

Used of secondary raw material: how to formulate new glass compositions

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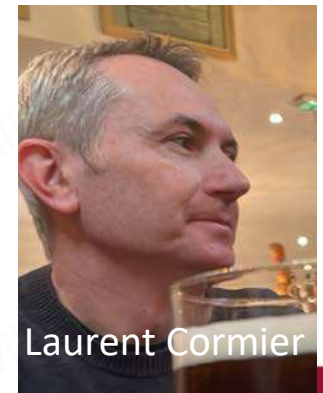
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Combustion processes – energy balances for container glass

Christian Roos

$dH_{\text{chem}} = 140 \text{ kWh/t}$ 1100 kg batch, 50 % cullet ($y_C = 0.5$)
shall lead to 1000 kg glass melt

$dH_{T,\text{liq}} = 410 \text{ kWh/t}$

$H_{\text{ex}} = 480 \text{ kWh/t} = (1 - y_C) \cdot dH_{\text{chem}} + dH_{T,\text{liq}}$

$H_{\text{in}} = 1110 \text{ kWh/t glass}$, this equals $\eta_{\text{ex}} = 43 \%$

$H_u^f = 13.9 \text{ kWh/kg}$ for methane $\rightarrow m_F = H_{\text{in}} / H_u^f$ equals 80 kg $\text{CH}_4/\text{t glass}$

$H_u^f = 33.3 \text{ kWh/kg}$ for hydrogen $\rightarrow m_F = H_{\text{in}} / H_u^f$ equals 33 kg $\text{H}_2/\text{t glass}$

$H_u^f = 5.17 \text{ kWh/kg}$ for ammonia $\rightarrow m_F = H_{\text{in}} / H_u^f$ equals 215 kg $\text{NH}_3/\text{t glass}$

220 kg CO_2 from combustion
100 kg CO_2 from batch
180 kg H_2O
1071 kg N_2

0 kg CO_2 from combustion
100 kg CO_2 from batch
299 kg H_2O
0 kg N_2

0 kg CO_2 from combustion
100 kg CO_2 from batch
341 kg H_2O
177 kg N_2 (is that so?)



3 examples of reducing CO₂ emissions from raw materials:

- **Use fine de verre : Poster by Wilfried Becret**
- **Development of new compositions from waste: Sophie Schuller**
- **Use of volcanic lavas and cullet**



$2-3.10^6$ t/year



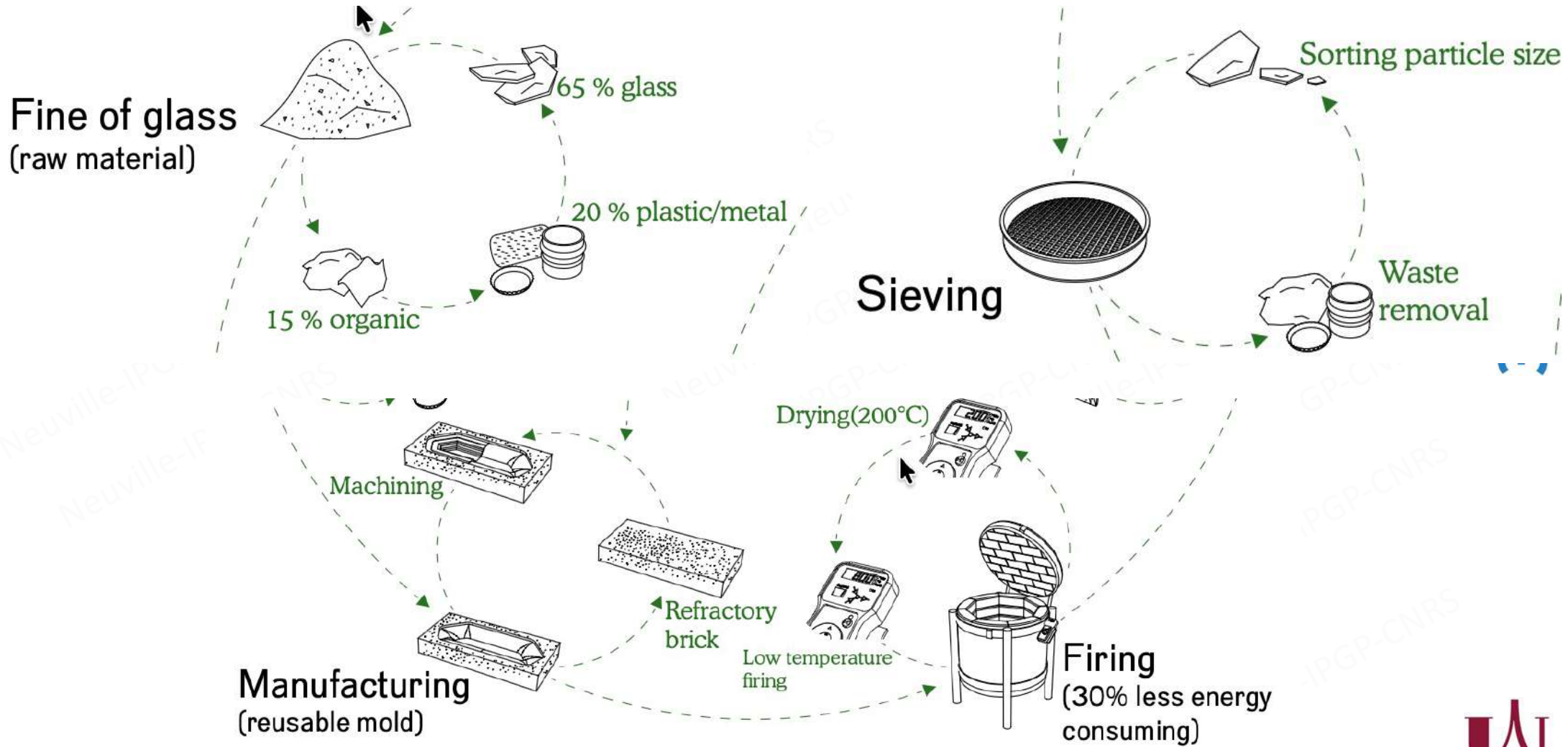
ADEME 2024

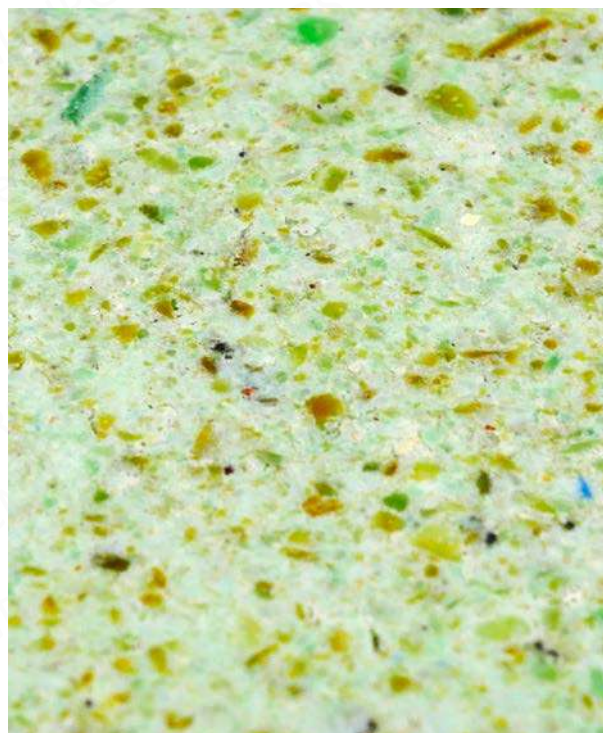
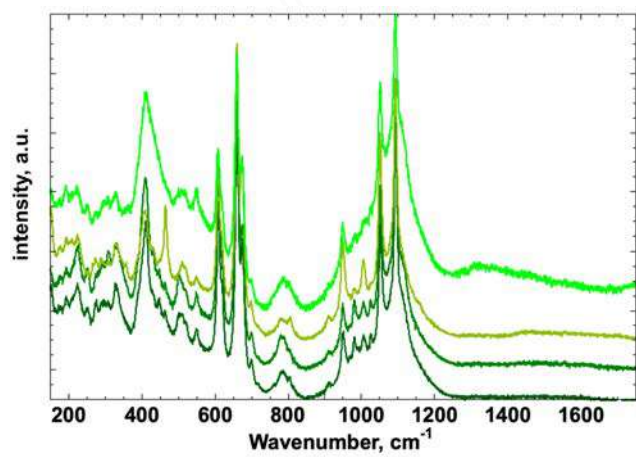


**400t/year
Not used**

These wastes are sent to deep underground storage, which is expensive and not very sustainable in the long term.







Production of Eco#1-90% glass - 90% recyclable materials

Pharmaceutical ampoule puzzle



Oysters from the Tau Lagoon



CEA : S. Schuller

Baked at 1,300°C, followed by a 30-minute resting period



Foundry sand



Owens Corning Fiberglass

Glass composition

Blend composition

- 13,2 % Clear Glass
- 21,9 % Light Amber
- 35,1 % Dark Amber
- 5 % fibres Owens Corning
- 13,2 % huitres
- 2,3 % sable
- 9,8 % Na_2CO_3



% massique	Composition verre ECO-1
SiO_2	60
Na_2O	12,7
B_2O_3	7,2
Al_2O_3	5,8
CaO	9,0
TiO_2	1,4
Fe_2O_3	1
K_2O	1,30
MnO_2	0,90
MgO	0,10

Achieving a homogeneous glass after casting





We need glass !



We need glass !

Direct detection of beer photodegradation
in commercial bottles and introduction
of a new Light-Struck Flavour Susceptibility Index

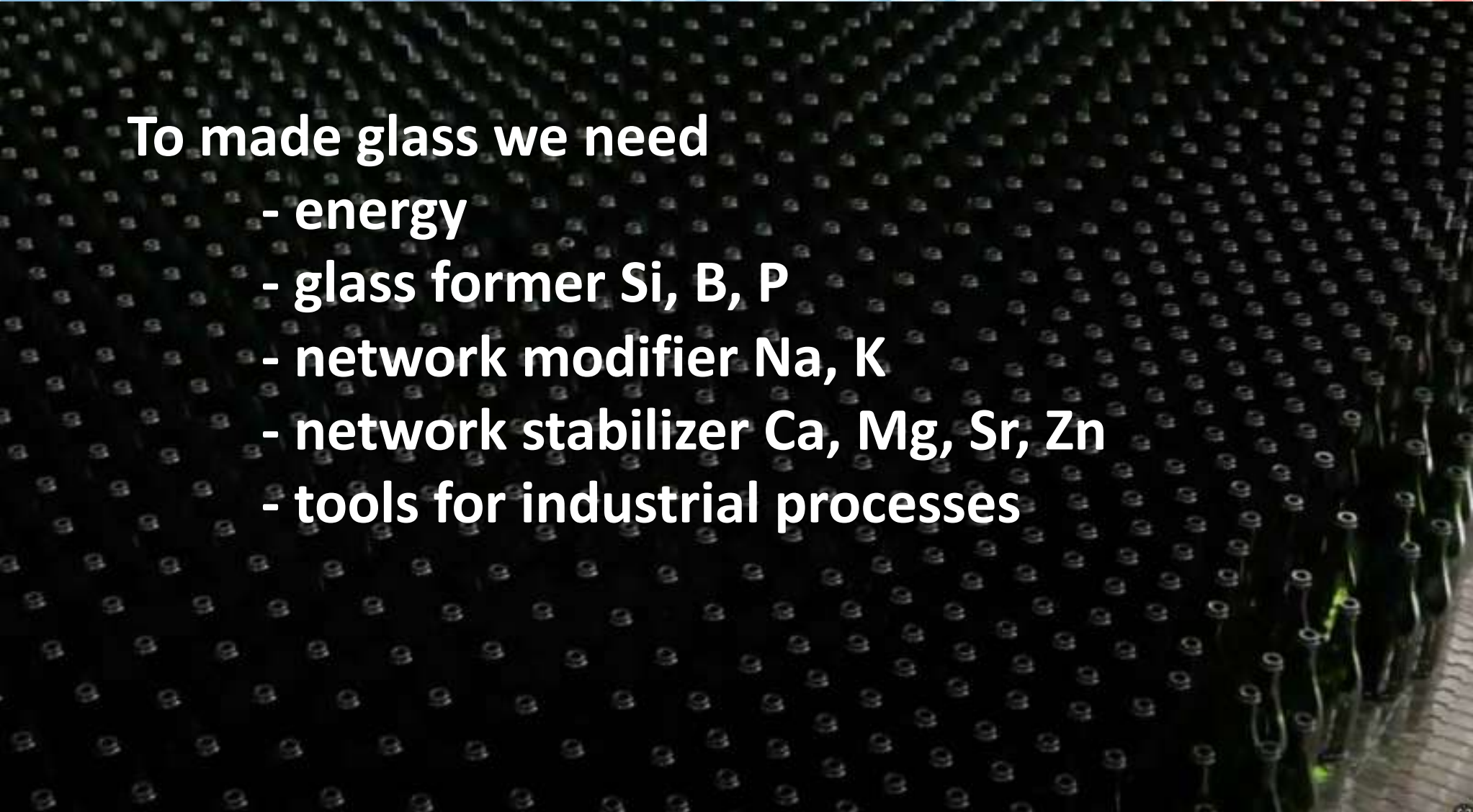
Rate of Degradation of Squalene, Phenolics, and
Polyunsaturated Fatty Acids in Olive Oil during Different
Conditions

Amber vs Clear Glass Packaging
Choose the Right One

Impact of Storage Position on Oxygen Ingress through
Different Closures into Wine Bottles

Colored glasses help
preserve champagne,
wine and jam....

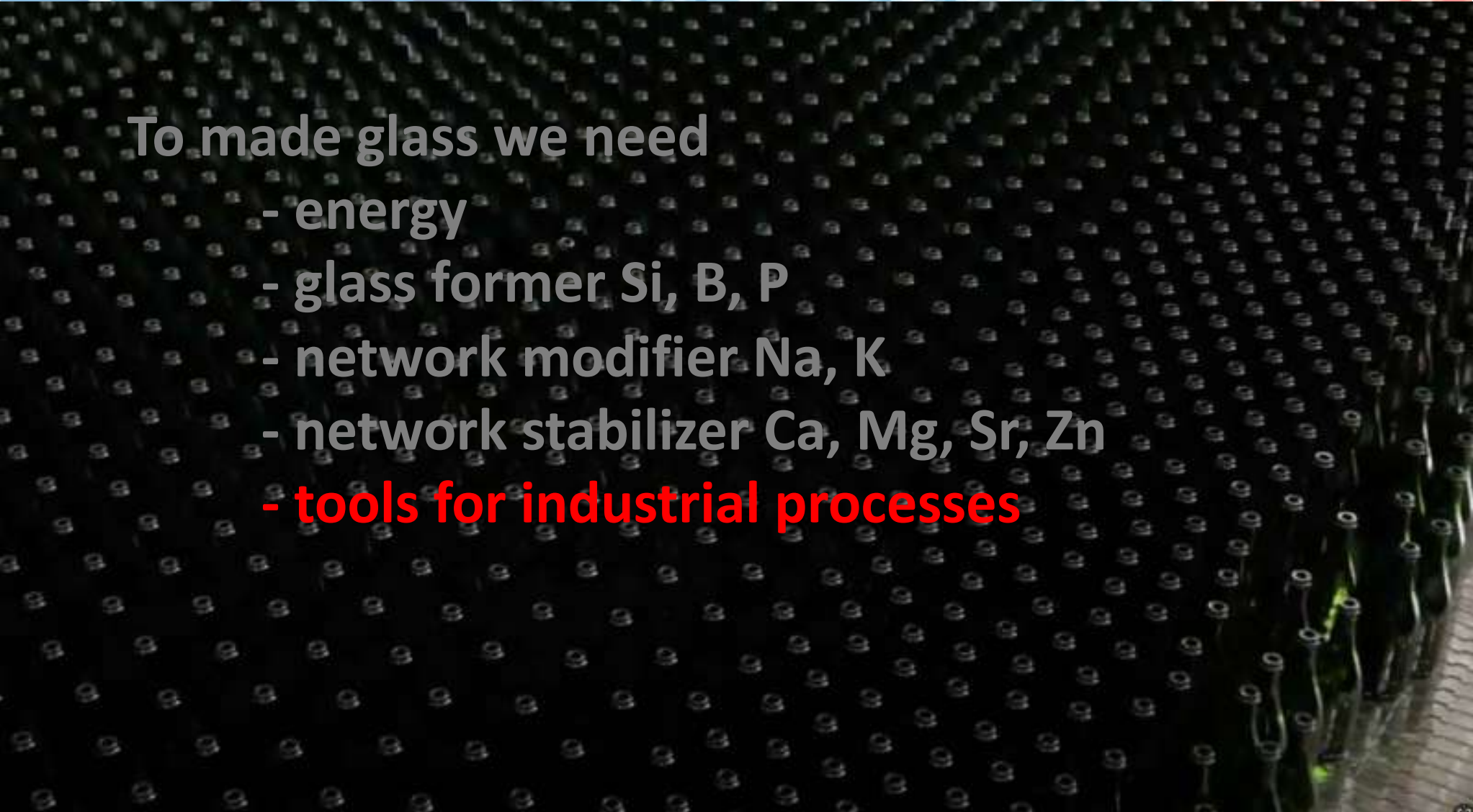




To make glass we need

- energy
- glass former Si, B, P
- network modifier Na, K
- network stabilizer Ca, Mg, Sr, Zn
- tools for industrial processes





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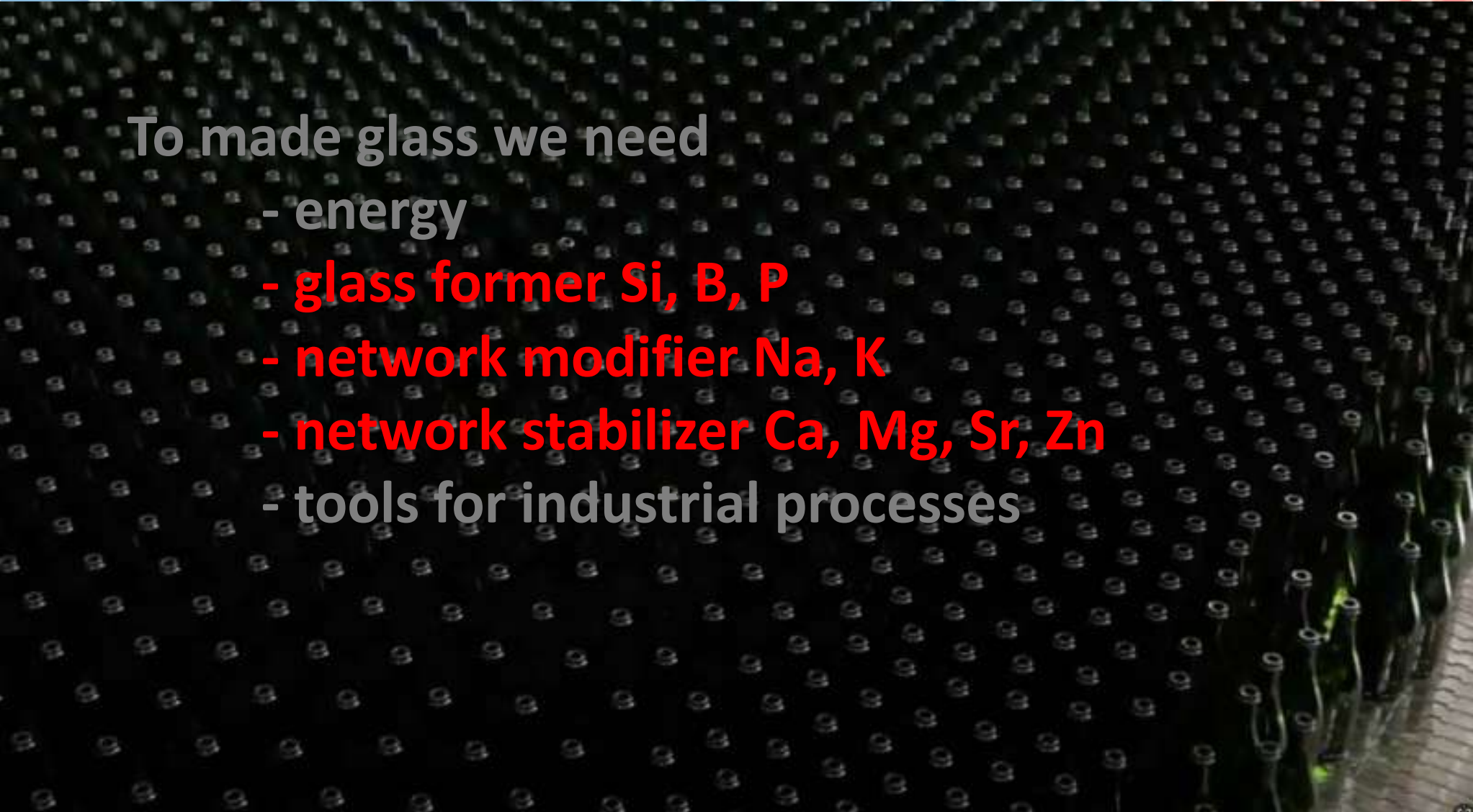


Same processes

Roman era

now



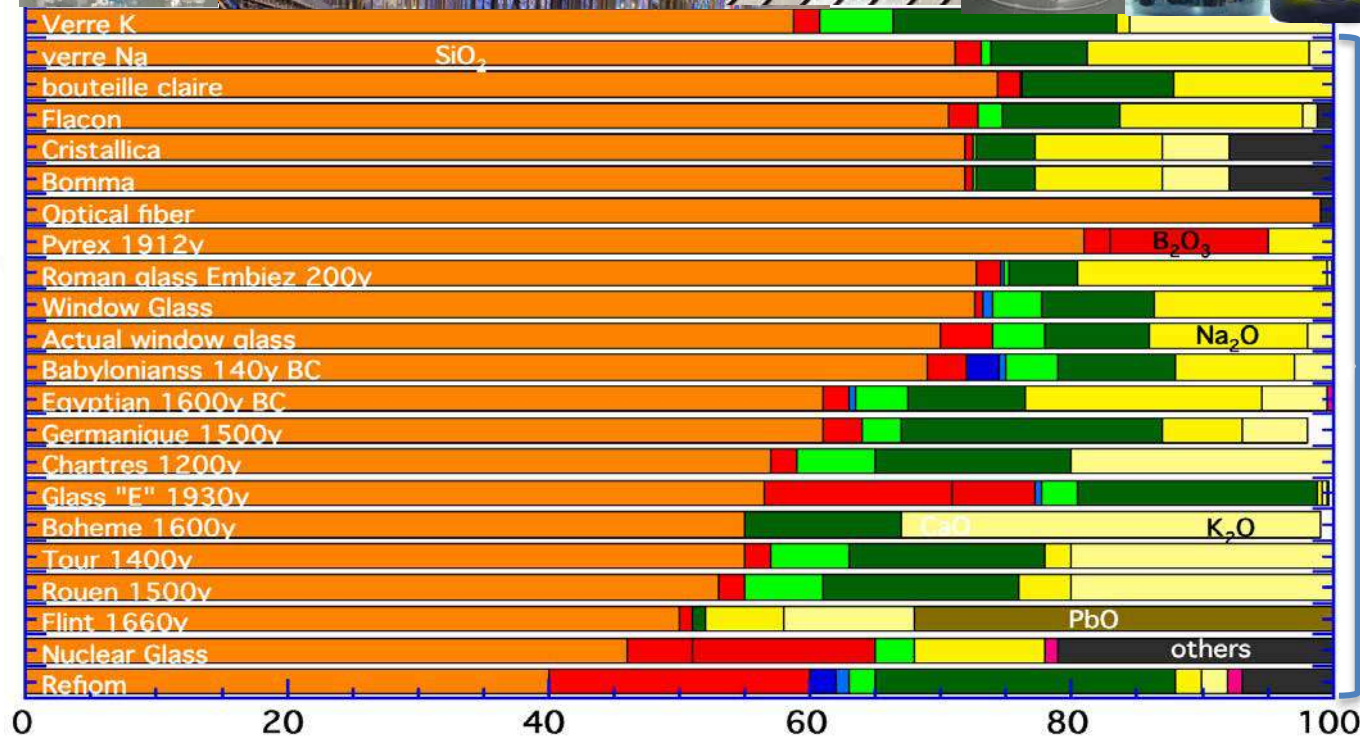


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Huge similarities between natural glasses and human glasses....



T=Si, Al, B

M'=Na, Li, K

M=Ca, Mg

X^n/X^{n+1}

Human

Embiez Glass





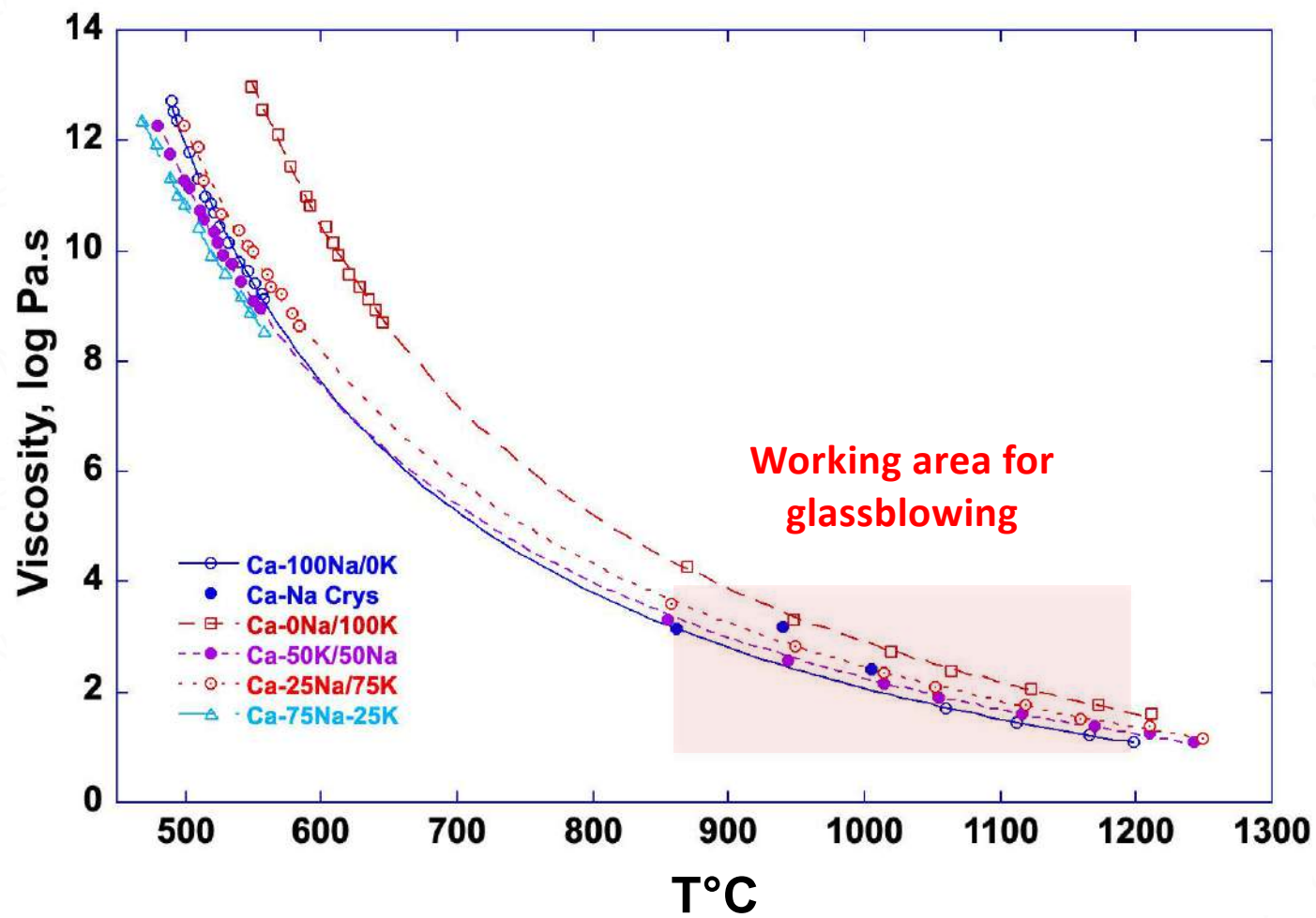
ANR

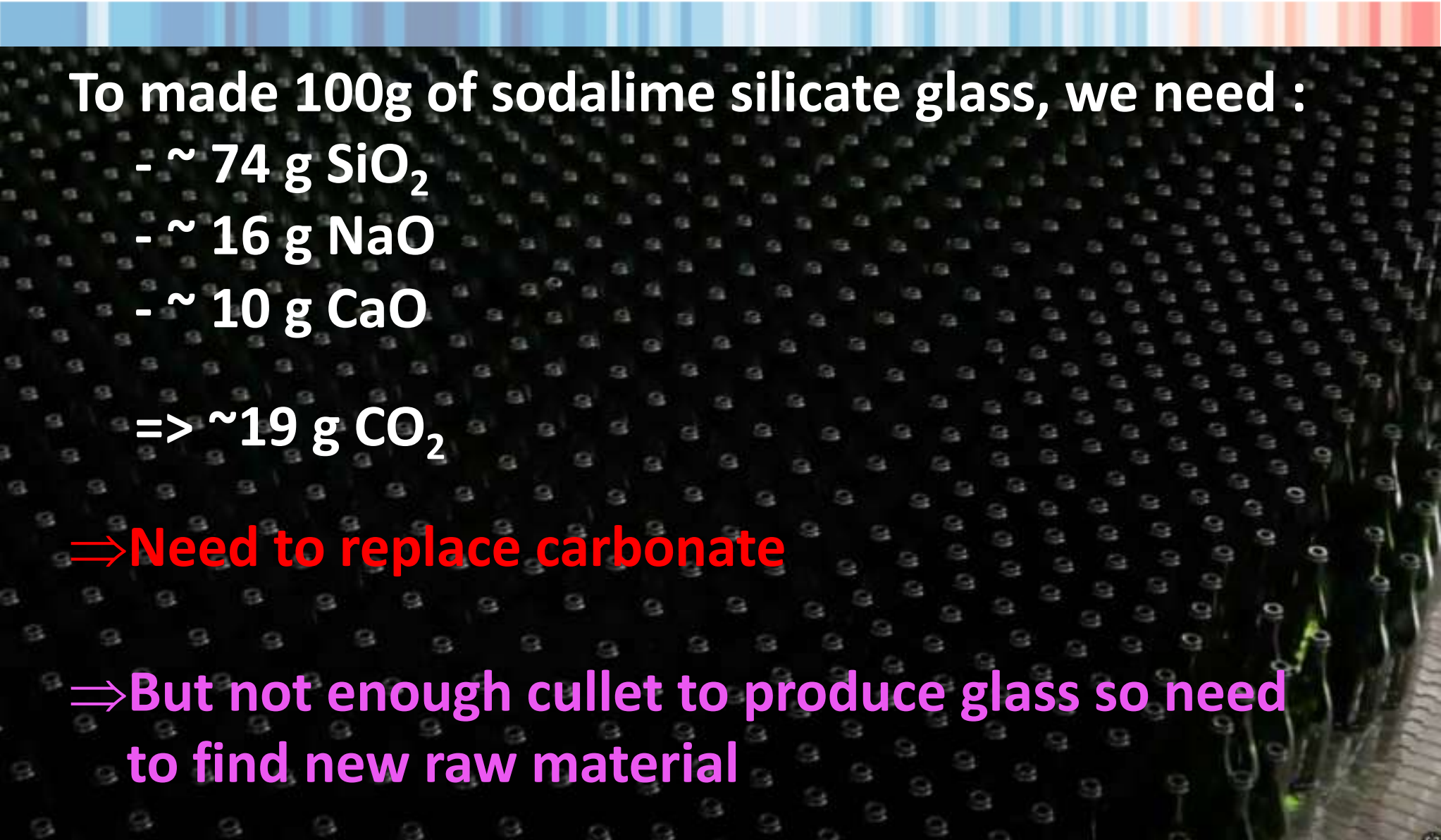
3VER

Mole%	SiO ₂	CaO	Na ₂ O	K ₂ O	K/(Na+K)
Ca-100Na/0K	65	11	24	0	0
Ca-75Na/25K	65	11	18	6	0,25
Ca-50Na/50K	65	11	12	12	0,5
Ca-25Na/75K	65	11	6	18	0,75
Ca-0Na/100K	65	11	0	24	1



ALICIA VAN HAM-MEERT





To make 100g of soda lime silicate glass, we need :

- ~ 74 g SiO_2

- ~ 16 g NaO

- ~ 10 g CaO

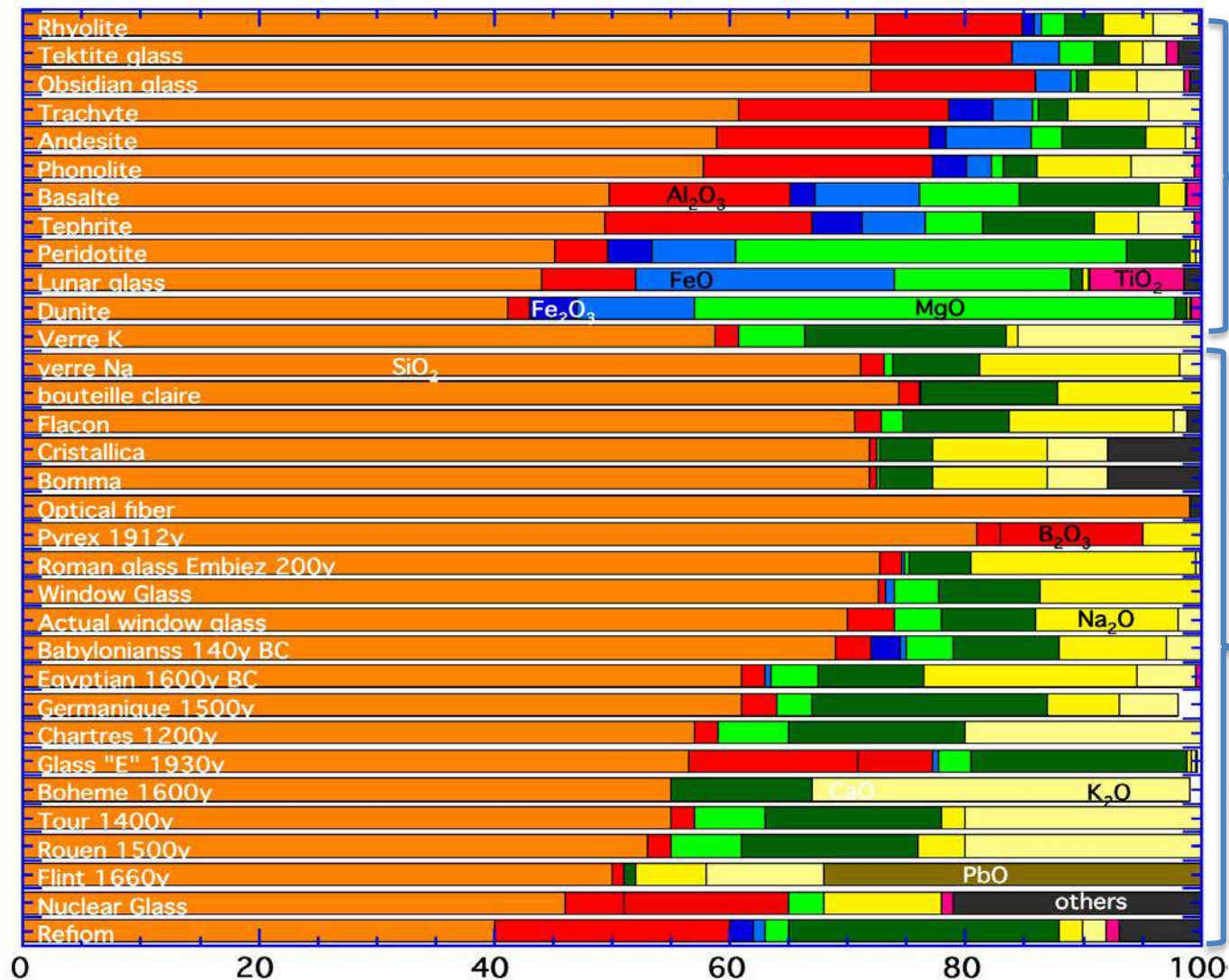
=> ~19 g CO_2

⇒ Need to replace carbonate

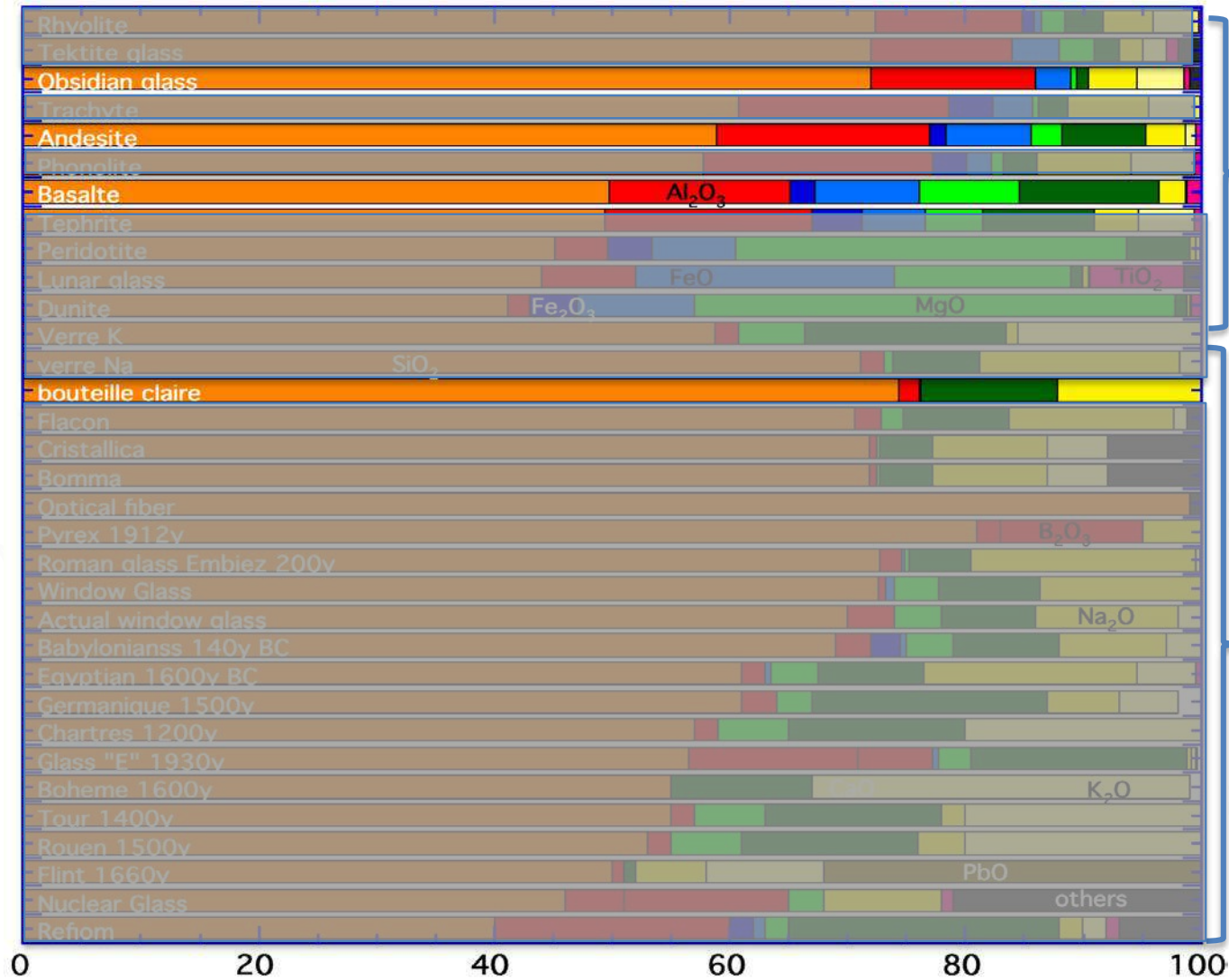
⇒ But not enough cullet to produce glass so need to find new raw material



Huge similarities between natural glasses and human glasses....



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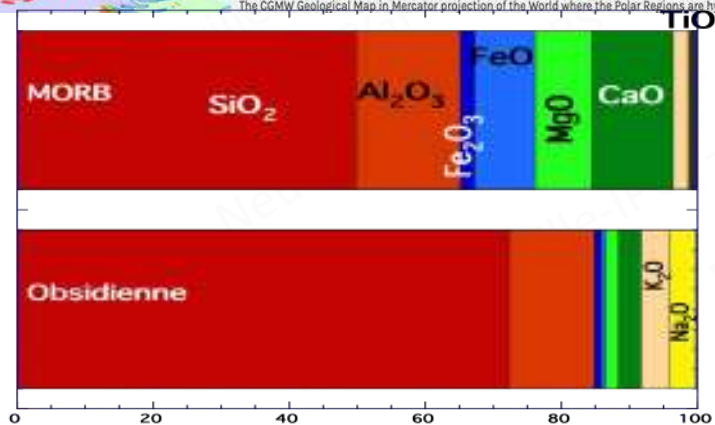
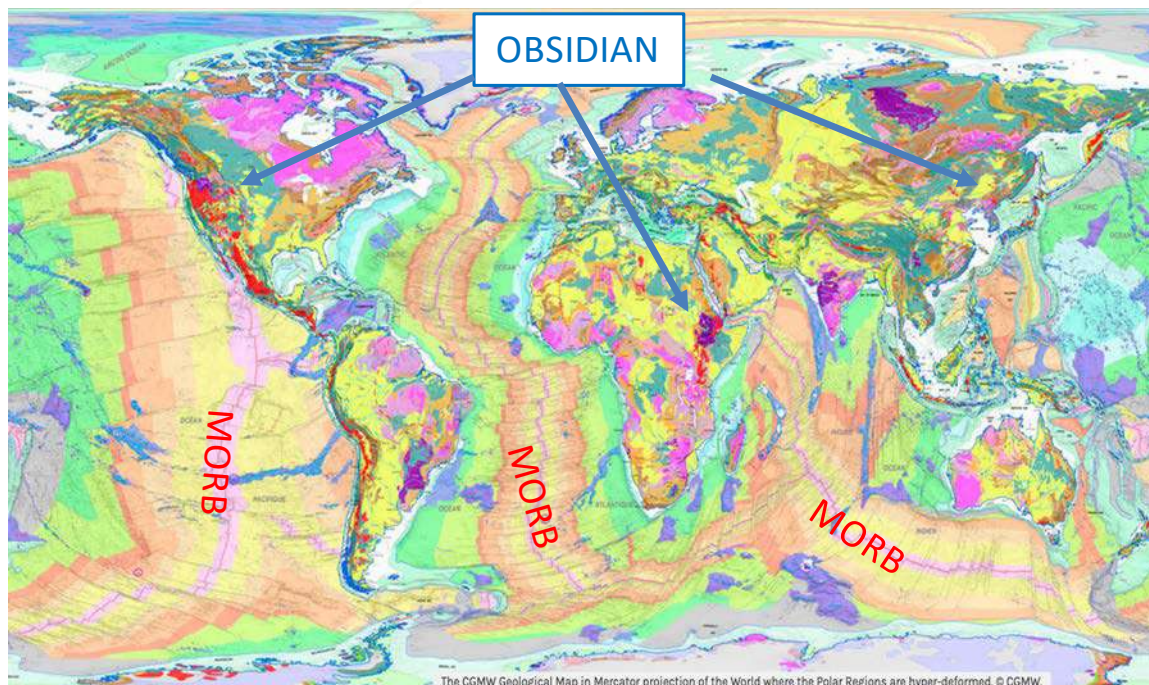


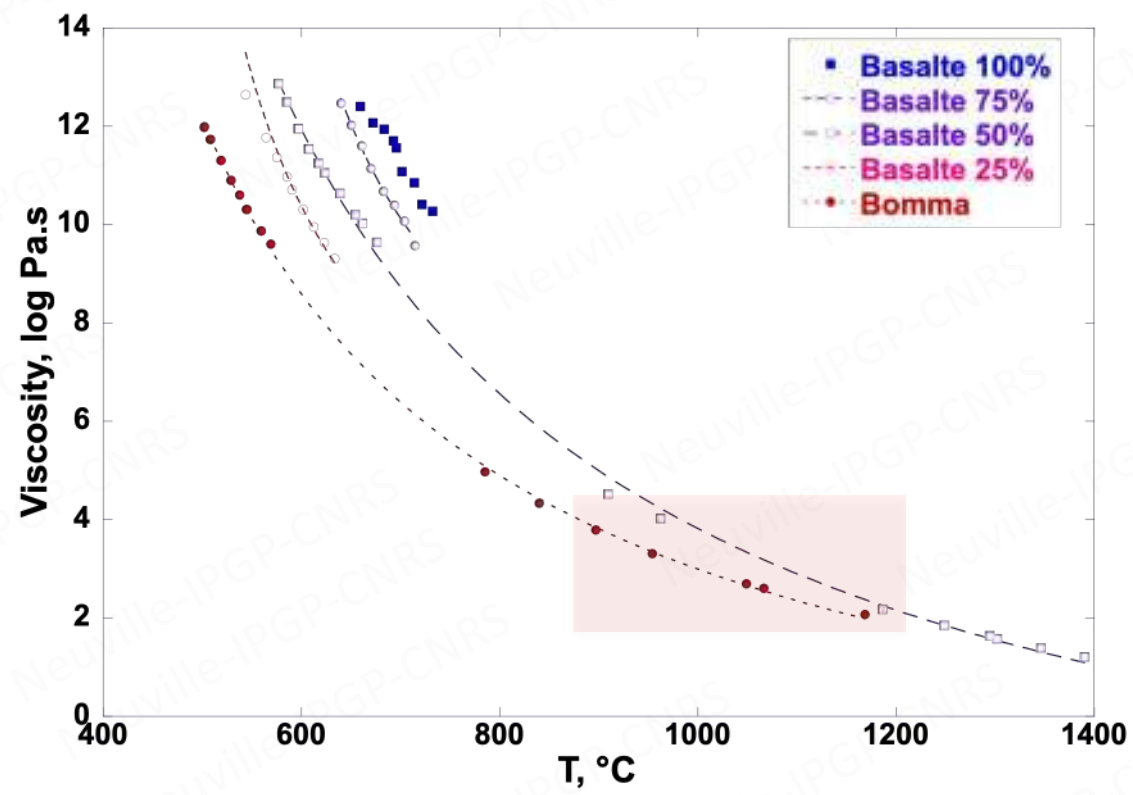


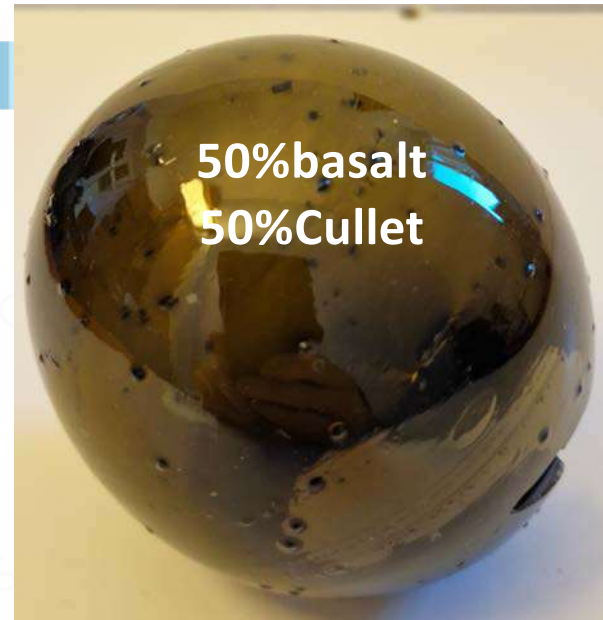
Who is the world's largest glass producer?

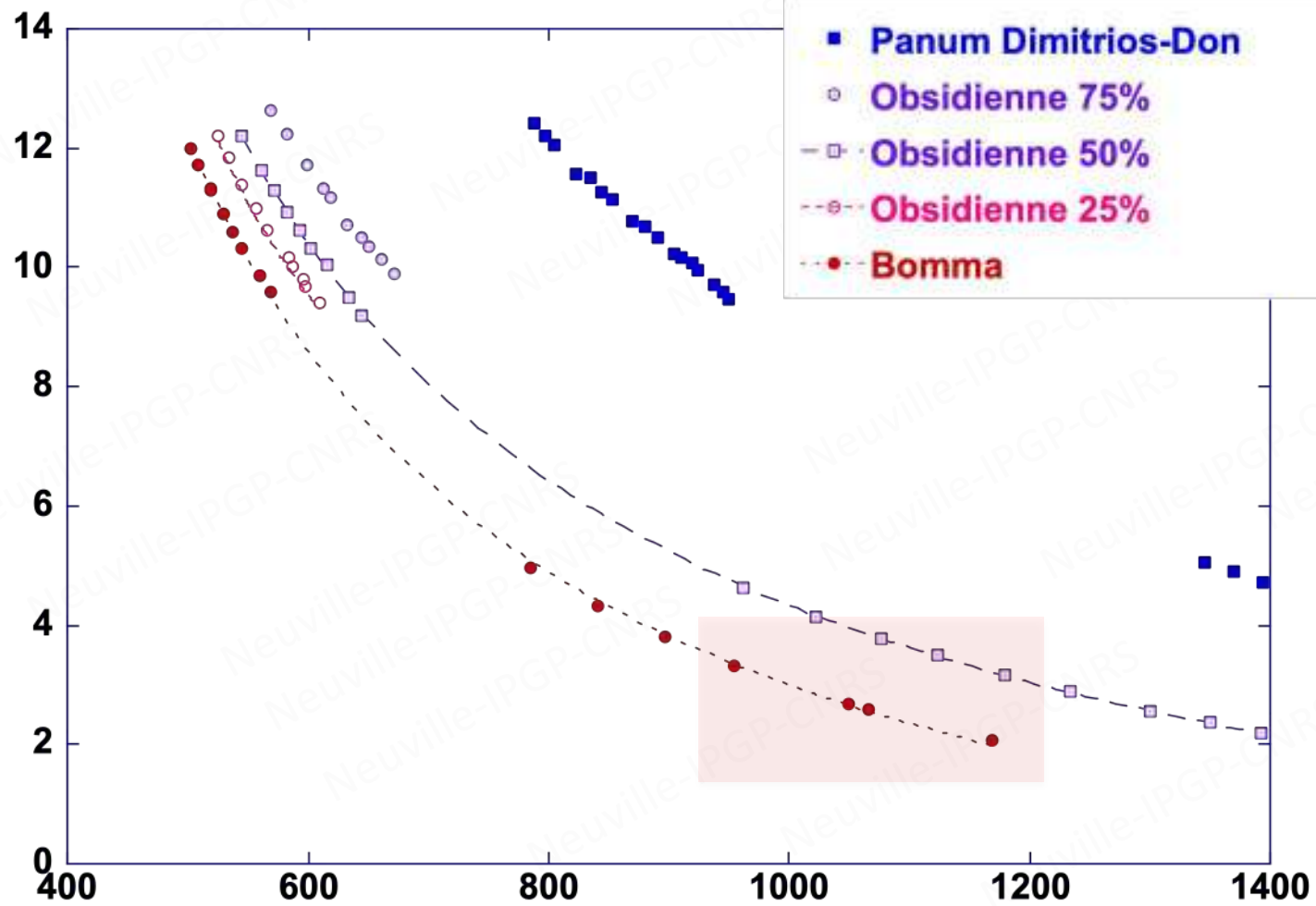
**Glass industry: 140 million tonnes per year
~72millions flat glass**

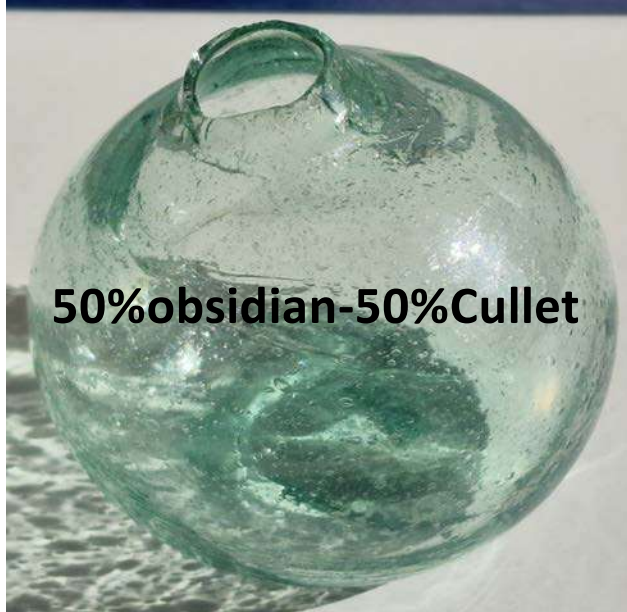
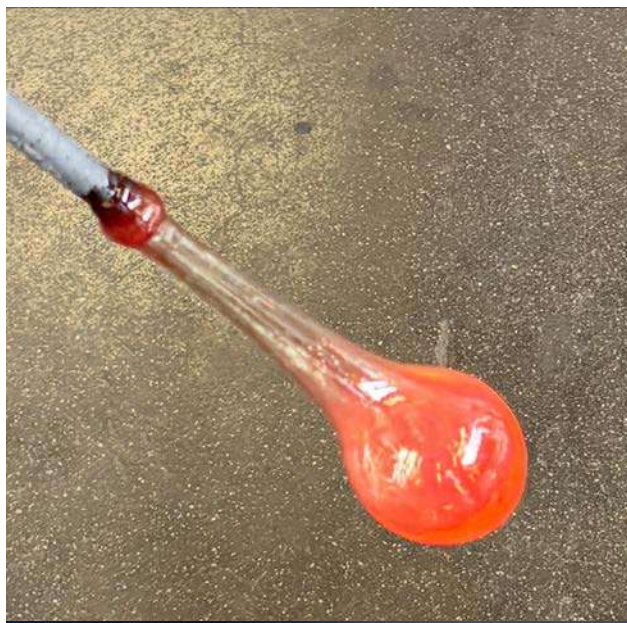
**The Earth: 37900 million tons per year
=> 1200 tons/second**



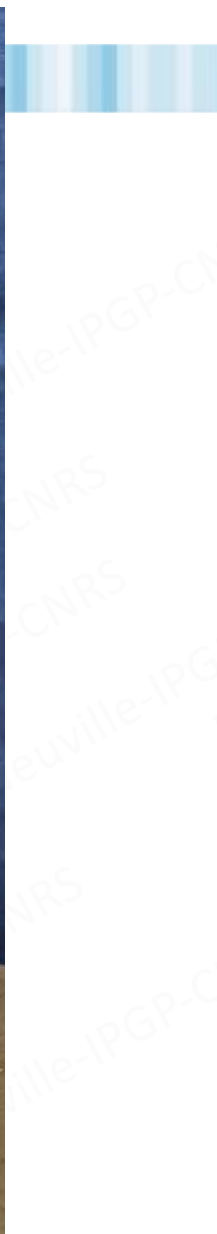






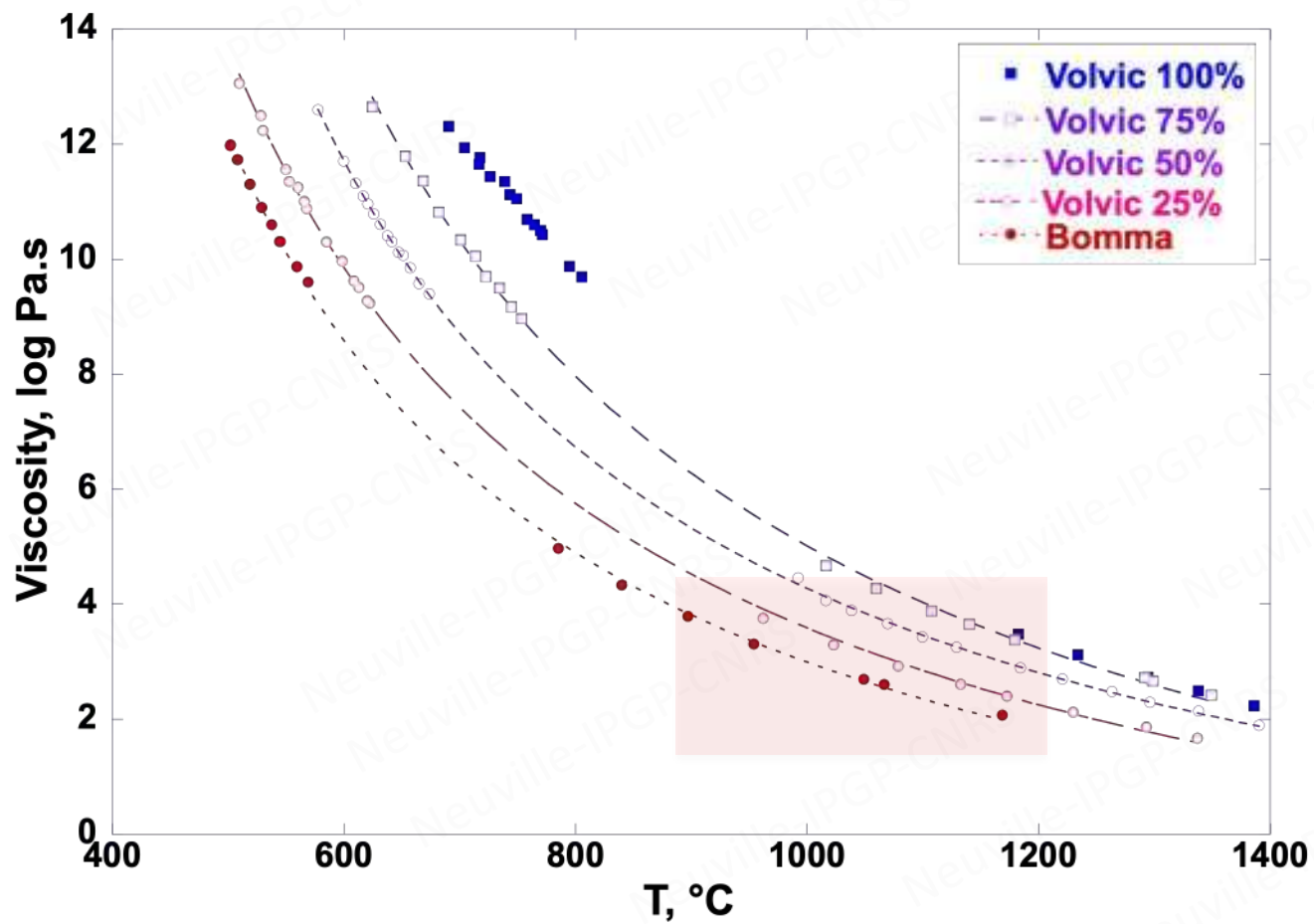


50%obsidian-50%Cullet



**25%obsidian
75%Cullet**







25%Volvic-75%Cullet



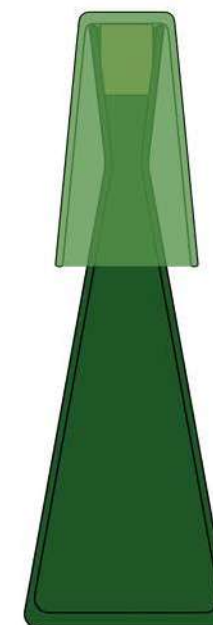
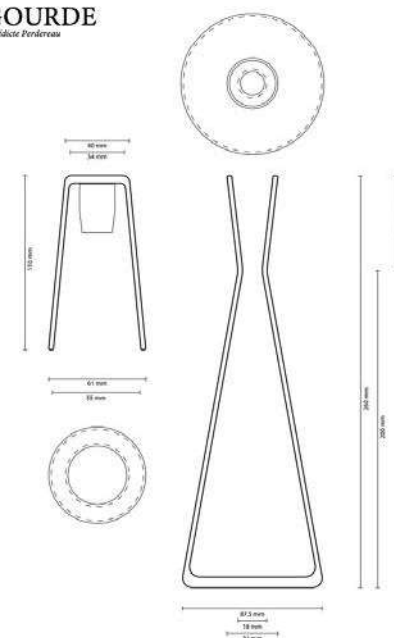
50%Volvic-50%Cullet

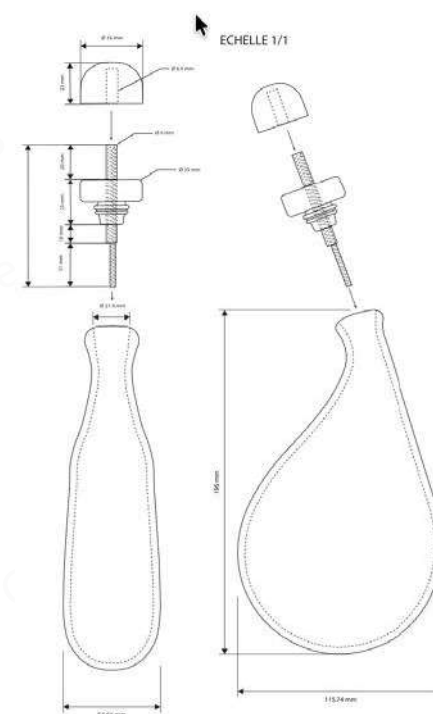


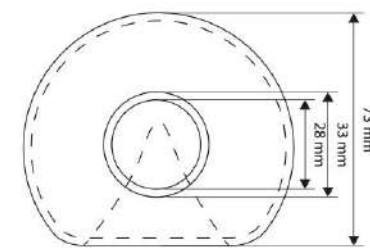
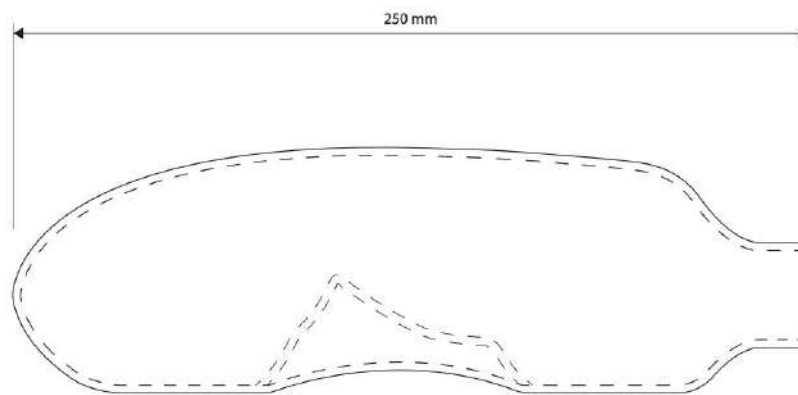
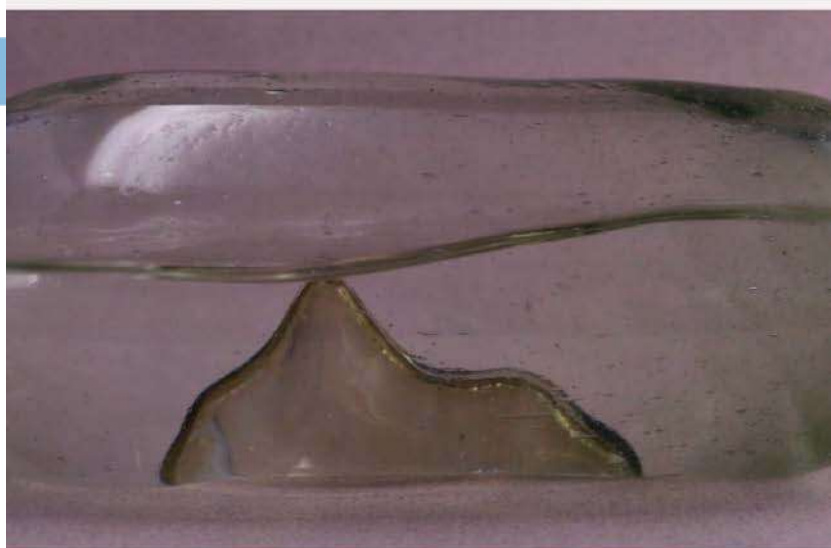


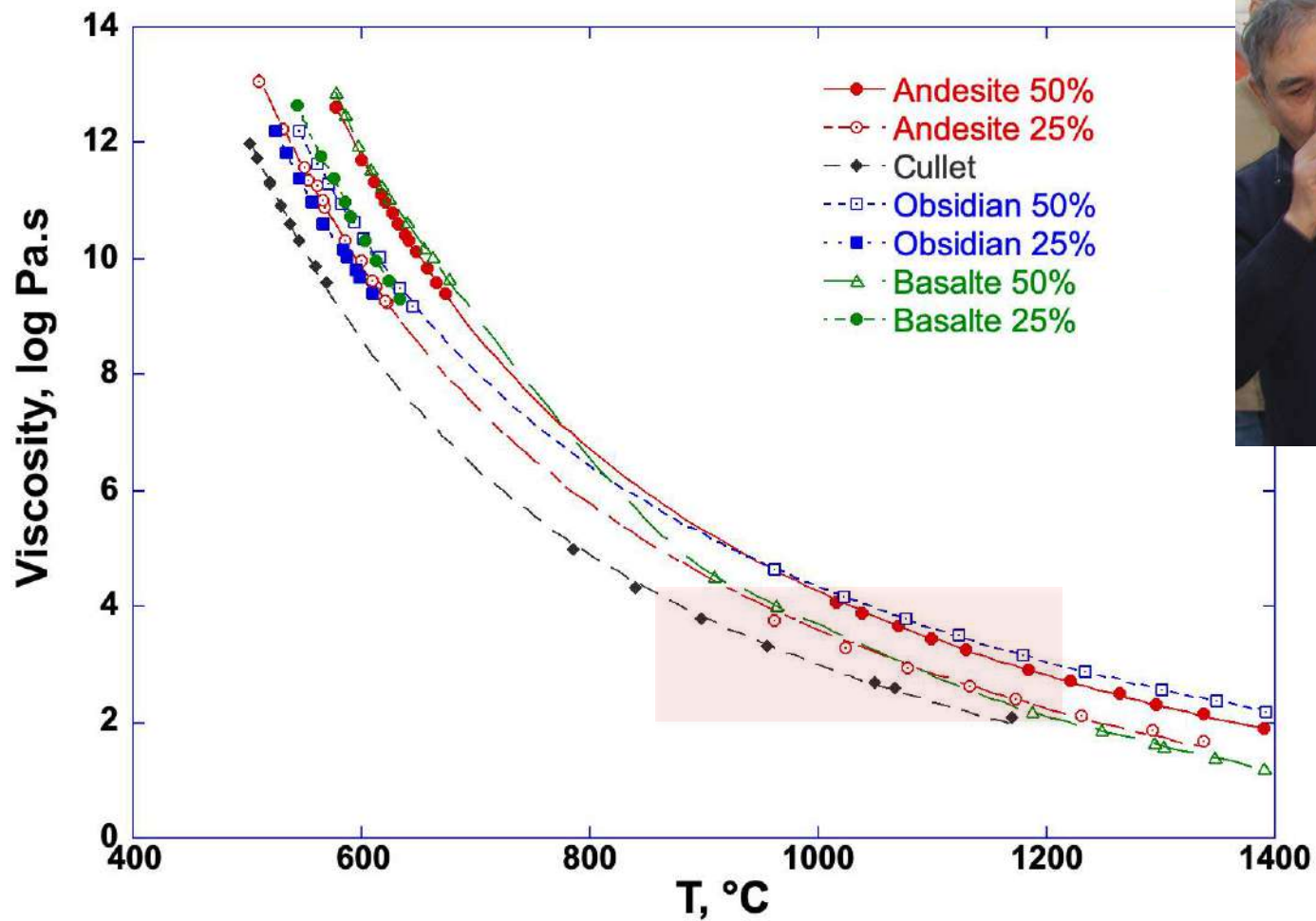


GOURDE
Bénédicte Fondeur











Lycée Jean Monnet, Yzeure : The high school for future glassmakers, where we experiment with new compositions



With the participation of the younger generation of glassmakers and Allain Guillot, MOF.

