patina has worn and includes elemental [minerals] particles from the rock, along with microfossils characteristic of the environment in which the ossuary was discovered. There were no suspicious indications of modern tools; illumination by ultraviolet showed no signs of new engraving or glue.

The inscription was vigorously cleaned by sharp mechanical tools, possibly combined with detergent and/or acid, but it is apparent that cleaning operations did not remove all the natural patina. The presence of microfossils in the patina covering the letters is known also from other ossuaries and by ancient objects occurring in the soils around Jerusalem and Judea.

Within the inscription and around it, there are scratches covered with patina. The forms are typical of scratches known in antiquities; they gouge both the ossuary and the engraved letters in the same directions.

The intense weathering of the rock precludes the possibility of new engraving, since this would have likely smashed the rock or cracked it; cleansers can contain carbonate with very negative oxygen isotopes.

It was also recorded in their opinion that they did not observe the gray and grainy material documented by Professor Goren that he called “James Bond.” The accuser’s attorney, in his summary, pointed out a number of problems in their opinion report and in their testimonies, including contradictions between the two of them, even though they carried out the examinations together. I [the Judge] will emphasize that Dr. Ayalon, the prosecution expert, praised the work of these two men and their good examinations so much that he even relied on their results (p. 819).

Judge Farkash’s Remark

However, due to the conclusion I already reached—that even if we completely ignore Dr. Ilani and Dr. Rosenfeld’s conclusions, there is a reasonable doubt as to the forging of the ossuary inscription—I do not see the need to decide, at this stage, about the claims of the accuser; these will be discussed below, as they may be important for the relevant issues.

Silicone Casting Results

Judge Farkash’s Remarks (153)

In addition, Golan argues in his defense that the silicone casting made by the Forensics Department [of the Israeli Police] drew out with it the material that was inside the letters of the inscription. So, [Golan’s claim] is that today you cannot examine the ossuary in its former condition before the forensic examination. According to this argument, the defense of Golan suffered substantial damage, and this reason alone is enough to acquit him.

Judge Farkash’s Remarks (154)

The role of the investigators is not to find evidence to convict the suspect, but to find evidence to expose the truth. Failure in this regard could lead to acquittal, but only if the investigation’s inadequacy is so severe that there is a fear that the defense of the accuser has been compromised because we find it difficult to deal properly with the... against him, or to prove his version...; according to this criterion the court should decide the tipping

point for such failure.... In our case, there is no dispute that the casting of the silicone by the forensics people changed the physical condition of the inscription of the ossuary.

But Superintendent Yoni Pagis testified that he never ordered the forensic investigators to make a casting of the silicone, but only permitted them to examine the ossuary. The idea to make a mold of the inscription was done at their own initiative.

Orna Cohen, a member of the committee who testified for the defense, expressed also her opinion that the silicone casting “polluted” the ossuary: “I saw a picture of what happened to the ossuary. What trauma it had. In fact, when using the casting silicone for taking a mold, you have to put some substance that separates the object from the silicone, because the silicone sticks to everything and pulls it out. Even if there was a patina, I guess that the patina was drawn out... I think [the inscription] is dirty and it will be hard to say something on the ossuary itself” (p. 4717, lines 6–12).

Professor Krumbein testified that during his examinations he encountered a problem: “There is another problem I want to document. My research was not so easy because of the remains of treatments. It is possible that the very soft rock and the copy [of the inscription] made by the police led to removal of the patina along with parts of the rock beneath it” (p. 4899).

Judge Farkash’s Remarks (156)

Therefore, there is a possibility of a high degree of confidence that the casting of the silicone removed other materials that were in the inscription of the ossuary. This damage prevented Golan from examining the ossuary itself, with the help of experts, in order to counter the opinion of the prosecution. So, it was impossible to check the “patina letters” that Professor Goren reportedly found in the inscription. It could be that the biopatina was pulled out along with the casting, but currently it is not possible to examine and to sample these findings. Moreover, of the experts who examined the ossuary before the casting of the silicone, Professor Goren is the only one who did not find real patina in the inscription, unlike other experts who reported finding real patina at the ossuary inscription. And we are talking about experts whose reliability and professionalism are not in question, and not suspected to have falsely reported or not “understand” what they saw (see for example the testimonies of Orna Cohen, Rahimi, Dr. Ilani, and Dr. Rosenfeld above).

Judge Farkash noted that “We are dealing with a criminal case, so the question cannot remain ‘hypothetical’ in the words of Professor Goren. We have to determine the accuracy of the evidence. In this situation, in light of the principles of the law case cited above regarding the failings of the investigation, and considering the entirety of the evidences for this charge [count no. 1], **I believe that the casting of the silicone affected Golan’s defense, so that he was deprived in such a way that it strengthens the reasonable doubt regarding his charge of guilt.**”

Images of the Ossuary (N/201), Evidence of Ms. Schlossberg and the Opinion of Mr. Gerald Richards (231–48)

In his answer to the indictment, Golan claimed that he bought the ossuary as is in the 1970s from an Arab dealer in East Jerusalem, and it stayed with him when he lived with his parents. According to him, he tracked down and found two photos [black-and-white] of the ossuary that were taken in the seventies. The ossuary can be seen in Image F/201, with two shelves, and with a school library book belonging to the Technion [in Haifa, where Golan studied engineering], a 1974 phonebook, an Elton John record, and an image of his girlfriend at the time, Ms. Schlossberg. To support his statement regarding the date of the picture, Mr. Gerald Richards, a private consultant in forensic science and an analyst of photographs and documents, testified. He holds a BA degree in photography and an MA in education, and he teaches courses in universities. Since 1970 he has worked in the FBI, first as an agent, then as a researcher; he has been a supervisor in the document and photograph labs, the head of operations and research (documents), and the head of the photography special unit. In his opinion, “although you cannot determine definitively whether the pictures were produced in the 1970s, there is no sign indicating or implying that they were not made in March of 1976, as indicated by the stamp that appears on the back of the picture. In addition, there is also normal wear and tear of the pictures as a result of time and handling... All the specified characteristics and features indicate that the photos were not produced recently, but were made in the mid-to-late 1970s.”

Judge Farkash’s Remarks

I was impressed by Mr. Richards, his professional expertise, knowledge, and experience in testing documents and images. His testimony was credible, coherent, and clear. I have carefully considered all the allegations relating to the snapshots N/201, but I think there is not enough support to prove that the pictures were staged or forged by Golan, however sophisticated he is. **I accepted Mr. Richards’s testimony and I adopt it.** Recall that the prosecutor did not put on the stand an expert in photography to testify, and in fact the prosecution admitted that it lacks definitive proof that the pictures were staged and filmed recently. I can only determine that it was not proven that the images were made recently, and there is no reason to assume that they were not taken in the 1970s. Therefore, and together with the above, **they also support the existence of a reasonable doubt regarding Golan’s guilt of this charge.**

Isotope Tests

Drs. Avner Ayalon and Miriam (Mira) Bar-Matthews (157–74), Summary and Conclusions by Judge A. Farkash

As we shall see, the isotope test was a central, but not the single, examination that the accusers relied on in bringing both this indictment [count number 1] and many other charges. It turned out that many of the discussions and disputes dealt with this isotope examination. This test is known and familiar in different scientific fields, but it was the first time that it has been used in an archaeological venue. So, we should investigate herein the validity of this examination as a scientific method to discover archaeological fakes. In summary, we should state that the isotope test samples the isotopes of the calcitic patina and mostly examines the isotopic composition (in other words the ratio of the different isotopes) of oxygen in calcite, as well as the carbon isotope composition of the calcite. Isotopes are different atoms of the same chemical element with similar chemical properties but different masses. Moreover, it should be noted that there are stable isotopes in nature that do not decay, and radioactive isotopes that are not stable and decay spontaneously [e.g., uranium]. The test method discussed in this case concerns the examination of stable isotopes only. As stated, this case has focused on examining the stable isotopes of oxygen and also of carbon.

Drs. Avner Ayalon and Mira Bar-Matthews both hold PhD degrees in geology, working at the Geological Survey of Israel as researchers. Their specialty is isotope geochemistry and the study of chemical processes and phenomena in nature. They engage primarily in reconstructing climate changes. Dr. Ayalon said that he had no background knowledge or interest in archaeology. He said he first heard about all the exhibits discussed in the media, and he did not know about this issue until he was asked to serve as a member on the committee (pp. 817–20).

The Judge noted that in support of the work of the prosecution experts [Ayalon and Bar-Matthews] the accuser invited two isotope researches to testify: Professor Yehoshua Kolodny [Hebrew University, Jerusalem; Israel Prize winner in Earth-Sciences], founder of isotope research in Israel, teacher and guide of Dr. Ayalon and the defense expert [Professor Aldo Shemesh]. He also invited Professor Alan Matthews [the husband of Mira Bar-Matthews] from the Hebrew University in Jerusalem.

Dr. Ayalon, a member of the IAA material committee, submitted his final report to the IAA. Dr. Ayalon explained the main points of his examination and results. His research focused on “isotope examination” that examined the isotopic composition of oxygen in the patina on the items subject of the charges. In essence, his conclusion was that the oxygen isotope composition of the letters’ patina could not have been formed naturally under the conditions of the temperature and the water composition typical of the mountains of Judea during the last two thousand years. Thus, he concluded that the composition of the patina found [in the inscription] can be only explained by artificial producing in different ways.

Previous studies carried out by Dr. Ayalon and Dr. Bar-Matthews on climate reconstruction of the stalactite cave [Soreq cave, 30 km west of Jerusalem] concluded that during the last 3,500 years there have been no drastic climate changes, both in terms of temperature and water composition. Based on these studies they were able to calculate the “expected range” of the isotope values of the calcite deposition in the Judean Mountains (pp. 826–7). Their calculation showed that the oxygen isotopic composition of calcite deposited in the patina in the Judean Mountain region for the last 3,500 years is in range of -4‰ [PDB] to -6‰ [PDB], which is the “expected range.” The isotopic testing of the patina of the artifacts that are the subject of this indictment [fake artifacts according to the prosecution] would determine whether the patina on the items was developed in the natural environmental conditions of the Judean Mountains. The experts’ working assumption was that the isotopic composition beyond the “expected range” indicates an artificial patina.

The primary defense claims about the isotope test sought to cast doubt on the “expected range” according to the prosecution experts. This doubt was grounded in the fact that the research was carried out only in caves, the results of which cannot determine the climate that prevailed outside the caves and in the locations where these archaeological artifacts were buried. In addition, the parties disagreed on the degree of “flexibility” of the expected range—that is, the degree of deviation from the expected range that can be explained by natural processes—and which results indicate [fakes].

Is It Possible to Recognize the Isotopic Examination as Acceptable “Scientific” Evidences?—The Legal Framework

Judge Farkash’s Remarks (175–81)

The isotopic test is not an example of direct evidence presented to prove the guilt of the defendants, but is only circumstantial evidence. It is “scientific” evidence that is important, such as experts’ testimonies (e.g., fingerprints, etc.) **The prosecution wanted to accept this isotope test as it was performed for the DNA experts’ testimonies.** Prosecutors seek to adopt the isotope test on patinas as an acceptable and reliable method for identification of archaeological forgeries, though everyone agrees that this method was being applied in the antiquities field for the first time.

There is no dispute that the credibility of any scientific testing in itself constitutes a prerequisite for admissibility of the results... As shown to the court a new test method “... has not been tested in the courts—the court should set a principled position concerning the ability to rely on its results, and having done so the way is paved for its admissibility based on the evaluation of the credibility of the specific expert testimony in court.”

Case law states that for recognition of a new examination as acceptable evidence, it must pass “fire-tests,” as figuratively named by the Honorable Judge Misha Cheshin.... A “Scientific Evidence” “must pass” the fire-tests “until the court recognizes it as an acceptable “scientific” evidence.... The court should be convinced that the scientific theory... are accepted in the scientific world; expert witness will testify that the procedures of the tests are acceptable in the scientific profession central in this issue; an expert witness will testify that he/she carried out the examination and that it was performed correctly.

The argumentation of Dr. Bar-Matthews is that artificial patina can be produced in different isotopic [oxygen isotopes] compositions, light or

heavy, depending on the temperature and composition of the water that permeates the patina as it is being deposited. In other words, the presence of patina with isotopic composition within the expected range cannot indicate that the accumulation of the patina on the item happened during the last 2,000 years. An authentic patina, as well as a fake patina, can be within the expected range. On the other hand, negative results outside the expected range cannot be explained in some natural way, but should indicate some human manipulation.

The attorney for Golan wished to learn whether the isotopic examination was not a clear-cut one and nothing could be deduced from it. Because the results within the expected range are not necessarily indicative of authenticity and they possibly can be fraudulent, and the results outside the expected range are not necessarily indicative of forgery,... the results were that the first part of the inscription is out of the expected range, despite... the starting point of the prosecution being that it is authentic. I cannot agree with this claim as it was formulated. The fact that the results within the expected range can suggest both authenticity and forgery, does not provide an answer about the results outside the expected range, for which the claim is that it could not be formed under natural conditions. In other words, they are the result of some human intervention.

There is more. As rightly noted by the attorney for the Golan, if we accept the isotopic examination as a reliable test and appropriate to detect forgeries, like a DNA sample or fingerprints, we should set rules and standards for its acceptance. In this case, only ten samples were taken from the ossuary and two of them did not have enough material for testing. Is it enough to get a reliable test from only eight samples to establish a criminal conviction? The question is asked more forcefully when, from the second part of the inscription—which the accuser claimed was forged—only four samples were taken. Half of them gave results within the expected range and half outside the expected range. The conclusion of the researchers is that samples within the expected range cannot necessarily signify an authentic patina.

However, the possibility that the patina is authentic exists, and provides one of two options (an authentic or sophisticated fake, having patina with isotopic composition within the expected range). That is to say that there is a reasonable option of 50% probability of the existence of calcitic patina in each of the two authentic letters (“Het” and “Ain”) out of four samples in total.

In relation to the ostraca 1 and 2, [count number 3], the results obtained in the letters “Shin” and “Vav” (–10.2‰ PDB and –7.74‰ PDB,

respectively) fall within the broader values that the defense expert Professor Aldo Shemesh found. Professor Shemesh is also an expert in isotopic geochemistry [Weitzmann Institute, Rehovot]. As I rejected the criticisms by the prosecution about Professor Shemesh's report and testimony, and determined that no flaw of any quality was found in his sampling, his findings have raised a real doubt in relation to the limits of the "expected range" as determined by the prosecution experts (see details below in count no. 3). I am aware that Professor Shemesh has not examined the ossuary and that he did not address the issue of stone samples (pp. 8636–37), because he has been called to testify on behalf of the defendant Deutsch, who is accused of [the ostraca charge]. Despite this, I do not believe there are enough [reasons] to dismiss Professor Shemesh's results and conclusions. See later [in count no. 3 below] my conclusion about Professor Shemesh's quality of sampling.

However, one sample from the side of the ossuary yielded the results of -6.68 per mil. There is no dispute that the ossuary itself is an authentic item, but the result is surprising, to say the least. Dr. Bar-Matthews then replied that "there is no such thing as a sharp and clear boundary, covered by our results which are around -4 to -6 , -6.5 . Minus 7, we have never received such a result for a secondary calcite, in all the Judean Mountains for the last 3,000" (p. 2565); "the figure of -6.68 is slightly exceptional, if it was in the Judean Mountains; if it was buried in the Judean Mountains, it is a little unusual" (p. 2567), and "the value of -6.68 is more negative than all the findings we have found to date."

Also, Professor Kolodny was asked: What is the lower limit of the "expected range?" He replied: "At some point it starts, and at some point it is no longer there... I do not know. I cannot draw the boundary." But later he added that there is a range "and things have to fall within this range." In other words, although he cannot define the boundary line, there is still a definite borderline. So, we find another surprise regarding the issue of the lower boundary of the ["expected range"], which was not explained satisfactorily.

My conclusion is that the claim of Professor Harrell regarding the possible effect of detergents on the isotopic composition of the letters patina is that the evidence has not been proven in a way that could be accepted as a reasonable doubt. Indeed, the argument about the cleaning of the inscription with a sharp object establishes, in my opinion, an additional reasonable doubt regarding the forgery of the ossuary inscription. Recall that Professor Goren testified that he chose the alternative formulation of cleaning the inscription "due to caution," because he thought it was possible that the inscription was cleaned using a sharp and hard tool, such as

a nail (p. 1082). As indicated above, this observation [of cleaning with a sharp tool] is also supported by other experts (e.g., Professor Krumbein, Mr. Neguer, and others), and as we shall see in the factual aspect, we cannot reject the possibility that this was done by Golan himself or on his behalf, and therefore it is not a purely theoretical option.

Material Aspect—Isotopic Tests—Professor Aldo Shemesh Summary and Conclusions by the Judge A. Farkash (637–702) (Count No. 3—Ostraca 1, 2, and 3)

The defense filed a counter, a report (Shemesh, 2007) on the isotopic subject by Professor Shemesh, Department of Environmental Sciences at the Weizmann Institute of Science. Professor Shemesh has a BA in geology and chemistry, a Master's degree on samples from the sea dealing with isotopes of the carbonate system, and a PhD from the Department of Geology at the Hebrew University. His doctoral thesis dealt with stable isotopes, oxygen isotopes, and rock phosphate. He studied as a postdoc at Columbia University in New York. Professor Shemesh's research deals with natural isotopes in geological systems; he was a student of Professor Kolodny. Professor Shemesh has also published numerous articles and served as a lecturer in various fields.

We note that there is no dispute about the professionalism and expertise of Professor Shemesh in the relevant field. The prosecution's experts—Dr. Ayalon, Dr. Bar-Matthews, and Professor Kolodny—praised Professor Shemesh and mentioned that he is the country's leading specialist in the field of isotope geochemistry (p. 4228). Needless to say, I [Judge Farkash] was impressed by his expertise and his extensive knowledge. The prosecutors seek to cast doubt on the degree of Professor Shemesh's objectivity. My impression is, as noted, that Professor Shemesh is loyal to his scientific duty and his objectivity is impartial as he declared at the beginning of his testimony.

In the chapter "scientific argument," Professor Shemesh elaborated on an introduction of scientific infrastructure about which we are dealing—the oxygen isotopes and their relationship to temperature and water composition. At the end of the chapter Professor Shemesh introduced the prosecution experts' claim that the isotopic composition of creating patina that is incompatible with low temperature (temperature of the soil surface or in shallow burial) and with the kind of water that is common in the country will be interpreted as a forgery or passed the reaction by being

[cooked] in a modern oven. It was noted that **we have no direct evidence of the isotopic composition of the water in ancient times**, since water from these periods was not saved to measure directly. In two papers, both by Bar-Matthews (co-authored by Dr. Ayalon and Rinsberger) he showed that the isotopic composition of water depends on the intensity of rain and the path by which it came to Israel. Both are clearly unknown parameters, not only from ancient periods in general, but also from particular sites.

A total of fifty-six well-documented archaeological items [from official excavations] were sampled [by Professor Shemesh], with a wide distribution from the north to south of the country [Israel]. This was done by a gentle scraping of the surface of the patina using a scalpel, sampling about 2–10 milligrams of material. The powder that was scraped off the pottery—the “patina”—was weight in the Weitzmann Institute. In cases where the powder was not enough, there were two “running” [examinations] of the same sample to determine the repeatability of the measurement. The measurement was done by a mass spectrometer analysis of stable isotopes. The calibration of the system was done by international standards and by the internal standards of the laboratory. All values are reported relative to PDB standard and the unit of the measurement is presented as per milligram.

The results of the samples analyzed by Professor Shemesh are presented in a table appended to his report. The conclusions from the data of the analysis were as follows:

- A. In samples which were examined by Dr. Ayalon and by Professor Shemesh, an excellent correlation between the results exists. Although the isotopic measurements were not executed on the same powder sample and every researcher sampled the artifact independently. We should assume that the patina samples on the artifacts lacked homogeneity to some degree.
- B. Most of the oxygen isotopic values of the patinas from the country are in the range of -2 -to -6.2 per milligram.
- C. Two of the three measured sites with a large number of samples (Tel Hazor, Tel Dan, and Tel Gat) yielded in their patinas measured values of oxygen isotopes that have a very wide distribution, completely contradicting the basic working assumption of Dr. Ayalon and Dr. Bar-Matthews. The measured variability range in Tel Hazor was of 8 per mill and in Tel Gat the measured variability range was of about 9 per mill. In Tel Dan, the distribution results of the oxygen isotopes] are smaller, about 1.5 per mill, although this distributed result analytically is very significant.

- D. The oxygen isotopic values of the patinas do not indicate a clear trend with regard to the geographical distribution in the country. Various sites in north and south, topographically high or low, sites more or less close to the shoreline, do not show any relationship to the values of the oxygen isotope.
- E. There was no relationship between the oxygen isotope values of the patina and the [archaeological] age of the sites.

Another problem, according to Professor Shemesh, is the lack of calibration of the patina. In professional scientific literature, there is no accepted worldwide calibration between the isotopic composition of a patina and the temperature of patina formation.

The prosecution's experts measured a total of ten samples. Professor Shemesh in his report has introduced the largest number of measurements of patinas from Israel [56], and it seems that even those are not enough. There is no patina calibration that links the isotopic composition to the ambient temperature.

Another aspect of the opinion of Professor Shemesh that calls into question the use of isotopes in a patina as a tool for determining the authenticity of archaeological artifacts is the fact that at one site the oxygen isotopic values of the patina are completely beyond the range of values of different temperatures and water composition. Thus, samples in Tel Hazor [delta oxygen -4 to -12 per mill] and Tel Gat [delta oxygen -3 to -12.5 per mill] that were measured showed a difference range of $8-9$ per mill, respectively. The conclusions of Professor Shemesh, as presented at the end of his report, are as follows:

- A. **The use of oxygen isotopic composition of a patina cannot determine authenticity and cannot yet be used as a geochemical tool. So, it cannot be used in court or in forensics without raising reasonable scientific doubt.**
- B. A lack of calibration/relationship between the forming temperature and the isotopic composition of the involved water and the isotopic composition of the deposited patina as exemplified by the data collected here, prevent the use of the paleotemperature equation that is common for carbonates [as was used by Dr. Ayalon and Dr. Bar-Matthews].
- C. To the best of Professor Shemesh's judgment, and based on his scientific experience and publications, the level of our understanding of the mechanism creating the patina and the processes that determine the isotopic composition is not yet developed enough to maintain that a new scientific tool allows identification of a fake patina. The data presented in this

report [of Professor Shemesh], as well as the data presented in the report of Dr. Ayalon, are still insufficient to create a new tool in geochemistry.

Professor Shemesh argued that, although he sampled a larger number of samples than the prosecution experts, in his opinion it was not enough.

“In my opinion, the amount of measurements in the report submitted by Dr. Ayalon were not enough to clarify the facts.... the first pillar in a geochemical research is first of all to collect the information, without any prejudice, without any intentional bias....” “I do not see a wide database, wide enough to determine such truths; certainly I did not see a database wide enough to come before the court.” “I emphasize that what I did is very far from being complete, far from being absolute, and far, for me, from running and waving conclusions” (p. 8574).

Disequilibrium

Another argument that was presented by Professor Shemesh as criticism of the isotopic test refers to the impossibility of proving, by an external criterion (not isotopic), that patina is deposited in isotopic equilibrium without the influence of kinetic processes effecting the system; that is, the patina as well as calcite were deposited under ideal conditions without “disturbances” by unrelated variable factors. Professor Shemesh’s opinion, in the absence of proof of equilibrium, is that it is impossible to use the isotopic composition equation as the prosecution experts did, since the equation assumes a deposition under equilibrium conditions (p. 8550 and later). For the claim about disequilibrium, Professor Shemesh relied, among others, on the article written by the prosecution experts (Dr. Bar-Matthews, Dr. Ayalon, and Professor Matthews, together with others) (Article—T/271) (p. 8694 and later).

Professor Shemesh also stressed... the one condition he insisted on before sampling the [patinas] for coming to an objective conclusion—“They taught me and educated me that in science you have to present everything... THE GOOD, THE BAD, AND THE UGLY.”

However, you cannot remove a sample from the database simply because the result is not “appropriate,” or was not expected, or is apparently an “abnormal” isotopic composition result; and if they did so [Dr. Ayalon and Bar-Matthews with the “Het” sample] then it will be a “scientific bias and a circular argument” (p. 8594; pp. 8627–28).

Professor Kolodny also praised Dr. Ayalon and Professor Shemesh, who were his students. He was proud of both of them and did not question their integrity (p. 4043).

Judge Farkash remarked that **“I accept** the position of Professor Shemesh that in the absence of an external objective criterion for disqualifying this sample or another sample, we cannot invalidate a sample based only on the outcome of its isotopic composition. **I am convinced that if we do so, it will be ‘scientific bias or circular argument.’”**

The Judge accepted the detailed examinations and results of Professor Shemesh, as well as his conclusion that it was impossible at this point to base any findings on the claim (that was not yet properly proven) of the [oxygen isotopes] “expected range” of patina on pottery. The patina results for the authentic pottery items found in the official excavations (from Tel Gat and Tel Hazor) gave many more negative results than the “expected range” determined by the prosecution experts. This conclusion was supported by the statements made by the prosecution witness Professor Kolodny, as follows: “These two distinguished men [Dr. Ayalon and Dr. Professor Shemesh—A. F.], **if they checked the same things, demonstrate a problem with... the method**” (p. 4090).

Judge Farkash's Remark

“I think, therefore, that it is sufficient to establish reasonable doubt about the validity of the isotope examination to check forgeries as a method, in terms of [patina on] ostraca [as well as on stones]. It is quite possible, as also affirmed by the defense expert Professor Shemesh, that in the future the isotope examination could be a viable method in detecting forgeries in antiquities—as the research progresses on this issue.”

Judge Farkash Summary of the Factual Aspect of the Ossuary (302–305)

The findings and conclusions set forth in the factual aspect of the trial can be the basis of conviction of Golan or can establish a reasonable doubt in this matter.

The Verdict

The accuser’s attorney rightly pointed out that the charge [count no. 1] in question is difficult to prove: “I know what I’m doing is exceptional and I’ve been saying that if the ossuary was standing alone in the trial we probably would not continue the process” (p. 11462, lines 11–15). Despite this, the prosecution believed that the evidence and Golan’s problematic behavior would establish his guilt.

After a thorough examination of the complex evidence and testimony presented before me, my conclusion is that Golan was able to raise reasonable doubt about this charge. Therefore, I decided on acquittal of Golan in this charge [count No. 1] because there is a reasonable doubt.

To avoid ambiguity I [the judge] would like to clarify that my conclusion is that the prosecution failed to prove beyond reasonable doubt the charge that the inscription of [the James] ossuary is a fake and that Golan or his representatives forged it. This is not to say that the inscription on the ossuary is real and authentic and was written two thousand years ago.

This topic is expected to continue to be investigated in the archaeological scientific arena and time will tell. Moreover, it was not proven that the words “brother of Yeshua” necessarily relates to “Jesus” as it appears in the New Testament.

Conclusions

The authors of this article present the two opposing scientific views regarding the JO, as well as the remarkable verdict of the Honorable Judge Farkash. We should bear in mind the unfortunate reality, according to the IAA (anti-theft department), that 90% of the artifacts in Israel, including the West Bank, were and are being looted (unprovenanced artifacts). Only 10% of the artifacts come from official and carefully documented excavations. Should all 90% of these archaeological treasures, and their history, be neglected? Or should they be investigated, debated, and eventually added to our heritage as national treasures after being acknowledged by scholars. An automatic rejection of unprovenanced artifacts as advised by many archaeologists is not a mature and responsible attitude.

We think that the integrity of the archaeology and the history of our forefathers is truly very important, and that the scientific and general communities should strive for a fruitful and positive discussion in a

free academic atmosphere regardless of the politics of the authorities. We should strive for a true scientific debate, so the most convincing scientific research will prevail (Barkay 2008). Judge Farkash encouraged this debate and determined that the artifacts are not at all fakes: “they could well be genuine.” The past belongs to all of us and not only to a small group of archaeologists.

The “Forgery Trial” sparked a fruitful and important debate on the issue of unprovenanced artifacts by top scientists from all over the world. The conclusions of the judge regarding the inscription of the James Ossuary contributed much to the forgery debate. By casting doubts on the accusations, the judge accepted some crucial facts: 1) the inscription was cleaned by a sharp object; 2) there is a real patina covering some letters in the words “Achui d’Yeshua”; 3) statistically the few samples analyzed by the prosecution experts are not sufficient for conviction; 4) the oxygen isotope “expected range” cannot determine forgeries; 5) oxygen isotopic examination of patinas on artifacts is as not yet perfected and cannot be used to determine whether the artifact is authentic; 6) the photos of the ossuary from the 1970s presented to the court are authentic; 7) the casting of the red silicone by the IAA forensic examiners changed the physical condition of the inscription of the ossuary, so much so that Golan’s defense was affected adversely; 8) the judge accepted Professor Krumbein’s statement that “the patina on the ossuary evolved over hundreds, if not thousands, of years, and... the patina within the inscription and the patina on the ossuary were created during the same time period”; 9) the IAA material committee’s conclusions were based on unverified climatic data and incorrect chemistry, and ignoring the possible effects of the cleaning, conservation, and enhancement of the inscription; 10) the judge accepted that disqualifying the “Het” sample or other samples, based only on the outcome of its isotopic composition, is a “scientific bias or a circular argument”; 11) the ability of the experts from the Royal Ontario Museum, Canada, to distinguish between genuine and pseudo-patina was valid, even though Professor Goren claimed otherwise; and 12) the IAA material committee came to incorrect and misleading conclusions regarding the discovery of microfossils in the patina. Judge Aharon Farkash’s verdict in the alleged forgery of the James Ossuary inscription clearly contributes more than ever to the strengthening of the contention that the inscription is genuine.

References

- Ayalon, A., M. Bar-Matthews, and Y. Goren. 2004. "Authenticity Examination of the Inscription on the Ossuary Attributed to James, Brother of Jesus." *Journal of Archaeological Science* 31:1185–89.
- Barkay, G. 2008. "Comments by Gabriel Barkay, full version." In *Jerusalem Forgery Conference, 16–18 January 2007*, ed. H. Shanks. Biblical Archaeology Society, 78–83.
- Ganor, E., J. Kronfeld, H. R. Feldman, A. Rosenthal, and S. Ilani. 2009. "Environmental Dust: A Tool to Study the Patina of Ancient Artifacts." *Journal of Arid Environments* 73 (12):1170–76.
- Goren, Y. 2005. "The Jerusalem Syndrome in Biblical Archaeology." Forum of Society of Biblical Literature, March 2005. <http://www.sblsite.org/publications/article.aspx?articleId=374>.
- Harrell, J. A. 2004 a. "Flawed Geochemistry Used to Condemn James Inscription." *Biblical Archaeology Review* 30:38–41.
- Harrell, J. A. 2004 b. "Discussion of 'Authenticity Examination of the Inscription on the Ossuary Attributed to James, Brother of Jesus' by A. Ayalon, M. Bar-Matthews and Y. Goren (*Journal of Archaeological Science*, 2004, 31, 1185–1189)." *Biblical Archaeology Review*. "Finds or Fakes." Biblical Archaeology Society website.
- Harrell, J. 2005. "Was Cleanser Used to Clean the James Ossuary Inscription?" *Biblical Archaeological Review* 31(1):54–56.
- Israel Antiquities Authority. 2003. Final Reports on the Yehoash Inscription and James Ossuary from the Israeli Antiquities Authority. http://www.bibleinterp.com/articles/Final_Reports.shtml.
- Ilani, S., A. Rosenfeld, and M. Dvorachek. 2002. "Archaeometry of a Stone Tablet with Hebrew Inscription Referring to Repair of the House." *Israel Geological Survey, Current Research* 13:109–16.
- Ilani, S., A. Rosenfeld, H. R. Feldman, W. E. Krumbein, and J. Kronfeld. 2008. "Archaeometric Analysis of the Jehoash Inscription Tablet." *Journal of Archaeological Science* 35:2966–72.
- Kalman, M. 2008. "Case Involving Jesus Brother Burial Box Hoax on the Verge of Collapse." *San Francisco Chronicle*, October 29.
- Kalman, M. 2009. "The Burial Box of Jesus' Brother: A Case against Fraud." *Time Magazine*, September 6.
- Keall, E. J. 2003. "New Tests Bolster Case for Authenticity." *Biblical Archaeology Review* 26 (4):52–55.
- Krumbein, W. E. 2005. "Preliminary Report: External Expert Opinion on Three Stone Items, n.p." *Biblical Archaeology Review*. "Finds or Fakes." Biblical Archaeology Society website.
- Orland, I. J., M. Bar-Matthews, N. T. Kita, A. Ayalon, A. Matthews, and J. W. Valley. 2009. "Climate Deterioration in the Eastern Mediterranean as Revealed by Ion Microprobe Analysis of a Speleothem that Grew from 2.2 to 0.9 ka in Soreq Cave, Israel." *Quaternary Research* 71:27–35.
- Rosenfeld, A., and S. Ilani. 2002. "SEM-EDS Analyses of Patina Samples from an Ossuary of 'Yaakov Son of Yossef Brother of Yeshua.'" *Biblical Archaeology Review* 28 (6):29.
- Rosenfeld, A., and H. R. Feldman. 2008. "Archaeometric Overview of the Jehoash Inscription and James Ossuary." In *Jerusalem Forgery Conference, 16–18 January, 2007*, ed. H. Shanks. Biblical Archaeology Society, 30–41.

- Rosenfeld, A., S. Ilani, H. R. Feldman, W. E. Krumbein, and J. Kronfeld. 2009. "Archaeometric Evidence for the Authenticity of the Jehoash Inscription Tablet, Updated and Expanded Version." *Antiguo Oriente* 7:57–73; original version, *The Bible and Interpretation*, 2008.
- Rosenfeld, A., S. Ilani, W. E. Krumbein, S. Daren, and H. R. Feldman. 2010 a. "A Stone Oil Lamp with Seven Nozzles from the Late Second Temple Period First Century CE." *Liber Annuus* 60:377–91.
- Rosenfeld, A., S. Ilani, W. E. Krumbein, S. Daren, and H. R. Feldman. 2010 b. "A Stone Oil Lamp with Seven Nozzles Carved with Jewish Symbols from the Late Second Temple Period." *The Bible and Interpretation*. <http://www.bibleinterp.com/articles/ros358005.shtml>.
- Rosenfeld, A., C. Pellegrino, H. R. Feldman, and W. E. Krumbein. 2011b. "The Connection of the James Ossuary to Talpiot (Jesus Family Tomb) Ossuaries." *The Bible and Interpretation*. <http://www.bibleinterp.com/articles/JOT.shtml>.
- Rosenfeld, A., H. R. Feldman, and W. E. Krumbein. 2012, in press. "On the Authenticity of the James Ossuary and Its Possible Link to the Jesus Family Tomb." In *Proceedings of the 3rd Princeton Symposium on Judaism and Christian Origins, "Jewish Views of the After Life and Burial Practices in Second Temple Judaism, Evaluating the Talpiot Tomb in Context,"* ed. J. H. Charlesworth. Jerusalem, 13–16 January 2008.
- Silberman, N. A., and Y. Goren. 2003. "Faking Biblical History." *Archaeology* (September/October): 20–29.
- Shemesh, A. 2007. "A Report on the Composition of Oxygen Isotopes of Patinas in Archaeological Artifacts as an Indicator for Authenticity" [unpublished report; in Hebrew; submitted to the Jerusalem District court]. *Environmental Sciences*. Weitzmann Institute for Science, Rehovot.