NO. XI / 2008

ISSN 1301-2746

# ADALYA

SUNA - İNAN KIRAÇ AKDENİZ MEDENİYETLERİ ARAŞTIRMA ENSTİTÜSÜ
SUNA & İNAN KIRAÇ RESEARCH INSTITUTE ON MEDITERRANEAN CIVILIZATIONS

# ADALYA

SUNA - İNAN KIRAÇ AKDENİZ MEDENİYETLERİ ARAŞTIRMA ENSTİTÜSÜ YILLIĞI
THE ANNUAL OF THE SUNA & İNAN KIRAÇ RESEARCH INSTITUTE ON MEDITERRANEAN CIVILIZATIONS

**ADALYA**
Vehbi Koç Vakfı
Suna - İnan KIRAÇ Akdeniz Medeniyetleri
Araştırma Enstitüsü Yıllık Dergisi
***Yönetim Yeri:*** Barbaros Mh. Kocatepe Sk. No. 25
Kaleiçi 07100 Antalya Tel: +90 242 243 42 74
Faks: +90 242 243 80 13 e-posta: akmed@akmed.org.tr
***Yayın Türü:*** Yerel Süreli Yayın ***Sayı:*** XI - 2008

***Sahibi:*** Vehbi Koç Vakfı Adına Erdal YILDIRIM
***Sorumlu Müdür:*** Kayhan DÖRTLÜK
***Yapım:*** Zero Prodüksiyon Ltd., İstanbul
Arslan Yatağı Sk. Sedef Palas No. 19/2
Cihangir 34433 İstanbul
Tel: +90 212 244 75 21 Faks: +90 212 244 32 09
***Baskı:*** Graphis Matbaa
Yüzyıl Mh. Matbaacılar Sit. 1. Cadde 139 Bağcılar - İstanbul



Adalya, **A&HCI** (*Arts & Humanities Citation Index*) ve
**CC/A&H** (*Current Contents / Art & Humanities*) tarafından taranmaktadır.

Adalya *is indexed in the **A&HCI** (Arts & Humanities Citation Index) and **CC/A&H** (Current Contents / Art & Humanities).*

Hakemli bir dergidir / *A peer reviewed Publication*



**Yazışma Adresi / *Mailing Address***
Barbaros Mah. Kocatepe Sk. No. 25
Kaleiçi 07100 ANTALYA-TURKEY
Tel: +90 242 243 42 74 • Fax: +90 242 243 80 13
akmed@akmed.org.tr
www.akmed.org.tr

ISSN 1301-2746

Vehbi Koç Vakfı

# İçindekiler


Gülsün Umurtak
*Some Observations on a Group of Buildings and their finds from the Early Neolithic II/2 Settlement at Bademağacı* ..... 1

Erkan Dündar
*Some Observations on a North-Syrian/Cilician Jug in the Antalya Museum* ..... 21

H. Kübra Ensert – Ahmet Görmüş – Demet Kara
*The Stele of Erzin* ..... 35

Murat Arslan
*Eurymedon Muharebesi'nden Sonra Aspendos ve Genel Olarak Pamphylia'nın Durumuna Bir Bakış* ..... 49

Nevzat Çevik - Süleyman Bulut
*The rediscovery of GAGAE / 'GAXE' in the south-east corner of Lycia. New finds from the total surface surveys* ..... 63

Thomas Corsten
*Die Grabinschrift des Priesters Albasis in Myra* ..... 99

Burak Takmer – Nihal Tüner Önen
*Batı Pamphylia'da Antik Yol Araştırmaları: Via Sebaste'nin Perge-Klimaks Arası Güzergahında Yeni Bir Yol Kalıntısı* ..... 109

Çilem Uygun – Eray Dökü
*Kibyra Yerel Kırmızı Astarlı Seramiklerinden Örnekler* ..... 133

Guntram Koch
*Kinder-Sarkophage der römischen Kaiserzeit in Kleinasien* ..... 165

Nevzat Çevik
*Northeast Lycia. The New Evidence – Results from the past ten years from the Bey Mountains Surface Surveys* ..... 189

Şevket Aktaş
*Tombs of the Exedra Type and Evidence from the Pataran Examples* ..... 235

Ergun Kaptan
*Kelenderis'te Alaşım Metalurjisine Ait Buluntular* ..... 263

Ayşe Aydın
*Adana, Anamur ve Silifke Müzesi'ndeki Figürlü Paye ve Levhalar* ..... 269

Özgü Çömezoğlu
*Myra's Place in Medieval Glass Production* ..... 287

Engin Akyürek
*Palamutdüzü: A Medieval Byzantine Village Settlement in the Bey Mountains* ..... 297

T. M. P. Duggan
*The paintwork and plaster on Evdir and Kırkgöz Hans by Antalya- and some implications drawn concerning the original appearance of 13th c. Seljuk State buildings* ..... 319

Altan Çetin
*Akdeniz Ticaretinde Memlûklar Devri Mısır - Anadolu Mal Mübadelesi* ..... 359

Sema Bilici
*Bazı Örnekleriyle Alanya Kalesi Kazılarında Bulunan İthal Kıbrıs Sırlı Seramikleri* ..... 373

ADALYA XI, 2008

# Myra's Place in Medieval Glass Production

Özgü ÇÖMEZOĞLU*

Excavations at the Church of St. Nicholas in the Demre Township of Antalya have continued under the direction of Prof. Dr. Yıldız Ötüken since 1989. Myra, the capital of Lycia from the 5th century, has housed a church and a tomb dedicated to St. Nicholas and thus became an important pilgrimage centre during the Middle Ages[1]. Glass items as well as architectural sculpture, metalwork and pottery constitute the largest part of the finds from the excavation.

Glass finds from these excavations have shown that glass was used at Demre for the purposes of lighting, storage, service and for jewellery from the Roman period through to the 13th century. These purposes are exemplified by glass lamps and window glass for lighting; bottles for daily use, pilgrim's bottles and jars for storage; bowls, beakers and pitchers for service; bracelets, beads and one ring, jewellery.

Three groups of glass finds from Demre indicate there was glass production at Demre during the Middle Ages, they are, foam glass, frits and wasters from the shaping process.

The first group, foam glass, includes chunks of glass attached to the earth with a very large amount of bubbles. Analysis carried out on the Demre glass finds have shown that this foam glass was formed during the melting of the raw materials (Figs. 1-2).

The raw materials used for glass production in the medieval Mediterranean were silicon dioxide ($SiO_2$) obtained from sand, calcium oxide (CaO) obtained from limestone or from the lime in seashells, and pure mineral sodium oxide ($Na_2O$)[2]. In addition, to colour the glass, other metal oxides were added to this mixture of raw materials. As the temperature gradually rises during the melting process, the batch materials react differently at different temperatures. When it reaches 1000°C, the melting process is accomplished. However, carbon dioxide ($CO_2$) and water vapour emitted in these reactions cause bubbles in the glass. Rising up, these bubbles also bring with them un-melted particles. This forms a layer on the surface, called "foam" or "bad glass", and it is removed from the surface by the glassworker using a tool. At Demre a large amount of such foam glass with an un-melted particle content has been found[3]. Analysis has shown that the content ratios comprising these

* Dr. Özgü Çömezoğlu, İstanbul Universitesi, Edebiyat Fakültesi, Sanat Tarihi Bölümü, Bizans Sanatı Anabilim Dalı, İstanbul.
E-mail: ozgu@istanbul.edu.tr

1 S. Y. Ötüken, "Myra Aziz Nikolaos Kilisesi Kazısı", Lykia 1, 1994, 115-117.

2 I. C. Freestone – Y. G. Gorin-Rosen, "The Great Glass Slab at Beth She'arim, Israel: An Early Islamic Glass Making Experiment?", Journal of Glass Studies 41, 1999, 111.

3 I would like to thank Asst. Prof. Dr. İlhan Hasdemir of Mimar Sinan University of Fine Arts, Department of Ceramics, for his help in identifying the batch materials.

chunks are very different from those of shaped glass: They have very little silicon dioxide and sodium oxide which is unusual for regular glass while they have very high amounts of aluminium oxide ($Al_2O$), calcium oxide (CaO), magnesium oxide (MgO) and iron oxide ($Fe_2O_3$). As inferred from the results of this analysis, the elements that take the longest time to melt adhered to the bubbles and so rose up to the surface. The foam glass found at Demre indicates the melting of batch materials; consequently, glass was produced from raw materials at Demre during the Middle Ages.

Another group of finds that attests to glass production are the frits, that are mainly amorphous and broken (Fig. 3). The frits are chunks broken off from a huge glass piece and they are so amorphous and thick that they cannot belong to a lamp, a vessel, a bracelet, or to window glass. Their thickness reaches *ca.* 1.5 cm. Frits are usually found at glassworks where the huge glass blocks produced in tank-like kilns are broken into smaller pieces in order to shape[4]. Glassworks that buy frits throw them into the melting pot, together with other batch materials in order to accelerate melting, which also results in lower fuel costs[5].

Although there is no known tank-like kiln at Demre, it is known that numerous tank-like kilns were employed for glass production in places around the medieval Mediterranean, like the examples found at Hadera (7th century), at Beth She'arim (9th century) and at Corinth (11th century)[6]. The frits found at Demre must have been brought to Demre through trade or were taken from a tank-like kiln here, whose location is presently unknown.

Another group of production waste provides evidence for glass working at Demre (Figs. 4-5). The colours of these waster pieces match the glass finds from Demre; however, they are so deformed that they cannot have been a part of vessels, bracelets, beads or window glass. These are pieces whose shaping could not be completed during the production. They were either not shaped well or had cooled off while shaping. Examples include a not-fully-shaped piece of window glass with a folded edge and a rim fragment (Fig. 4). In addition, some pieces must be those cut off in the course of shaping the mouth or other parts of vessels while they were still hot.

Although so much evidence was gathered indicating glass production, no tools related to glass kilns or to glass production have been found during the course of excavations at St. Nicholas Church at Demre. If itinerant masters worked at Demre, as was the case at Jalame, then they must have taken their tools with them[7]. An important example for this type of production is Anemurium. The kiln identified at Anemurium functioned from the 5th through the 7th century, to produce simple vessels and window glass. It is thought that itinerant masters came to the town to supply the local demand, built temporary kilns and then left after producing sufficient glass[8]. This is supported by the fact that glass produc-

4 Freestone – Gorin-Rosen, 108; G. R. Weinberg, Excavations at Jalame, Site of a Glass Factory in the Late Roman Palestine (1988) 25.

5 S. E. Stern, "Roman Glassblowing in a Cultural Context", AJA 103, 1999, 454.

6 Stern, 482; Freestone - Gorin-Rosen, 108-116; G. D. Weinberg, "A Medieval Mystery: Byzantine Glass Production", Journal of Glass Studies 22, 1975, 129.

7 Weinberg, 33-35.

8 E. M. Stern, "Ancient and Medieval Glass from the Necropolis Church at Anemurium", in IX. Congrés de l'Association pour l'Histoire du Verre (1985) 44.

tion waste was found in these excavations but no tools were found. At a workshop found at Beirut and thought to have been active in the 7th century, foam glass, frits and production wastes were found, as is the case at Demre, but the remains of a kiln were also identified[9].

Most of the production waste came from the infilling to raise the ground level in the western area and this infilling dates from about the middle of the 11th century. This filling must have been brought from elsewhere and it contained mixed finds dating from the Roman period to the 11th century. As the glass production waste was found within a filling, the location of the workshop in the city remains unknown. In order to shed light on this topic, we think that excavations need to be conducted inside the city.

It is worth noting that the wasters produced as a by-product during the shaping phase match the colours of the Byzantine period glass vessels. In addition, some of these wastes suggest that they were pieces left incomplete during the shaping of known forms. For example, a piece of window glass dated to the 9th-13th centuries was deformed when its edge was being shaped (Fig. 4). The large number of glass finds from Demre and the fact that they were produced in the same style and colours both suggest that glass was produced here during the Middle Ages. Low number of items of daily use in the kitchen, other than oil lamps and window glass, indicates that pottery was preferred to glass for daily use at Demre. It is also worth noting that the amount of undecorated items is quite high. Consequently glass production at Demre aimed at supplying local demand, as was the case at Sardis[10].

The chemical content of the glass finds from Demre is shown in Fig. 1; the first batch material is silicon dioxide ($SiO_2$) and the second is sodium oxide ($Na_2O$) which decreases its resistance to heat, lowering the melting point and increasing the viscosity. The presence of magnesium oxide (MgO) and potassium oxide ($K_2O$) indicate vegetal residue in the raw materials. They indicate either vegetal ash was added, in addition to soda, to the raw materials or vegetal materials were mixed in the raw materials together with other elements. The magnesium oxide (MgO) and potassium oxide ($K_2O$) levels recorded in the table vary from between 2 to 4 per cent and this does not necessarily show that Demre glass was a potash-glass but rather it is a soda-glass. Being close to the sea, soda could be obtained easily from the sea salt. Potassium oxide ($K_2O$), on the other hand, was obtained from woody plants or bushes and was therefore used more often in mountainous and forested areas.

Research around the Mediterranean, in Italy, Egypt and also at Raqqa[11], has shown the magnesium oxide (MgO) and potassium oxide ($K_2O$) levels were less than 1% until the 9th century as pure soda was used; and after the 9th century levels rose to 2-3% as vegetal ash was added to the mixture.

---

9 D. Foy, "Un atelier de verrier à Beyrouth au dèbut de la conquête islamique", Syria 77, 2000, 241-242.

10 A. von Saldern, Ancient and Byzantine Glass from Sardis (1980) 2, 36, 95-96.

11 Freestone – Gorin-Rosen, 109. For Italy see A. Silvestri – G. Molin – G. Salviluo, "Roman and Medieval Glass from the Italian Area: Bulk Characterisation and Relationships with Production Technologies", Archaeometry 47/4, 2005, 797-798. For Raqqa see J. Henderson, "The Production of Early Islamic Glass in al-Raqqa, Syria", Levant 31, 1999, 232-234; J. Henderson – S. D. McLoughlin – D. S. McPhail, "Radical Changes in Islamic Glass Technology: Evidence for Conservatism and Experimentation with New Glass Recipies from Early and Middle Islamic Raqqa, Syria", Archaeometry 46/3, 2004, 451.

Analysis of the glass finds from Demre show some examples from both the earlier periods and the 11th-13th centuries had very low levels (less than 1%) of magnesium oxide (MgO) and potassium oxide ($K_2O$) distinct from what is known from other Mediterranean sites. In addition, some examples from the earlier periods had very high levels of magnesium oxide (MgO) and potassium oxide ($K_2O$) - 2-4%. For example, a fragment from nodal bars dated to the 6th-7th centuries (Fig. 1 - nr. 6081) has higher levels as distinct from pre-9th-century examples from the Mediterranean sites mentioned above. Another example (Fig. 1 - nr. 8052) from a layer containing Roman and Early Byzantine finds also produced similar results. Further, the fragment with inventory nr. 9428, which came from the layer dating from the 11th-13th centuries, just above the filling, contains lower levels than the post-9th-century examples from Italy, Egypt and Syria. Four examples of frits (Fig. 1 - nrs. 8658, 9040, 9108 and 9131) were analysed and were seen to contain less than 1% magnesium oxide (MgO) and potassium oxide ($K_2O$). Nrs. 9040, 9108 and 9131 came from the filling dated to the 11th century and earlier whereas nr. 8658 came from the layer mentioned above, dated to the 11th-13th centuries.

Although these finds have differences in their raw materials, they all display common features of workmanship and colours. These finds are mainly dated from the level of the find, not according to the colours of the raw materials. Analysis indicates differences in the proportions of batch materials may have arisen from either imported glass or vegetal waste that could have contaminated the batch materials. However, it is inferred that there was no deliberate attempt to make any changes at any time.

The elements comprising less than 1% in the glass could be stray, although some are indeed pigments. For example, iron oxide ($Fe_2O_3$) is found naturally together with silicon dioxide ($SiO_2$) and gives a green colour to the glass. The green coloured item listed in Fig. 1 – nr. 7030 stands out with its high level of iron oxide ($Fe_2O_3$). The amount of iron provides colour variations ranging from blue-green to green, yellow-green and to yellow. On the other hand, yellow and yellow-green shades were obtained by mixing manganese oxide (MnO) and iron oxide ($Fe_2O_3$), exemplified by Fig. 1 - nrs. 6951, 7928 and 5245 with yellow-green, green-yellow and light blue. High manganese oxide (MnO) levels lead to a purple colour, as seen in nr. 9576. The variety of colouring depends on the use of iron oxide ($Fe_2O_3$) and manganese oxide (MnO), as well as the oxygen ($O_2$) level in the kiln[12]. Besides, manganese oxide (MnO) is also used as decolouriser[13]. Copper oxide (CuO) is the pigment employed to produce the blue, yellow-green and green examples[14].

The following facts strongly suggest that Demre was a suitable place for glass production: the River Myra flows through the city and into the sea nearby, thus silicon dioxide ($SiO_2$), the main material for glass production, is abundant; sand and limestone which contain the sea creatures with lime can be easily found to procure the lime for the glass; and the salt needed for sodium, which provides the transparency and fluidity, can also be easily obtained.

---

12 P. Mirti – P. David – M. Gulmini, "Glass Fragments from the Crypta Balbi in Rome: the Composition of Eight Century Fragments", Archaeometry 43/4, 2001, 495-501.

13 C. M. Jackson, "Making Colourless Glass in the Roman Period", Archaeometry 47/4, 2005, 764.

14 Mirti – David – Gulmini 2001, 499; A. Silvestri – G. Molin – G. Salviluo, "Roman and Medieval Glass from the Italian Area: Bulk Characterisation and Relationships with Production Technologies", Archaeometry 47/4, 2005, 811.

The glass finds from Demre stand out with their common features of workmanship through the Middle Ages. The same vessels forms, techniques and colours seem to have been preferred from the sixth through the thirteenth century. Colourless examples form the largest number, followed by shades of green, yellow and blue. The preferred production technique was free-blown and mould-blown glass was rarely employed. For decorative purposes, glass threads in blue or of the same colour as the vessel were used. Mould-blown glass and impression decoration techniques seen around the medieval Mediterranean are seldom found and painted decoration is found only on some bracelets.

The most common products were: window glass, lamps and pilgrim's bottles. The number of religious and lighting items is much higher than storage and service vessels as well as rings and bracelets; consequently, glass was deliberately chosen for certain items. In particular oil lamps were preferably made from glass after the earlier period, the large amount of window glass used, and the need for pilgrim's bottles all indicate the continuous demand for glass in medieval Demre. The established quantities of finds from certain groups, indicates continuity; in addition, the homogeneity observed in workmanship, forms and colours indicate the continuity of the same tradition. It was also observed that the masters working at Demre produced most of the glass forms and techniques found elsewhere around the Mediterranean and this may suggest a local workshop or itinerant masters who built temporary workshops or masters coming from other Mediterranean sites who may have worked here[15].

15 This research was supported by AKMED, ARIT and Istanbul University's Scientific Research Projects (Project no: T-644).

# Öz

## Ortaçağ Cam üretiminde Myra'nın yeri

Antalya'nın Demre İlçesi'ndeki Aziz Nikolaos Kilisesi kazılarında bulunan camlar arasında 3 grup burada Ortaçağ'da üretim yapıldığını gösterir. Bu buluntular cam köpükleri, fritler ve şekillendirme atıklarıdır.

İlk gruba giren ve yer yer toprağa yapışmış topak halindeki parçalar, çok miktarda yuvarlak kabarcıklar içermektedir. Demre cam buluntularının analizleri sonucunda, bu parçaların hammaddenin ergitilmesi sırasında ortaya çıkan cam köpükleri oldukları anlaşılmıştır (Res. 1-2). Analiz sonuçları, bu parçaların içerdiği elementlerin oranlarının, şekillendirilmiş camlarınkinden oldukça farklı olduklarını göstermektedir. Bu parçalarda Si2O ve Na20 oranının işlemleri tamamlanmış camlarda olamayacak kadar düşük olduğu, Al2O, CaO, MgO ve Fe2O3 miktarlarının ise fazla olduğu dikkati çeker. Analiz sonuçlardan da anlaşıldığı gibi, en uzun sürede ergiyen elementler, hava kabarcılarına yapışarak camın yüzeyine çıkmıştır. Demre'de bulunan köpükler, burada hammaddenin ergitildiğini göstermektedir. Bundan da, Demre'de Ortaçağ'da cam hammaddesinden üretim yapıldığı anlaşılmaktadır.

Cam ütetimini gösteren diğer bir buluntu grubu, şekilsiz ve birçok yönden kırık olan fritlerdir (Res. 3). Bu buluntular, büyük bir cam kütlesinden kırılmış parçalar şeklindedirler. Bir kap, kandil, bilezik ya da pencere camına ait olamayacak kadar biçimsiz ve kalındırlar. Kalınlıkları yaklaşık 1.5 cm'yi bulur. Fritler, tank tipi fırınlarda büyük bloklar halinde yapılan camların kırılarak kapların şekillendirildiği cam atölyelerine götürülen parçalarıdır. Fritleri satın alan cam atölyelerinde, bu kırıklar diğer hammaddelerle beraber potaya atılır ve böylece ergimeyi hızlandırırlar. Bu şekilde, yakıt tasarrufu da yapılmış olur. Demre'de bulunan fritler de ya ticaret yoluyla getirilmiş olan ya da burada henüz tespit edilmemiş bir yerde bulunan tank tipi fırından alınmış olmalıdırlar.

Diğer bir grup üretim atığı, Demre'de şekillendirme yapıldığının kanıtıdır (Res. 4-5). Bu parçaların renkleri, Demre'de bulunan cam eserlerin renkleri ile uyumludur. Ancak, formları bir kabın, bilezik, boncuk ya da pencere camının parçası olamayacak kadar bozuktur. Şekilsiz olan bu parçalar, üretim sırasında şekillendirilmesi tamamlanamamış olanlardır. Ya düzgün şekillendirilemeyen, ya da yeterince hızlı şekillendirilemediği için biçimlendirme sırasında soğuyan parçalar oldukları anlaşılır. Tam formu verilememiş katlı kenarlı bir pencere camı ve bir ağız parçası (Res. 4), bunun örnekleridir. Ayrıca, bazı parçalar, kaplar henüz sıcakken kabın ağız gibi kısımlarının biçimlendirmesi sırasında kesilerek atılan parçalar olmalıdırlar.

Cam üretimine dair bu kadar buluntunun yanısıra, Demre Aziz Nikolaos Kilisesi kazıları sırasında, fırın ya da cam üretiminde kullanılan aletler bulunmamıştır. Demre'de kazı

yapılan alanda cam atölyesi bulunmamasının en önemli sebebi, bu alanın kiliseye, hacıların toplanma alanına çok yakın olmasıdır.

Demre'de bulunan üretim atıklarının büyük çoğunluğu, az miktarda Erken Bizans ve nadiren Roma Dönemi, yoğunlukla ise, 11. yy.'a kadar Orta Bizans Dönemi cam buluntuları içeren dolgu toprak içinden çıkmışlardır. Çok az sayıdaki atık ise dolgu üzerinde 11-13. yy. buluntularının ele geçtiği tabakadan gelmişlerdir. Bu da, söz konusu camların, batı alanın dolgusunda kullanılan toprağın içinde, atölyenin atıklarının bulunduğu yerden getirildiğini gösterir. Fırının yeri henüz bilinmemektedir.

Şekillendirme sırasında ortaya çıkan atıkların, Bizans Dönemi'ne tarihlenen cam kaplar ile renk ve form açısından ortak özellikler taşıdıkları dikkat çeker. Demre buluntuları arasında, 9-13. yy.'lar arasına tarihlenen bir pencere camının kenar kısmının şekillendirilirken bozulmuş olması da yukarıda sayılan diğer özellikler gibi, Demre'de Ortaçağ'da cam üretiminin varlığını destekler. Demre'de bulunan cam eserlerin sayısal yoğunluğu ile aynı üslup ve renkler kullanılarak yapılmış olmaları, Demre'de Ortaçağ boyunca üretim yapıldığını gösteren diğer bir özelliktir. Kandiller ve pencere camları dışında mutfak kullanımına yönelik cam buluntuların sayıca çok yoğun olmamaları, Demre'de günlük hayatta camın değil, seramiğin yoğun olarak kullanıldığını gösterir. Bezemesiz örneklerin yoğunluğu da dikkat çekicidir. Bunların sonucu olarak Demre'de cam üretiminin ihtiyacı karşılamaya yönelik olduğu anlaşılmaktadır.

Akdeniz çevresinde, İtalya, Mısır ve Rakka'da yapılan çalışmalarda, 9. yy.'ın başlarına kadar, saf soda kullanımının etkisiyle MgO ve K2O oranının %1'in altında; 9. yy.'dan itibaren ise, karışıma bitki küllerinin de katılmasıyla %2-3 civarında görüldüğü saptanmıştır. Demre cam buluntularının analizleri sonucunda, Akdeniz yerleşimlerinin bazılarının aksine, MgO ve K2O oranının hem erken dönem camları arasında, hem de 11-13. yy.'lar arasına tarihlenen camlar arasındaki örneklerde düşük olabildiği (%1'in altında) gözlemlenebilmektedir. Buna ek olarak, bazı erken dönem camlarında bu oranın yüksek (%2-4) olduğu saptanmıştır. Sözü geçen tüm bu buluntuların hammaddelerindeki bu değişikliklerin yanısıra, işçilik ve renk açısından tümünün ortak özellikler taşıdıkları görülmektedir. Analizler sonucunda, hammaddede oranların değişiklikler göstermesinin ya dışarıdan işlenmek üzere getirilen camlardan; ya da hammaddeye bitki atıklarının karışmış olabileceğinden kaynaklandığı düşünülebilir. Ancak belli bir dönemde bilinçli olarak bir değişiklik yapılmadığı anlaşılmaktadır. Camın içinde bulunan %1'in altındaki elementler ise hammaddeye karışmış elementler olabileceği gibi, içlerinde renk vericiler de vardır.

Buluntuların arasındaki işçilik, form ve renk açısından homojen yapı, aynı gelenekle üretildiklerini anlatmaktadır. Demre'de çalışan ustaların, Akdeniz çevresindeki cam formlarının ve tekniklerinin çoğunu uyguladıkları görülür. Bu da, Demre'de yerleşik bir atölye olabileceği gibi, gezici ustaların geçici atölye kurmuş olabileceği veya diğer Akdeniz yerleşimlerinden gelen ustaların burada çalışmış olabileceğini düşündürür. Myra çayının içinden geçerek denize dökülmesi ve bu sebeple camın ana maddesi olan silisyumdioksiti (SiO2) ve camdaki kireç ihtiyacının karşılanabildiği kalkerli deniz canlılarını içinde barındıran kumun ve kireçtaşının rahatça bulunabilmesi, Demre'nin cam üretimi için oldukça uygun bir yer olduğunu düşündürür.

| INV.NO. | COLOUR | $SiO_2$ | $Na_2O$ | CaO | $Al_2O_3$ | MgO | $K_2O$ | $Fe_2O_3$ | $P_2O_5$ | MnO | $SO_3$ | Cl | $TiO_2$ | $Cr_2O_3$ | NiO | CuO | SrO | WO3 | PbO | ZnO | $Co_2O_3$ | BaO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4974 (foam) (Bb 0.33-0.23) | - | 44.3 | 0.639 | 23.2 | 7.96 | 11.1 | 1.61 | 8.94 | 0.930 | 0.132 | 0.0552 | - | 0.537 | 0.291 | 0.144 | 0.0263 | 0.0391 | 0.0414 | - | 0.013 | - | - |
| 8658 (frit) (Bb-32 f 142-135) | Colourless | 67.4198 | 14.9440 | 11.1055 | 3.4173 | 0.8392 | 0.6004 | 0.7077 | 0.1029 | 0.0695 | 0.0749 | 0.5484 | - | - | - | 0.0162 | 0.0614 | 0.0855 | - | - | - | - |
| 9040 (frit) (Bb-32 f 070-065) | 2.5G7/6 (light green) | 67.2822 | 14.8964 | 11.1585 | 3.4467 | 0.8096 | 0.5994 | 0.7235 | 0.1017 | 0.0763 | 0.0804 | 0.4506 | 0.0864 | - | - | 0.0185 | 0.0612 | 0.1815 | - | - | 0.027 | - |
| 9108 (frit) (Bb-32 f 060-055) | 2.5G7/6 (light green) | 68.0 | 14.7 | 11.1 | 3.35 | 0.802 | 0.587 | 0.657 | 0.0979 | 0.0671 | 0.0872 | 0.421 | 0.0769 | - | - | 0.0155 | 0.0634 | - | - | - | - | - |
| 9131 (frit) (Bb-32 f 050-045) | 2.5G7/6 (light green) | 67.577 | 14.6724 | 11.177 | 3.4081 | 0.8676 | 0.6272 | 0.6767 | 0.0993 | 0.0539 | 0.0949 | 0.4804 | 0.1239 | - | - | 0.014 | 0.0636 | 0.0641 | - | - | - | - |
| 5245 (K-6 interior 140-116) | 2.5BG7/4 (light green) | 66.9112 | 13.307 | 9.0894 | 2.1446 | 2.768 | 2.4885 | 0.84 | 0.3003 | 1.2407 | 0.1251 | 0.3672 | 0.1006 | - | - | 0.1037 | 0.0761 | 0.0709 | 0.0665 | - | - | - |
| 5817-18 Bd 4-5B (-030)- (-035) | 2.5GY7/6 (light yellow - green) | 66.1973 | 20.3191 | 6.4297 | 2.3116 | 0.6566 | 0.4904 | 0.7538 | 0.0524 | 1.6639 | 0.3663 | 0.5832 | 0.0902 | - | - | 0.0162 | 0.0624 | - | - | - | - | - |
| 6081 (Bb-18 065-050) | Colourless | 67.2910 | 13.9973 | 8.5908 | 1.7864 | 2.7473 | 2.8175 | 0.4906 | 0.2859 | 1.0477 | 0.1669 | 0.5304 | 0.1022 | - | - | 0.0203 | 0.0672 | 0.0586 | - | - | - | - |
| 6425 (Bb-12 105-095) | 2.5G8/8 (light green) | 66.3 | 13.5 | 9.65 | 2.20 | 2.75 | 2.59 | 0.718 | 0.324 | 1.21 | 0.105 | 0.351 | 0.102 | - | - | 0.0201 | 0.0657 | 0.0650 | 0.0237 | 0.001 | - | - |
| 6511 (Bd-3 030-020) | 2.5BG7/4 (light blue) | 70.2384 | 16.9835 | 7.3119 | 3.1677 | 0.5227 | 0.5562 | 0.44 | 0.0485 | - | 0.1546 | 0.4868 | - | - | - | - | 0.477 | 0.0346 | - | - | - | - |
| 6921 (Bb-32 130-125) | Colourless | 67.4475 | 12.2995 | 9.4241 | 1.9033 | 3.1606 | 2.5453 | 0.5587 | 0.2856 | 1.2531 | 0.147 | 0.499 | 0.075 | - | - | - | 0.0777 | 0.0764 | - | - | - | 0.25 |
| 6951 (Bb-22 130-125) | 2.5GY7/6 (light yellow - green) | 69.0 | 13.1 | 6.60 | 2.54 | 2.36 | 2.03 | 0.864 | 0.338 | 2.31 | 0.0922 | 0.466 | 0.140 | - | - | - | 0.0579 | 0.0827 | - | - | - | - |
| 7030 Bd 4-5 (-010)- (-020) | 2.5G6/8 (green) | 66.7 | 17.7 | 7.97 | 2.32 | 1.77 | 1.23 | 1.03 | 0.0920 | 0.0852 | 0.357 | 0.155 | 0.130 | 0.055 | 0.017 | 0.0198 | 0.196 | 0.0811 | 0.0344 | - | - | - |
| 7730 (Bb23-24 115-100) | Colourless | 66.6 | 13.8 | 9.17 | 1.68 | 3.57 | 2.56 | 0.481 | 0.267 | 0.832 | 0.183 | 0.432 | - | - | - | 0.0155 | 0.0782 | 0.116 | - | - | 0.024 | 0.17 |
| 7928 (Bb-25 150-140) | 7.5GY7/6 (light green - yellow) | 67.7 | 12.6 | 9.27 | 2.26 | 2.51 | 2.48 | 0.694 | 0.318 | 1.35 | 0.120 | 0.320 | 0.115 | - | - | 0.0230 | 0.0693 | 0.0463 | 0.0247 | 0.011 | - | - |
| 8052 Bd 4-5 (-050)- (-055) | 5PB4/8 (blue) | 65.9 | 15.1 | 8.97 | 2.15 | 2.65 | 1.94 | 1.34 | 0.227 | 0.797 | 0.146 | 0.323 | 0.119 | - | - | 0.104 | 0.0633 | 0.0937 | - | 0.012 | 0.062 | - |
| 8126 (Bb-32 c 045-040) | 2.5BG7/4 (light blue) | 68.4631 | 16.8026 | 8.5413 | 3.2917 | 0.5616 | 0.8365 | 0.5039 | 0.1178 | - | 0.2441 | 0.4337 | 0.0909 | - | 0.0177 | 0.0121 | 0.0503 | 0.0328 | - | - | - | - |
| 9395 Bb-A 0.00- (-005) | 2.5Y7/10 (yellow) | 69.3 | 18.5 | 7.64 | 2.02 | 0.498 | 0.693 | 0.381 | 0.0880 | 0.0270 | 0.125 | 0.537 | - | - | - | - | 0.0507 | 0.170 | - | - | 0.034 | - |
| 9428 (Bb-34 170-160) | Colourless | 70.7294 | 18.898 | 5.8809 | 1.9673 | 0.3664 | 0.4217 | 0.36 | 0.0212 | | 0.3173 | 0.6886 | - | - | - | 0.0142 | 0.0465 | 0.035 | - | - | - | - |
| 9546 (Bb-33a 090-080) | 7.5RP4/4 (purple) | 64.1 | 13.1 | 10.5 | 2.19 | 3.10 | 2.40 | 0.633 | 0.300 | 2.74 | 0.196 | 0.493 | 0.140 | - | - | 0.0170 | 0.0666 | 0.0785 | - | - | - | - |

Fig. 1 XRF Analyses

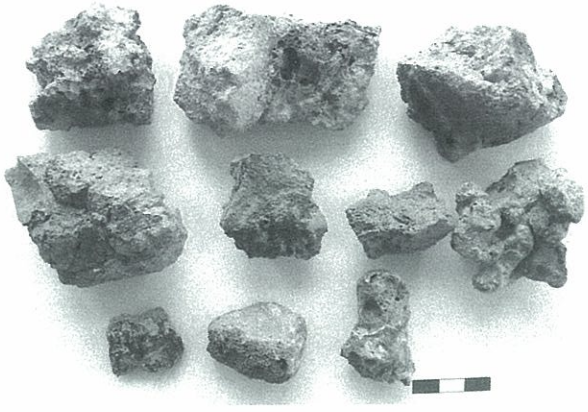

Fig. 2
Foam glass

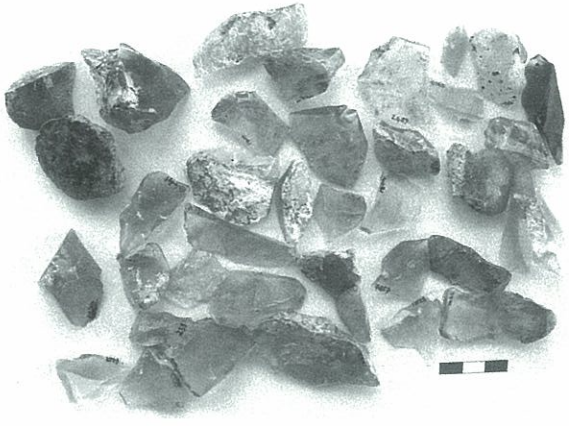

Fig. 3
Frits

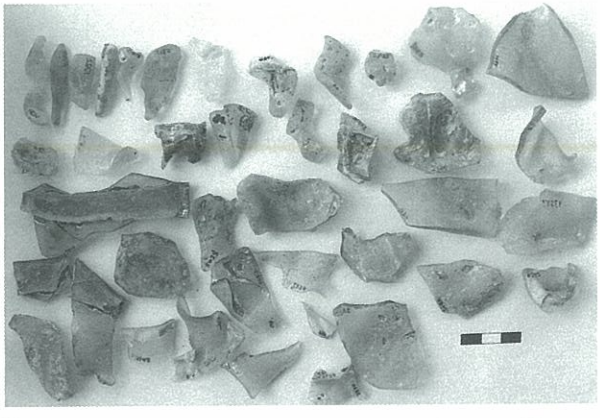

Fig. 4
Wasters from the shaping process

Fig. 5
Wasters from the shaping process