Data XRF analysis (Röntgenfluorescentiespectrometrisch onderzoek)

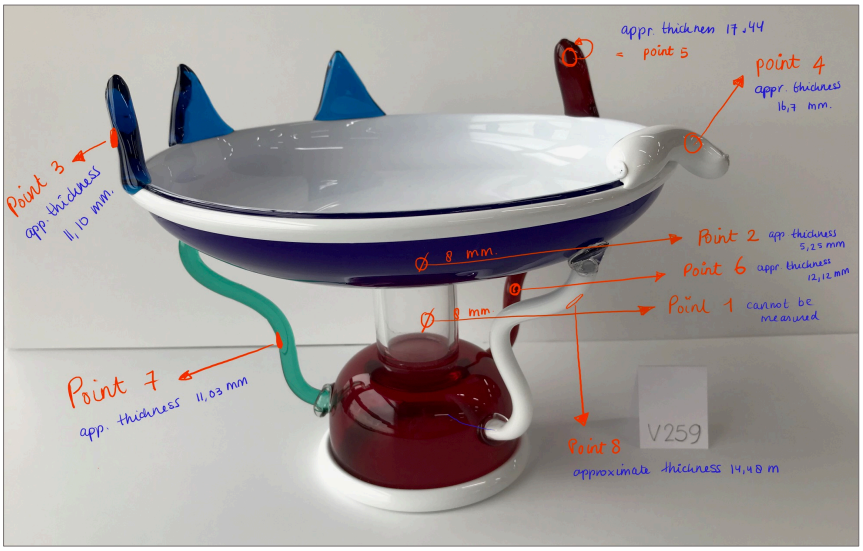
Object :	**V259 (KN&V) red on edge of cuppa**
Artist :	Ettore Sottsass (execution Toso Vetri d'Arte)
Title and date :	Sol - glass, freeblown, applique — 1982
Conservator :	Mandy Slager - Restauratieatelier
Analist :	Luc Megens - sr. Researcher RCE
Date analysis :	21-03-2024 16:33:16

Visual examination - microscopy	Ion - Chromatography	pXRF - analysis (relative to objects in the project)
Date: 01-08-2023	Date: 16-09-2020	Date: 21-03-2023
Very poor	**Likely unstable**	**Further research needed**

Specific research question
What type of glass? Which elements are detected by pXRF that might be related to the stability of the glass? Does comparison of all the objects analysed in this project reveal particular information? Can we identify any correlations between the *p*XRF results and the visual and IC results relating to the condition of an object? Would it be possible to carefully work towards condition categorization based on non destructive *p*XRF analysis of composition in combination with visual and IC analysis? Additional analysis needed: what are the options? Does the current information give impetus to further (non destructive) research to support the monitoring of condition?

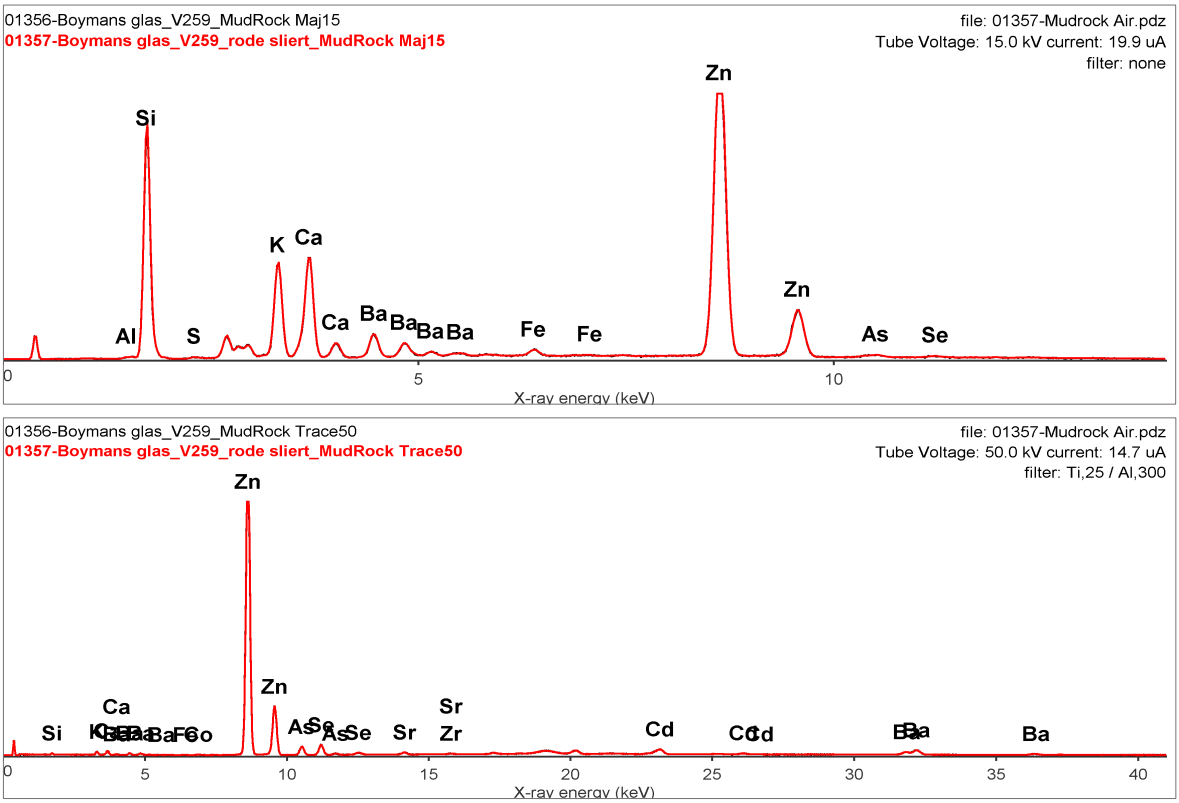
Examination and analysis	
Instrument	Bruker Tracer 5g
Instrument settings	MudRock Application in ambient air, 8 mm collimator 1: 50 kV, 14.7 µA, filter Ti 25 µm/Al 300 µm, 45 s 2: 15 kV, 19.9 µA, no filter, 60 s
Additional information	Setting 1 for heavier elements and setting 2 to better detect the lighter elements (from Mg). Automatic quantification, average of 2 measurements. DualMudrock Air version 730.0646.01 .

Location mapping of compositional analysis and measurement of approximate glass thickness



Practical limitations	None
App. thickness in mm.	**17,44** (at location of measurement - point 5 - red on rim of cuppa)

Spectra



Results

Limitations	Na2O can not be accurately quantified (underestimated). Sn and Sb are not quantified with the MudRock application. As isn't quantified properly in Pb glass. Quantitative results give an indication of composition, but not exact concentrations.											
Main elements in wt%	**Na2O**	**MgO**	**Al2O3**	**SiO2**	**P2O5**	**SO3**	**K2O**	**CaO**	**ZnO**	**BaO**	**PbO**	**UO2**
	6,93	0,25	0,23	77,13	< LOD	0,20	3,73	3,06	7,49	1,07	0,08	< LOD
Trace elements in ppm	**Cl**	**Ti**	**V**	**Cr**	**Mn**	**Fe**	**Co**	**Ni**	**Cu**	**As**	**Rb/Sr**	**Zr/Mo**
	< LOD	1051	27	89	105	141	10	30	50	742	2/161	35/72
Type of glass I	**Soda - Lime**											
Type of glass II	Mixed alkali											

Additional information

The quantitative data were obtained by applying the DualMudrock_Air quantification method (version 730.0646.01) in the Bruker Tracer 5g. This quantification is based on rock standards and is therefore not entirely accurate for glass. This is especially the case when the concentration of an element lies far outside the range of concentrations of that element in the standards, as the matrix effect is then not accounted for in the extrapolation. Furthermore, antimony is not quantified in this method, even though it is present in many of the analyzed glasses. For this reason, the concentration was estimated based on a comparison with the most closely matching glass standard from the Corning Museum of Glass (Adlington, 2017). Sodium is quantified very unreliably because the measurement was conducted in air (which strongly absorbs the fluorescence radiation of Na), and this element is detected only within a maximum of the uppermost micrometer of the sample due to self-absorption. The depth up to which elements with high-energy fluorescence radiation are detected (such as Pb, Rb, Sr, Zr, Sn, Sb) can exceed the thickness of the glass. In that case, these concentrations are underestimated because a portion of air behind the glass is measured. This must also be taken into account when comparing the values for these elements (see also the glass thickness measurement above).

Most parts of the bowl consist of soda-lime glass, but the white worm on the rim of the bowl consists of lead crystal. (This accentuates the expertise of the glasmakers in finding compatible glass for all the parts). The green swirl is colored by copper and chromium, the blue triangles by copper. No coloring element was detected in the blue bowl, but a layer of colorless glass is likely present over the blue glass. In the red and white swirls, no elements were detected that could explain the color. The similar bowl from the Coolen-Kalkman collection is made of comparable glass, but the green swirl there does not contain copper and chromium. The glass of the blue triangles does contain copper, just like in V 259.

Discussion of results

1. In absolute and relative comparison a larger spreading of the K2O and PbO measures can be detected. This is mostly due to the fact that the energy the fluorescent radiation of K emits is lower than of Pb. De subsequent percentage calculations derive from this. With greater distance of the detector to the surface the radiation of K is abosrbed much stronger by the air than is the case with Pb.
2. Not yet possible to draw conclusions on sensitivity of glass to instablility by means of pXRF. But in combination with the visual and IC results it might be possible to group objects or determine correlations between the diagnostic data.
3. Quantitative XRF results on composition are not the same as the components of a recipe.
4. <LOD = Below Limit of Detection - element might be present but in a smaller amount than can be detected by means of pXRF.
5. Unclear where exactly the IC analysis was performed ('exterior surface of the object...').
6. Possiblity: glass coloured with cadmium selenide. No elements detected that can confirm this.

Object in relation to other objects in this project

See also: RCE Report:

Megens, L., 2025, Verkenning van de samenstelling van verschillende types glas in Museum Boijmans van Beuningen in relatie tot het risico op degradatie, RCE projectnummer 2023-099, Amsterdam, Rijksdienst voor het Cultureel Erfgoed, Rijkserfgoedlaboratorium which can be found in Conservation Studio under *verwante media*.

Suggestions for further research

1. Further pXRF analysis on comparable objects
2. Search for (archival) information on manufacturing process or recipes
3. Correlations to be found by comparing data to reflectance spectral images with Optical Coherence Tomography? U of Nothingham
4.Correlations to be found by comparing current data with info acquired by means of Terahertz (THz) examination? U of Eindhoven
5. Further research by means of Raman Spectroscopie or Inductively Coupled Plasma Mass Spectrometrie (ICP-MS) or Scanning Electron Microscopy (SEM) - possible in situations where sample fragments are available. Many more analytical examination can then be explored, but usually analysis on museum objects is limited due to non invasive requirements and practical complications when having to move objects to lab facilities.

Literature

1. Shelby, J.E., Introduction to Glass Science and Technology, Cambridge 2005, p.30.
2. Megens, L., 2021, Verkenning van de samenstelling van verschillende types glas in het Nationaal Glasmuseum Leerdam in relatie tot het risico op degradatie, RCE projectnummer 2020-110, Amsterdam, Rijksdienst voor het Cultureel Erfgoed, Rijkserfgoedlaboratorium.
3. Burghout, F. en M. Slager, Cloudy Patches and Misty Glass: Early Signs of Glass Disease? In: Roemich H. and K. van Lookeren Campagne (eds.) Recent Advances in Glass, Stained-Glass and Ceramics Conservation, Amsterdam, the Netherlands, 7-10 October 2013, pp. 327-329.
4. Adlington, L.W., 2017. The Corning Archaeological Reference Glasses: New Values for “Old” Compositions. Pap. Inst. Archaeol. 27, 1–8. https://doi.org/10.5334/pia-515