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The Composition of a Glass Chunk from ʻEn Yaʻal (Naḥal Refa'im)

Ian C. Freestone

A glass chunk from the excavation of a Roman Villa at ʻEn Yaʻal (Naḥal Refa'im; Avner 2015) was chosen for chemical analysis. It was found together with high-quality glass vessels in a context dating to the second–third centuries CE (L229, B1394; see Winter 2015). The purpose of the analysis was to investigate the likely origins of the glass and the reason for its unusually high quality compared to other glass finds from this period that were found in Israel.

A sample of a few millimetres was mounted in epoxy resin, polished flat down to 0.25 µm diamond, vacuum coated with carbon and analyzed using an electron microprobe.[1] Results—a mean of seven individual analyses—are shown in Table 1. This is a soda-lime-silica glass with K_2O and MgO below one percent, as is typical of the natron glass of the Roman period (e.g., Brill 1988; Shortland et al. 2006). All other elements are within the range expected of Roman glass of the first–third centuries CE.

Roman glass of the second–third centuries CE is commonly divided into two main groups. One was decolorized by MnO, and the other by Sb_2O_5. In the present case, the MnO content (0.03%) is at the natural level expected of glassmaking sand, while Sb_2O_5 was clearly artificially added. Sb_2O_5 is a more effective decoloriser than MnO: typical Sb-decolorized glass has less of a tint, and the lack of color should, in principle, be more stable.

Table 1. Analysis Results

Component	m(7)
Na2O	19.17
CaO	6.40
SiO2	66.95
MgO	0.70
K2O	0.46
P2O5	0.05
Al2O3	2.25
FeO	0.49
TiO2	0.08
MnO	0.03
Sb2O5	0.68
Cl	1.12
SO3	0.35
PbO	0.03
SrO	0.10
Total	*98.84*

The ʻEn Yaʻal sample was compared to Roman glass from other sites (Fig. 1). The base sample for the graph in Fig. 1 comprises the glass from the early third-century CE Iulia Felix wreck (Silvestri 2008; Silvestri et al. 2008), which provides a good visualisation of the main types of glass at that time: decolorized with manganese (high CaO, low Na_2O); decolorized with antimony (low CaO, high Na_2O); and an intermediate type, formed through recycling and the mixing of the other two types. Also presented in Fig. 1 are a large number of antimony-decolorized vessels from Britain, analyzed by C. Jackson (see Baxter, Cool and Jackson 2005) and a small group from a second-century CE workshop excavated at Basinghall Street, London (Freestone et al., in press). The reason for the lack of correspondence between the

British and Iulia Felix glass assemblages is unclear. The results showing a high quantity of Na_2O in the Iulia Felix glass could be due to the use of a more expensive glass closer to the centre of the Empire, but could represent systematic differences in the analyses of the different laboratories. On balance, an analytical error seems unlikely, and it is probable that the differences are real.

As Fig. 1 indicates, the ʻEn Yaʻal glass falls within the general region of the graph associated with Sb-decolorized glass, but is well outside the Iulia Felix group and is marginal to the general British group studied by Jackson. However, the ʻEn Yaʻal glass is almost identical to the colorless glass analyzed from the Basinghall Street workshop in London; it is therefore likely to have a similar origin. Isotopic analysis indicates that much of this material originates in the eastern Mediterranean (Degryse 2014).

It is widely accepted that the manganese-decolorized glass of the Roman period was produced from Mediterranean coastal sands, and it is generally considered to have been a Syro-Palestinian product, probably from the Carmel region of Israel. The origin of the antimony-decolorized glass is less clear. However, trace elements indicate that it was made from a different sand than the Mn-decolorized glass (Freestone et al., in press). The Diocletian Price Edict refers to Judean greenish glass and Alexandrian colorless glass (Whitehouse 2004;

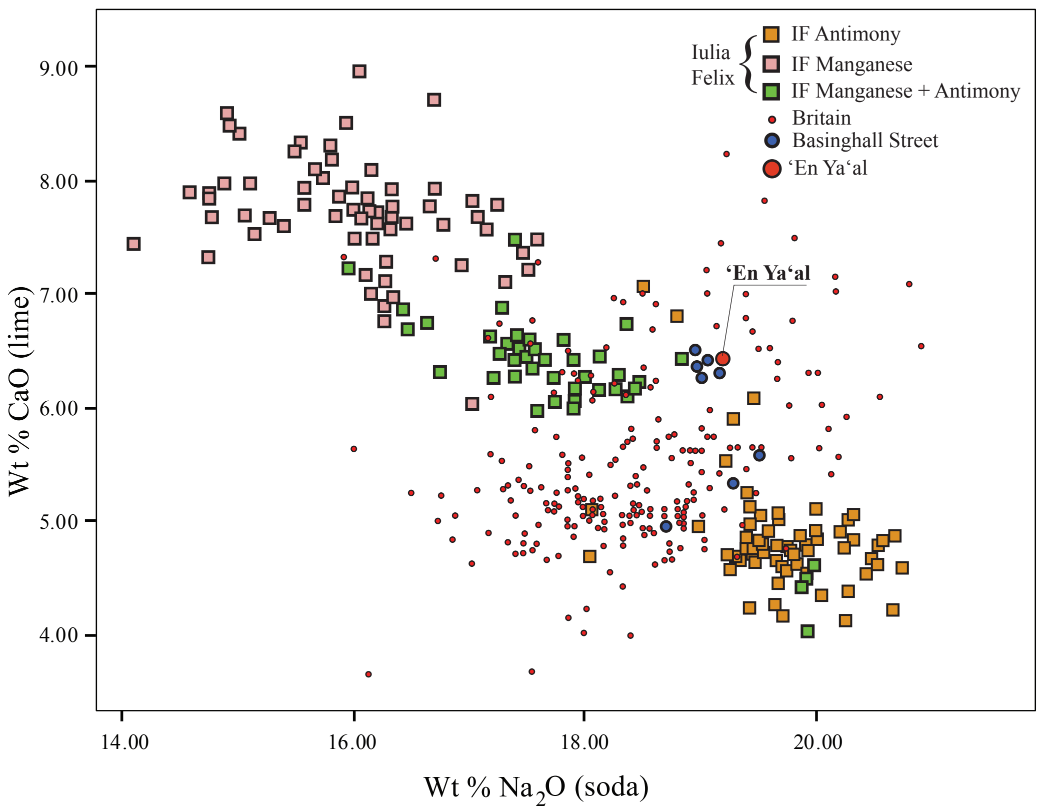

Fig. 1 The ʻEn Yaʻal sample compared with colorless and weakly colored glass from the Iulia Felix wreck and colorless glass from Britain and Basinghall Street, London.

but see Barag 2005), and an Alexandrian origin would be consistent with the analytical evidence that we have, although an origin elsewhere on the coast of Syria-Palestine cannot be completely ruled out. To a certain extent, more analyses of glass from Israel are needed to resolve this issue. There are very few available analyses of glass from the critical sites dating from the first–fourth centuries CE. Hence, we do not know the relative availabilities of the different types of colorless glass in the region.

To conclude, the ‘En Ya‘al glass most likely originated in Egypt, but an origin in a Palestinian furnace remains possible. More analyses of glass of the period from Israel are needed before this issue can be resolved.

Note

[1] This is the method preferred for glass analysis by many researchers because of the small sample size it requires and the high accuracy it allows for. The analysis was carried out using a JEOL 8100 Superprobe operated at 15kV accelerating potential, with 30s count time on peaks and 10s on backgrounds. Primary standards were pure elements and oxides. An analysis of Corning Museum standards A and B (Brill 1999) gave good agreement for all major and minor elements.

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