

MATTIA IVALDI



WINE AND SCIENCE  
A LOVE STORY

DENOMINAZIONE DI ORIGINE  
CONTROLLATA E GARANTITA

IMBOTTIGLIATO ALL'ORIGINE DA  
MATTIA IVALDI  
UNIVERSITA' DEGLI STUDI DI TORINO - ITALIA

CONTIENE SOLFITI - CONTAINS SULPHITES -  
ITALIA L12LCH

Net. Cont. 750 ML e PRODUCT OF ITALY Alc. 13,5 % by Vol.

# Outline

1. Back in the '800
2. Message in a bottle
3. An help from Physics



Vigna Rionda, Serralunga D'Alba (CN), Italy – one of the finest Italian MeGA (*cru*)



*Pinot Noir*

*Where does the wine come from?*

France

Egypt

Georgia

Italy



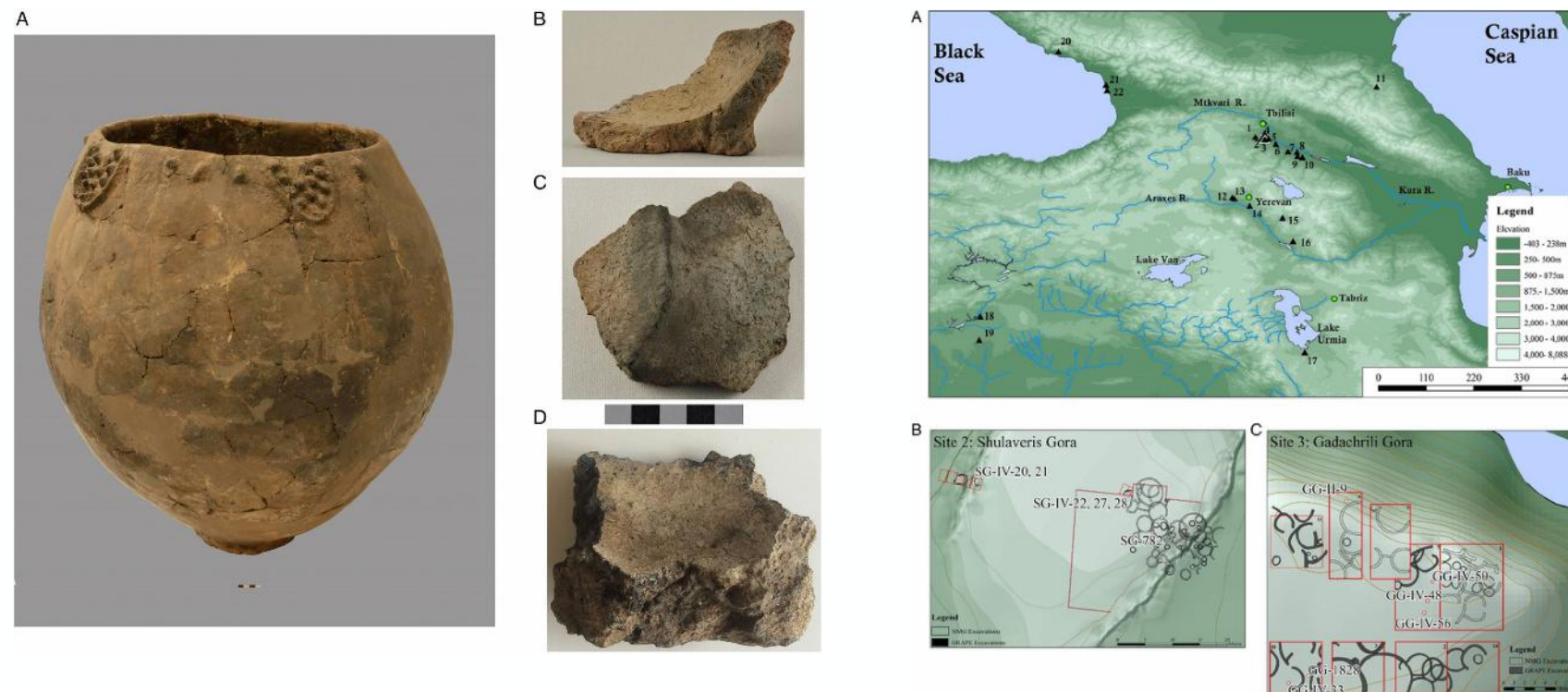
# Where does the wine come from?

France

Egypt

Georgia

Italy



McGovern P. et al, Early Neolithic wine of Georgia in the South Caucasus, PNAS November 28, 2017 114 (48) E10309-E10318

# Back in the '800

THE  
LONDON, EDINBURGH, AND DUBLIN  
PHILOSOPHICAL MAGAZINE  
AND  
JOURNAL OF SCIENCE.

CONDUCTED BY

SIR DAVID BREWSTER, K.H. LL.D. F.R.S.L. & E. &c.  
RICHARD TAYLOR, F.L.S. G.S. Astr. S. Nat. H. Mosc. &c.  
SIR ROBERT KANE, M.D. M.R.I.A.  
WILLIAM FRANCIS, PH.D. F.L.S. F.R.A.S. F.C.S.  
JOHN TYNDALL, PH.D. F.R.S. &c.

*"Nec araneorum sane textus ideo melior quia ex se fila gignunt, nec noster vilior quia ex alienis libamus ut apes."* JUST. LIPS. *Polit. lib. i. cap. I. Not.*

VOL. X.—FOURTH SERIES.  
JULY—DECEMBER, 1855.

LONDON.

TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET,  
*Printers and Publishers to the University of London;*

SOLD BY LONGMAN, BROWN, GREEN, AND LONGMANS; SIMPKIN, MARSHALL  
AND CO.; WHITTAKER AND CO.; AND PIPER AND CO., LONDON:

—BY ADAM AND CHARLES BLACK, AND THOMAS CLARK,  
EDINBURGH; SMITH AND SON, GLASGOW; HODGES  
AND SMITH, DUBLIN; AND PUTNAM,  
NEW YORK.

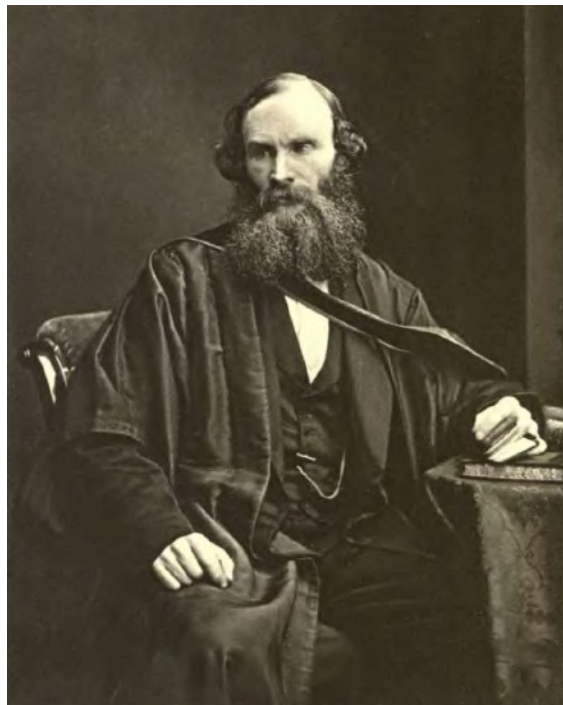
**XLII. *On certain curious Motions observable at the Surfaces of Wine and other Alcoholic Liquors.* By JAMES THOMSON, A.M., C.E., Belfast\*.**



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## Back in the '800

**T**HE phænomena of capillary attraction in liquids are accounted for, according to the generally received theory of Dr. Young, by the existence of forces equivalent to a tension of the surface of the liquid, uniform in all directions, and independent of the form of the surface. The tensile force is not the same in different liquids. Thus it is found to be much less in alcohol than in water. This fact affords an explanation of several very curious motions observable, under various circumstances, at the surfaces of alcoholic liquors.



James Thomson FRS FRSE LLD

Belfast, 16/02/1822–Glasgow, 08/05/1892

Physicist, engineer, inventor, polyedric scientist.

*Fun fact:* proposed the triple-point concept.

**VIDEO**

**<https://tinyurl.com/y3wjb6fr>**

# *Back in the '800*



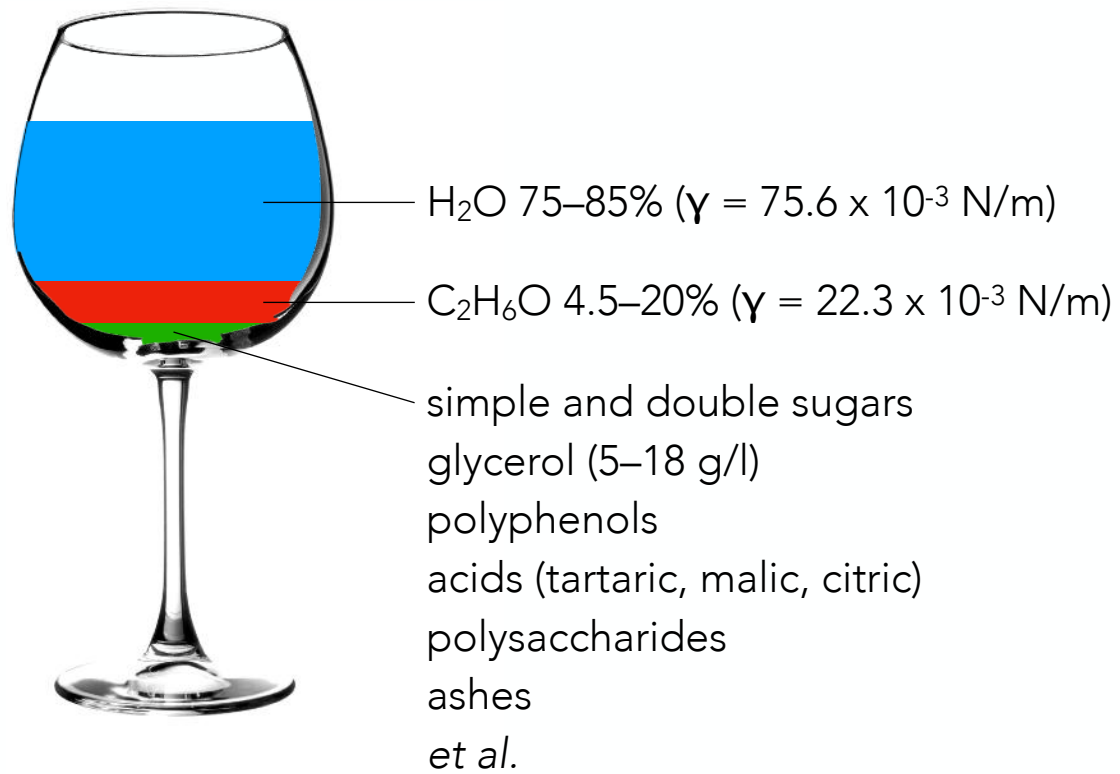
Carlo Marangoni

Pavia, 29/04/1840–Firenze, 14/04/1925

Physicist.

*Fun fact:* invented a Nefoscopio to observe clouds.

# Back in the '800



Carlo Marangoni

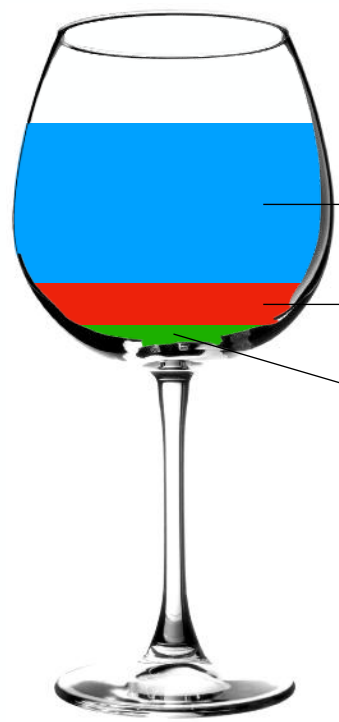
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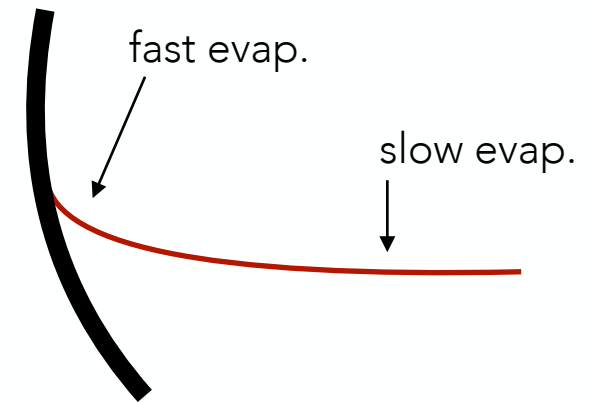
# Back in the '800



H<sub>2</sub>O 75–85% ( $\gamma = 75.6 \times 10^{-3} \text{ N/m}$ )

C<sub>2</sub>H<sub>6</sub>O 4.5–20% ( $\gamma = 22.3 \times 10^{-3} \text{ N/m}$ )

simple and double sugars  
glycerol (5–18 g/l)  
polyphenols  
acids (tartaric, malic, citric)  
polysaccharides  
ashes  
*et al.*



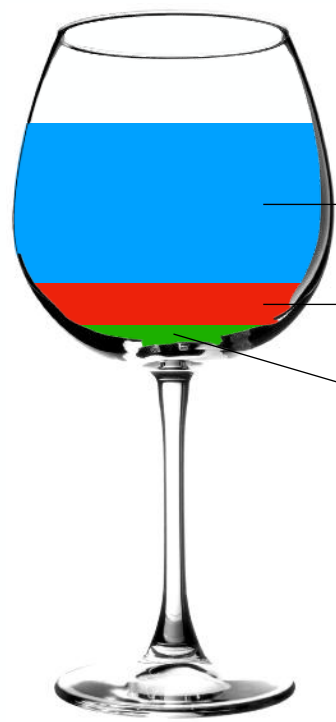
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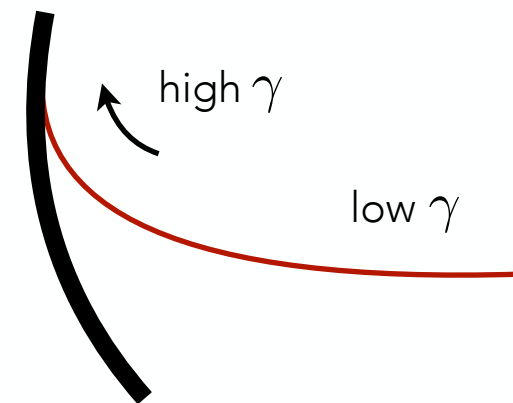
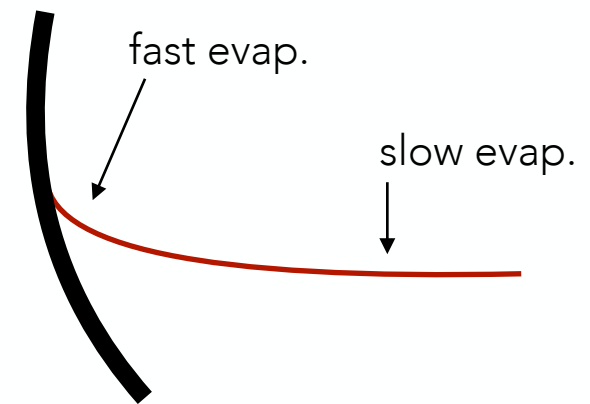
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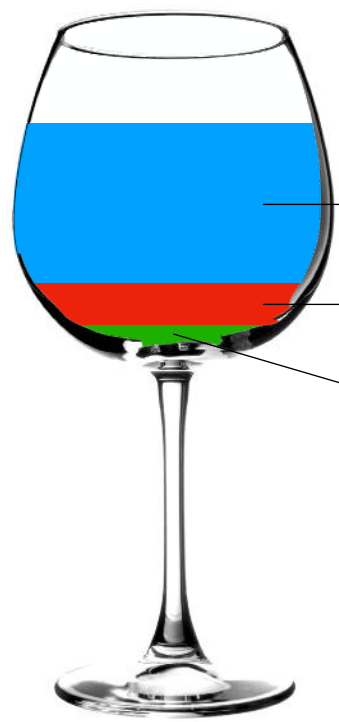
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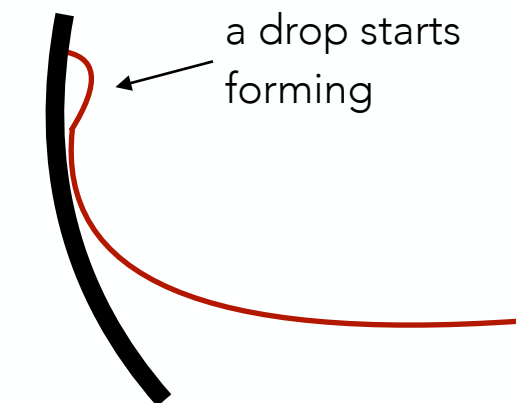
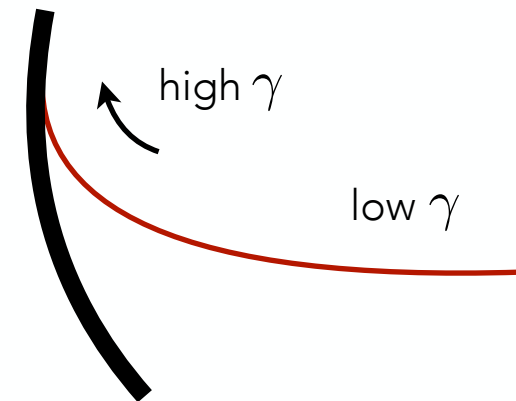
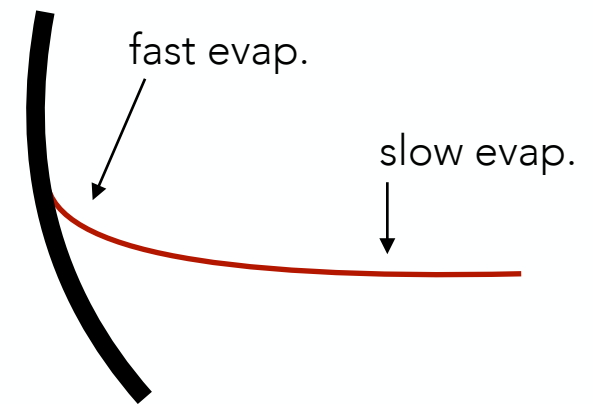


Carlo Marangoni

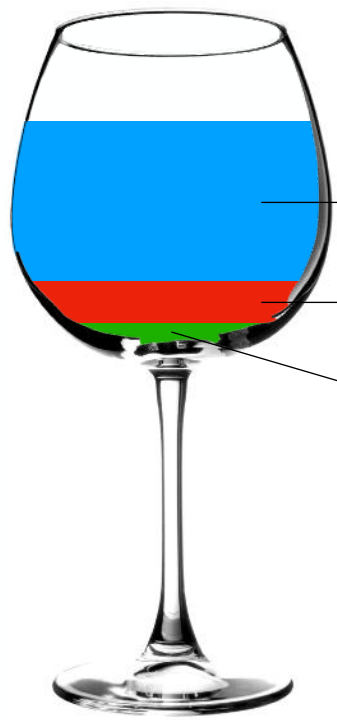
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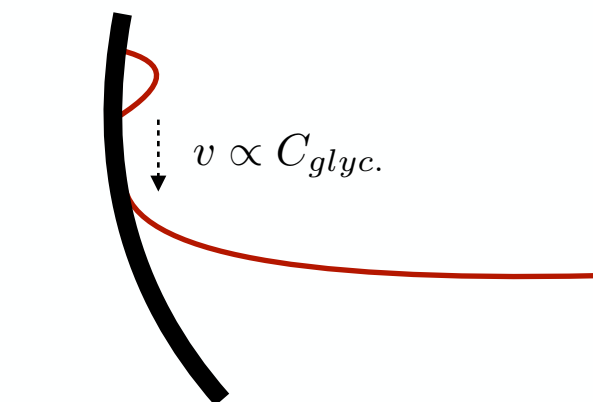
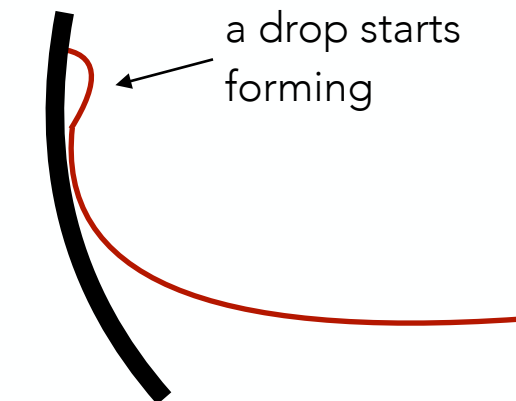
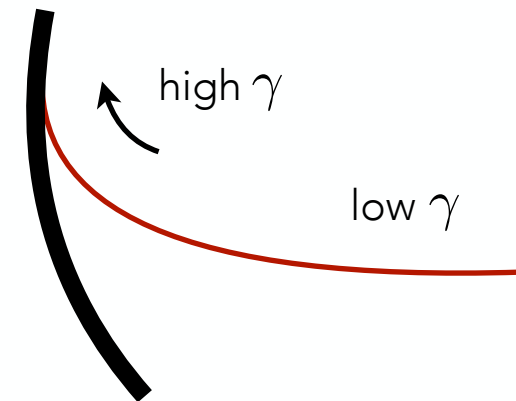
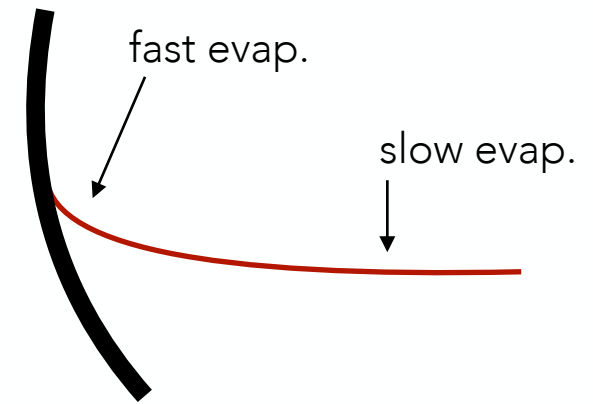


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*How old is the oldest still-drinkable Champagne?*

179 y

194 y

113 y

54 y

*How old is the oldest still-drinkable Champagne?*

179 y

194 y

113 y

54 y



*"heavily oxidised, with a sherry-like character, notes of truffles, caramel and mushrooms, complex flavour of figs and even a slight nose of sea"*



# Message in a bottle



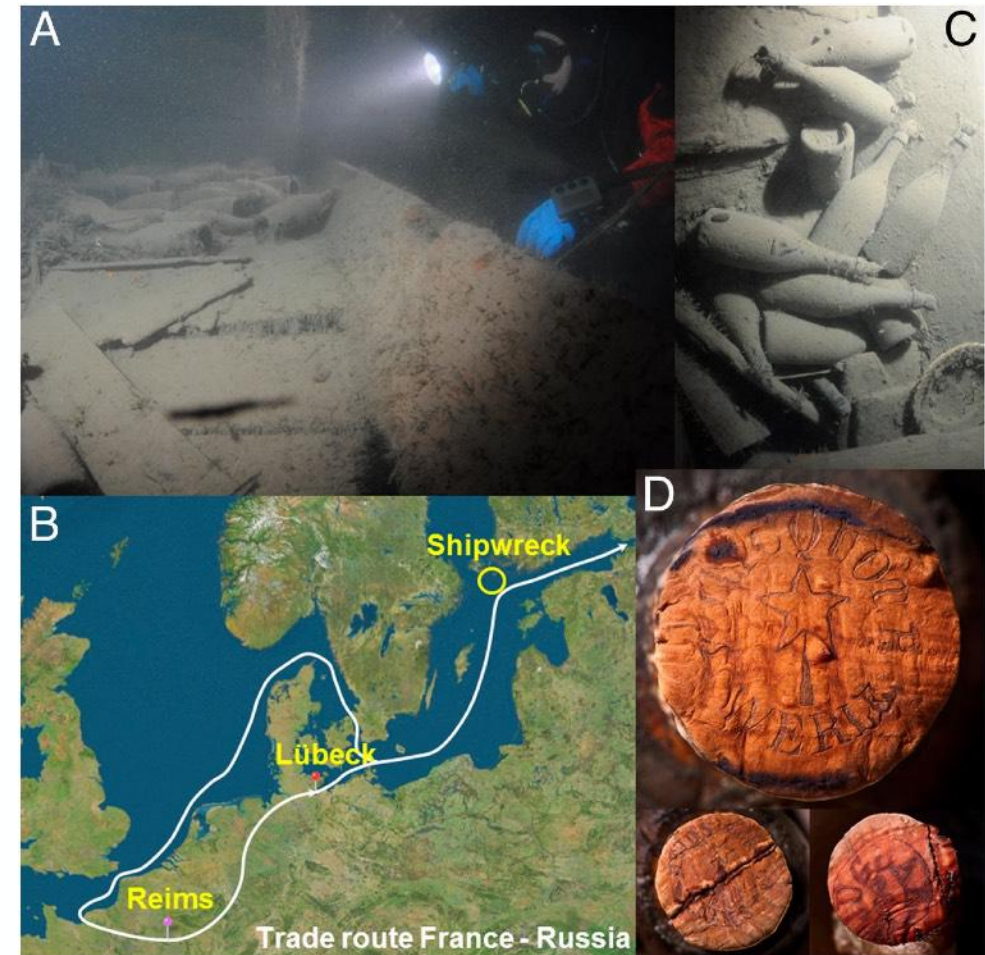
Landskapet Åland (Island of perch)  
6500+ islands and cliffs  
Population 29489 (2017)



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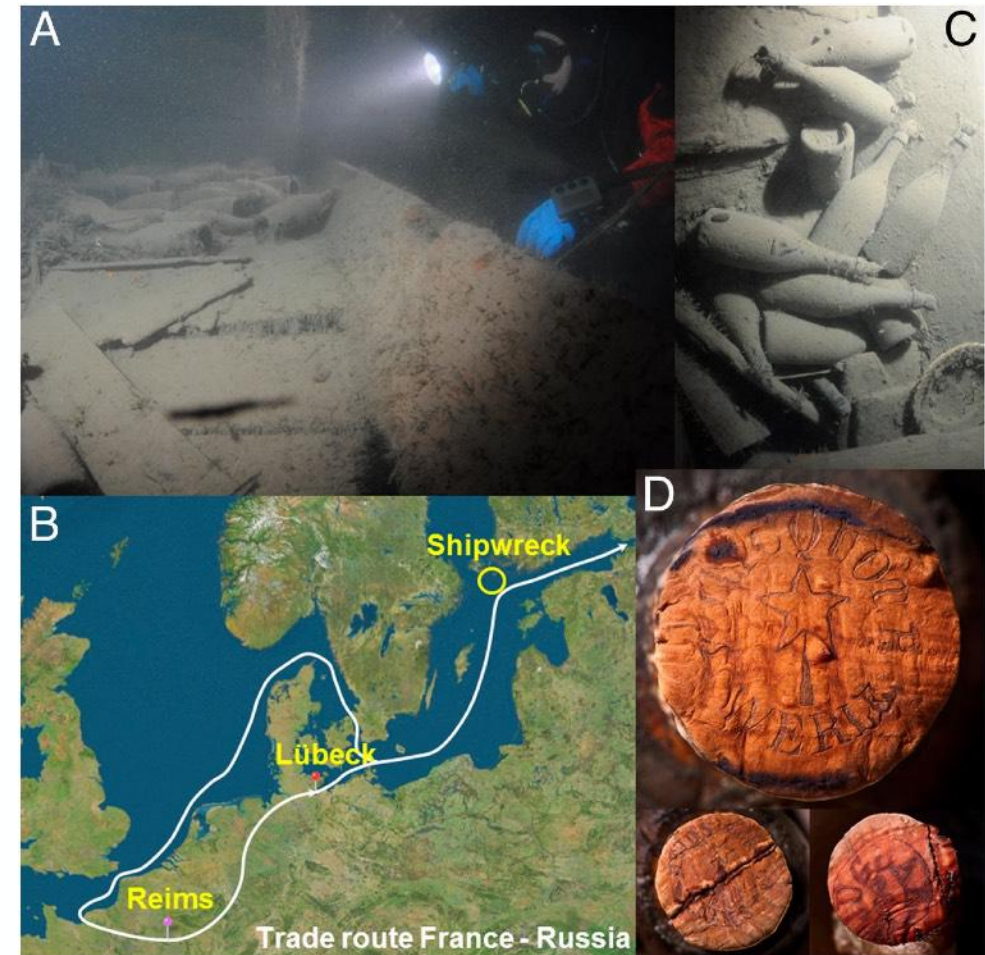
Jeandet P. et al, Chemical messages in 170-year-old champagne bottles from the Baltic Sea: Revealing tastes from the past, PNAS May 12, 2015 112 (19) 5893-5898



# Message in a bottle



Landskapet Åland (Island of perch)  
6500+ islands and cliffs  
Population 29489 (2017)



Close-to-perfect slow-aging conditions:

- ▶ total darkness;
- ▶ fairly constant temperature (2–4 °C);
- ▶ low salinity (<10 g/kg NaCl).

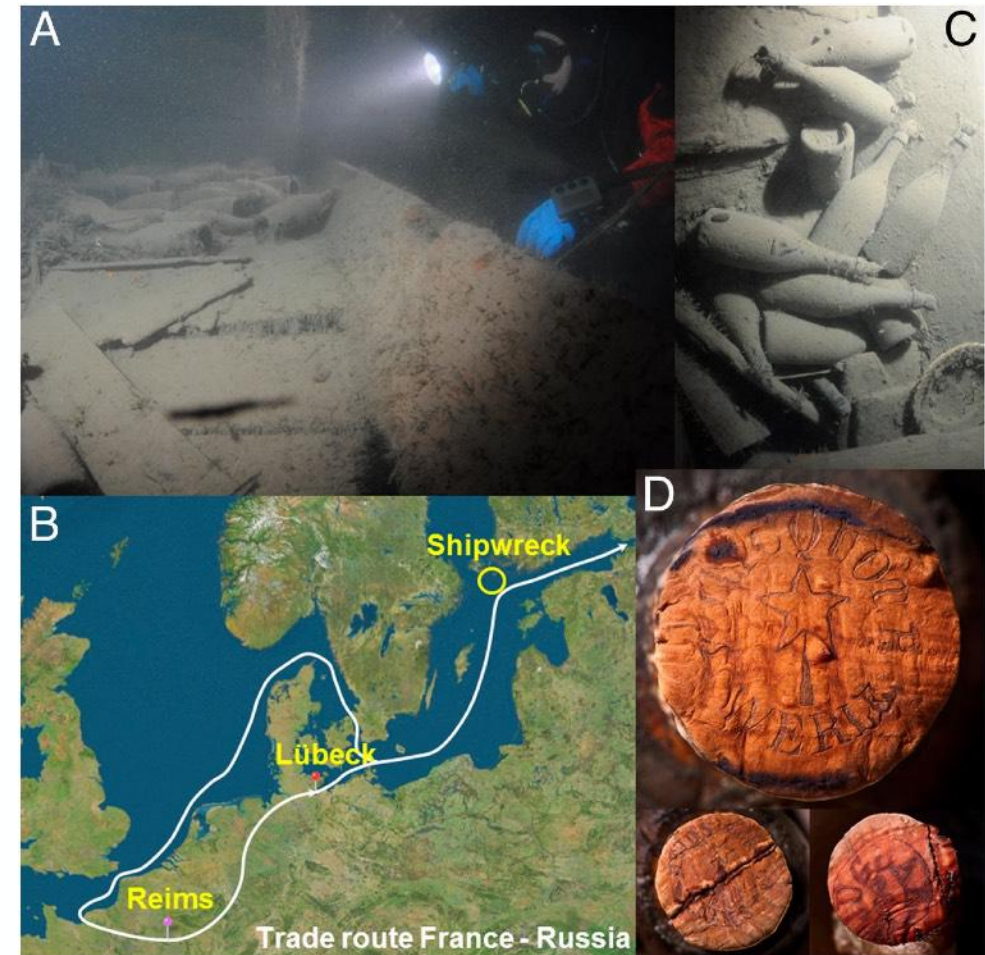
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- ▶ low salinity (<10 g/kg NaCl).

- ★ When were these wines produced?
- ★ What winemaking processes were in use at the time?
- ★ Were they traveling on a regular trade route?
- ★ What was their final destination?

Jeandet P. et al, Chemical messages in 170-year-old champagne bottles from the Baltic Sea: Revealing tastes from the past, PNAS May 12, 2015 112 (19) 5893-5898

# Message in a bottle



3x

VS



3x

Jeandet P. et al, Chemical messages in 170-year-old champagne bottles from the Baltic Sea: Revealing tastes from the past, PNAS May 12, 2015 112 (19) 5893-5898

# Message in a bottle

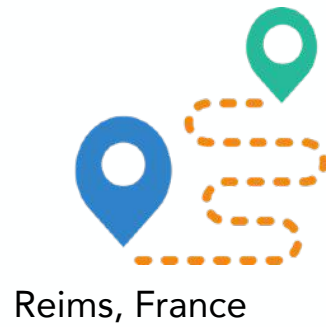


3x

vs



3x



What was the final destination?

- ▶ extraordinary high sugar content ( $> 140$  g/l) wrt current *liqueur d'expédition* dosage (0–50 g/l)

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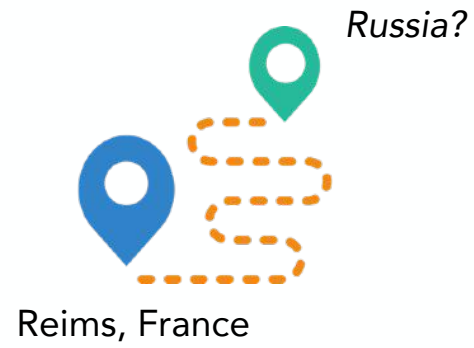


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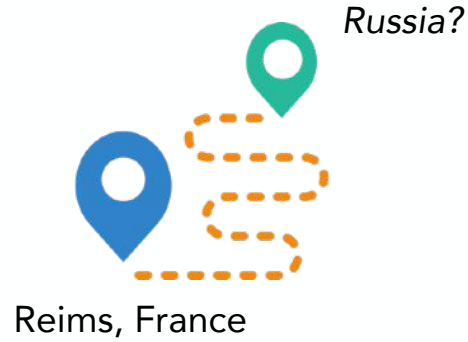


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**The Champagne à la Russe had a sugar dosage of 300 g/l!**

Here they always have some sugar on any table close to their wine glass, for they add sugar not only to red wine but also to champagne.

Veuve Clicquot Archives (1810–1840) Correspondence exchanged by Madame Clicquot with Louis Bohne and Louis Boissonnet, 1810s–1840s (Veuve Clicquot Archives, Reims, France)

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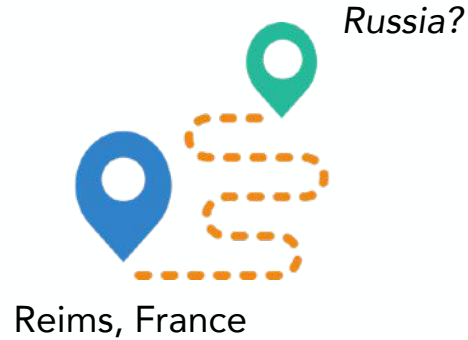


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What winemaking processes were in use at that time?

- ▶ unusually high metallic cation concentration (Fe 13–118 mg/l, Cu 100–1400  $\mu$ g/l) wrt to modern Champagne (Fe 1–4.6 mg/l, Cu 27–78  $\mu$ g/l): higher use of the *taille*, Cu sulfate already used despite the first traces of *buillie bordelaise* (1880s);
- ▶ high malic acid contents (malic/lactic acid ratio 0.46–0.81): malolactic fermentation was left uncontrolled, and was occurring either in barrels at the beginning of spring or in the bottle;
- ▶ *et al.*

Jeandet P. et al, Chemical messages in 170-year-old champagne bottles from the Baltic Sea: Revealing tastes from the past, PNAS May 12, 2015 112 (19) 5893–5898



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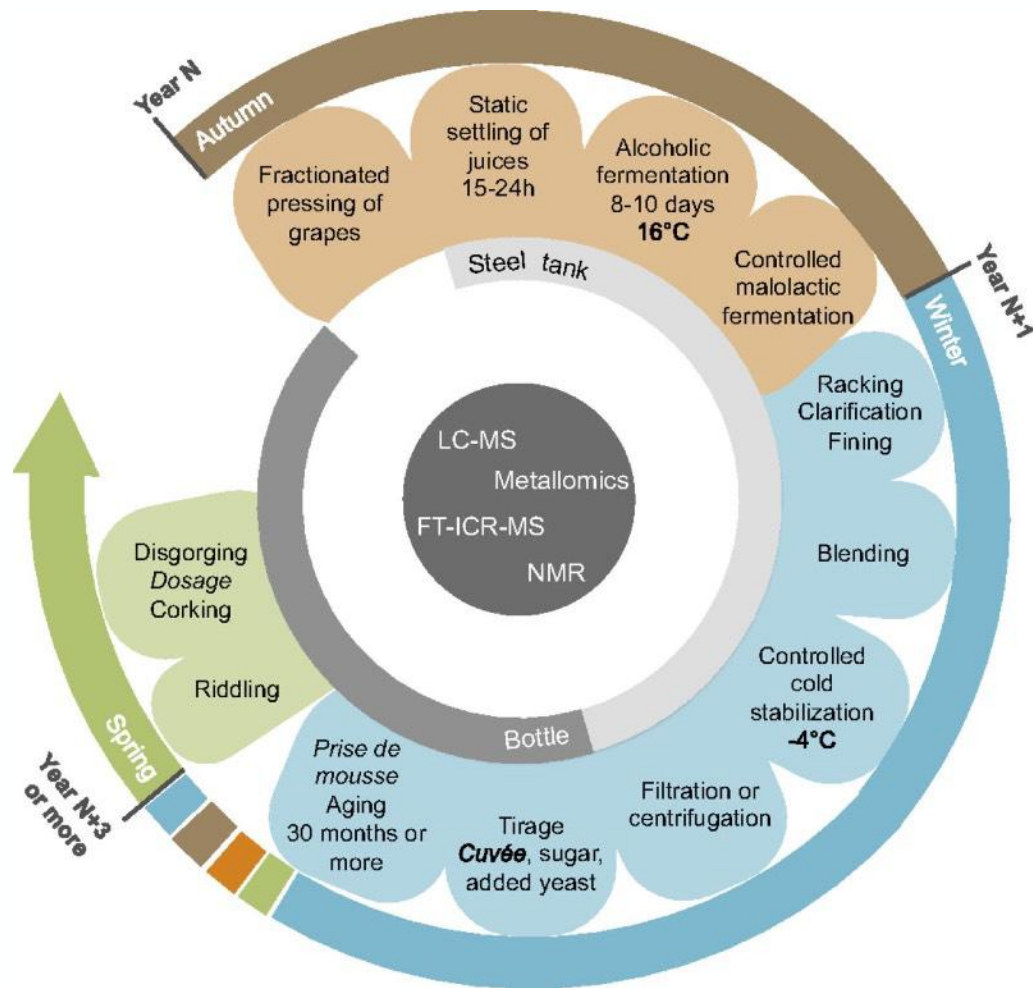
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- ▶ high malic acid contents (malic/lactic acid ratio 0.46–0.81): malolactic fermentation was left uncontrolled, and was occurring either in barrels at the beginning of spring or in the bottle;
- ▶ *et al.*

What is the flavour of the Baltic Champagne?

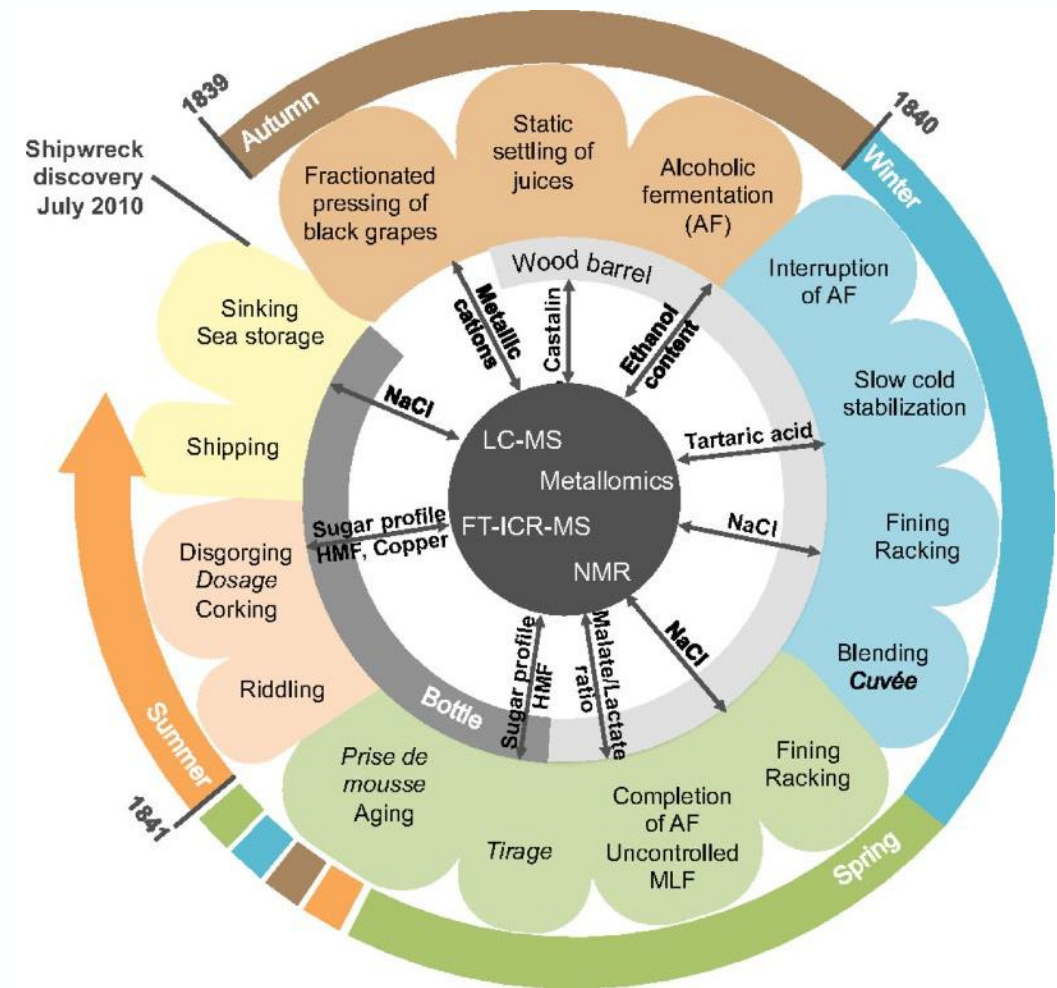
- ▶ animal and empyreumatic notes from volatile phenols, *Brettanomyces*, and *Saccharomyces cerevisiae*;
- ▶ reduction and wet hair from light sulfurous compounds;
- ▶ cheesy from butanoic and octanoic acids;
- ▶ upon swirling: grilled, spicy, smoky, leathery, fruity and floral notes

Jeandet P. et al, Chemical messages in 170-year-old champagne bottles from the Baltic Sea: Revealing tastes from the past, PNAS May 12, 2015 112 (19) 5893–5898

# Message in a bottle



Modern Champagne-making process



Putative Champagne-making process at the beginning of the 19th century.

Jeandet P. et al, Chemical messages in 170-year-old champagne bottles from the Baltic Sea: Revealing tastes from the past, PNAS May 12, 2015 112 (19) 5893-5898

*How much does the most expensive wine cost?*

368 k\$

558 k\$

250 k\$

2.1 M\$

How much does the most expensive wine cost?



Romanée Conti Vigne Originelle Française Non Reconstituée 1945  
Domaine de la Romanée-Conti

368 k\$

558 k\$

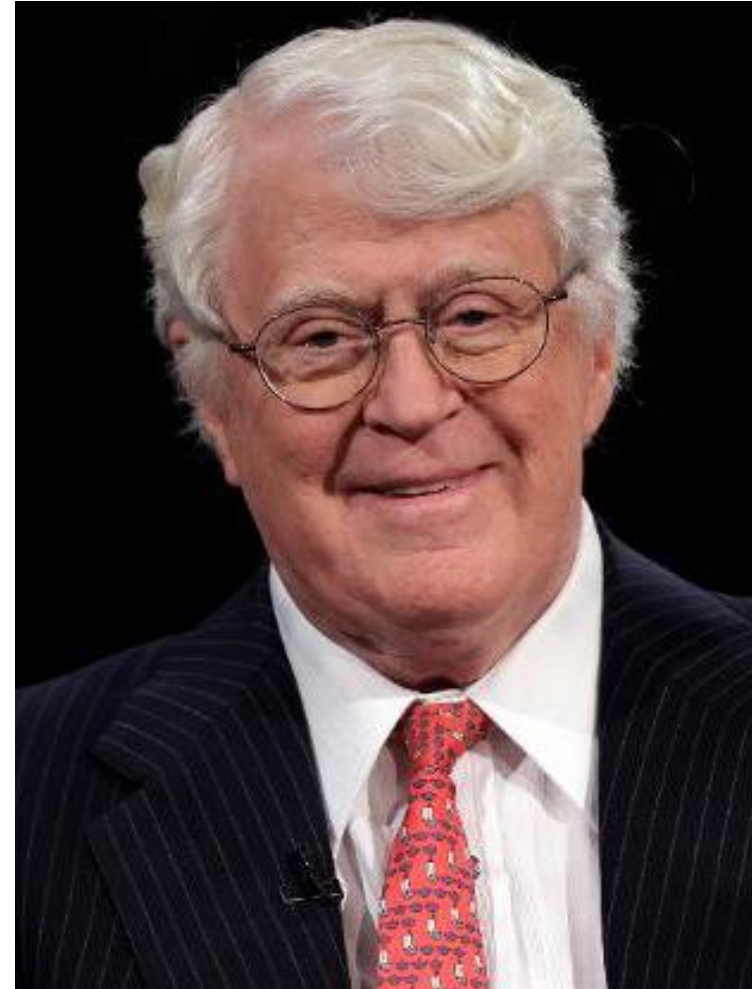
250 k\$

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# *An help from Physics*

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# An help from Physics

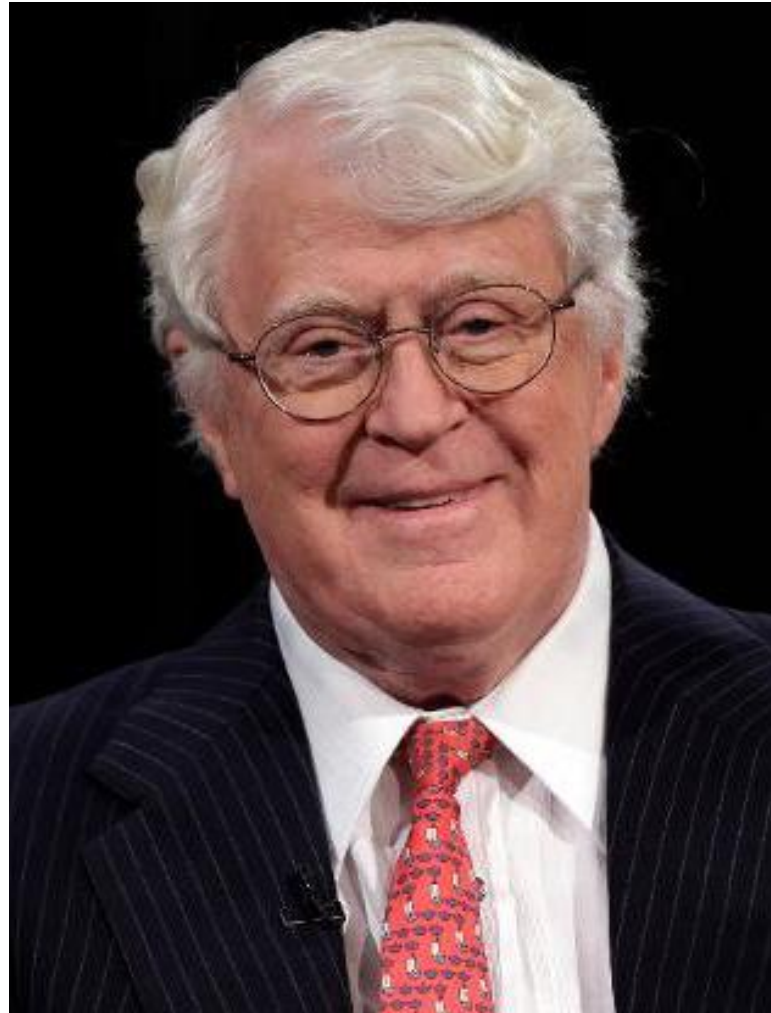


William (Bill) Koch  
Businessman, sailor, collector.  
1.8 G\$ net worth





# An help from Physics



William (Bill) Koch  
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500 k\$



# An help from Physics



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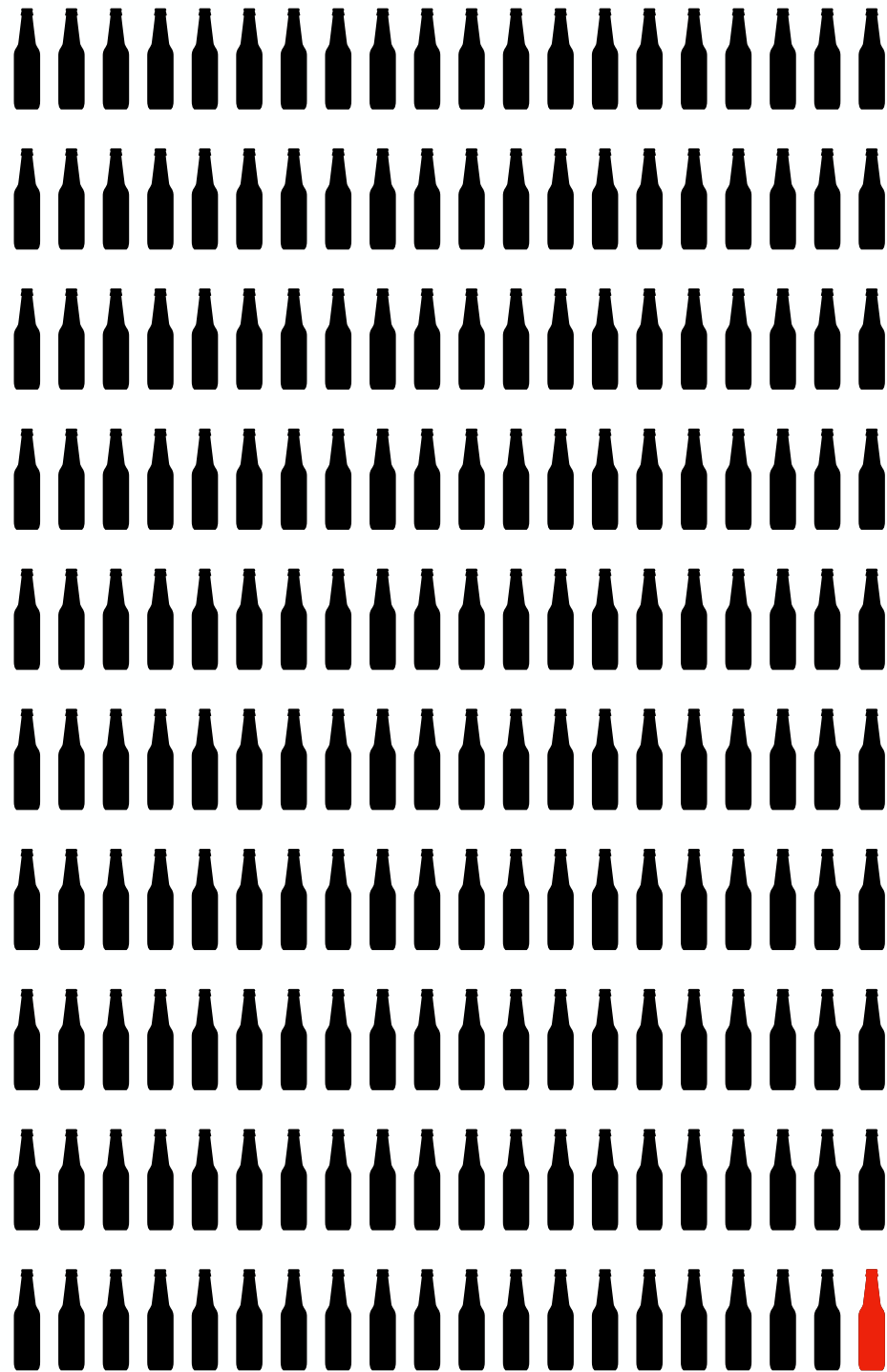
500 k\$

# *An help from Physics*



# *An help from Physics*

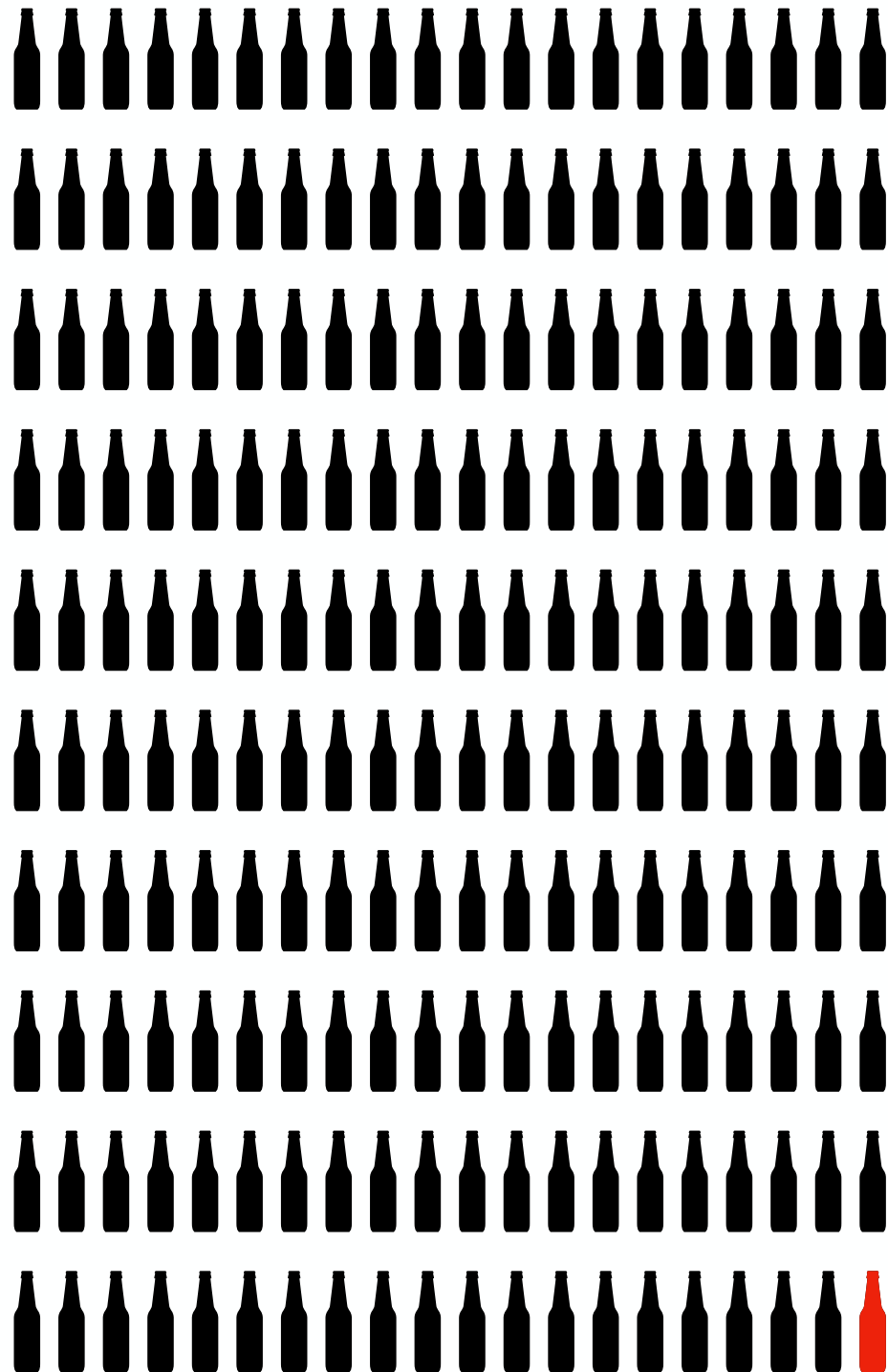
400/43000



4.5 M\$

# An help from Physics

400/43000



4.5 M\$

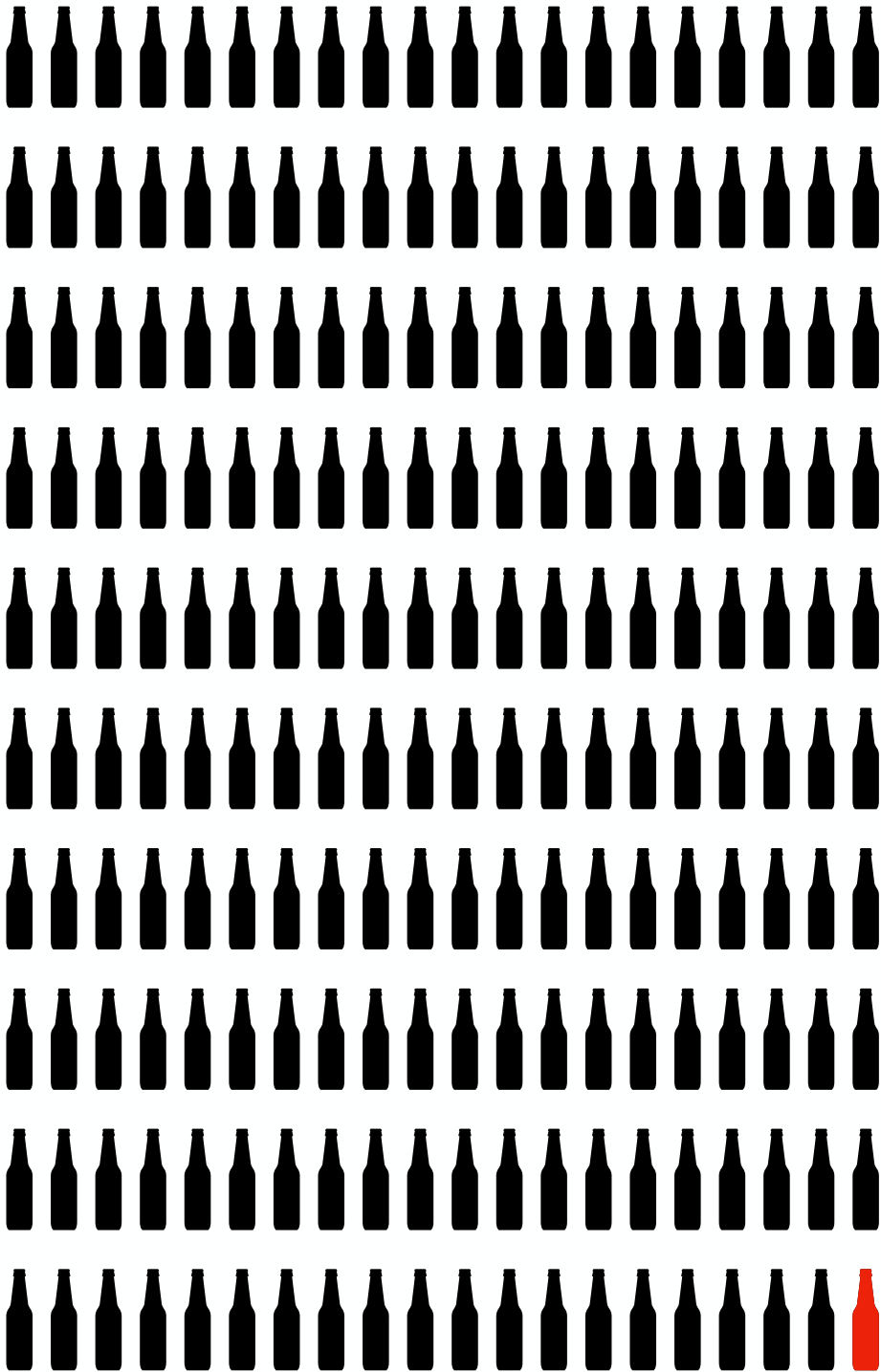


Rudy Kurniawan (Zhen Wang Huang)  
Wine collector, crook.  
Earliest possible release date 09/01/2021



# An help from Physics

400/43000

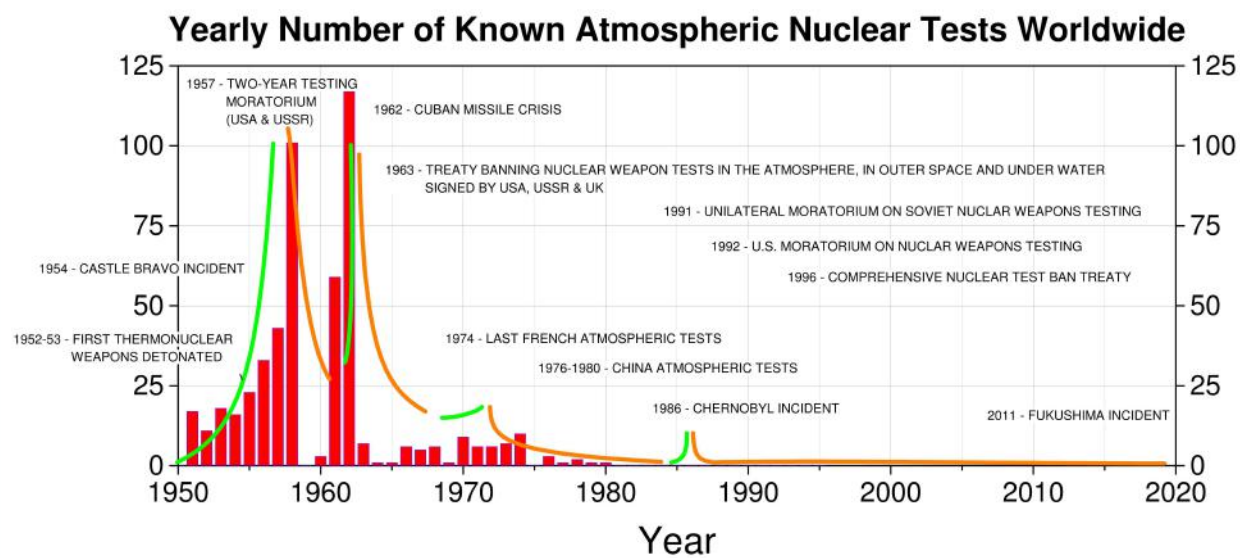


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S. Pravikoff, Michael & Marquet, Christine & Hubert, Philippe.  
(2018). Dating of wines with cesium-137: Fukushima's imprint.

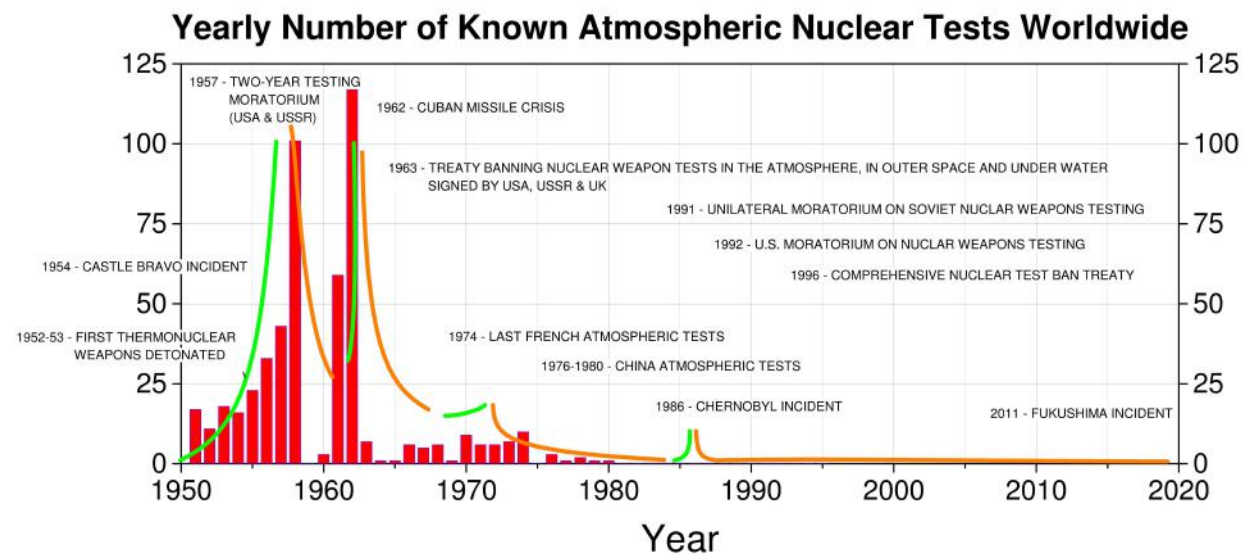
P. Hubert, F. Hubert, V. Raffestin-Tort. La datation des vins; une application des mesures des très faibles radioactivités. Bulletin de l'Union des Physiciens 862 (2004) p. 381.

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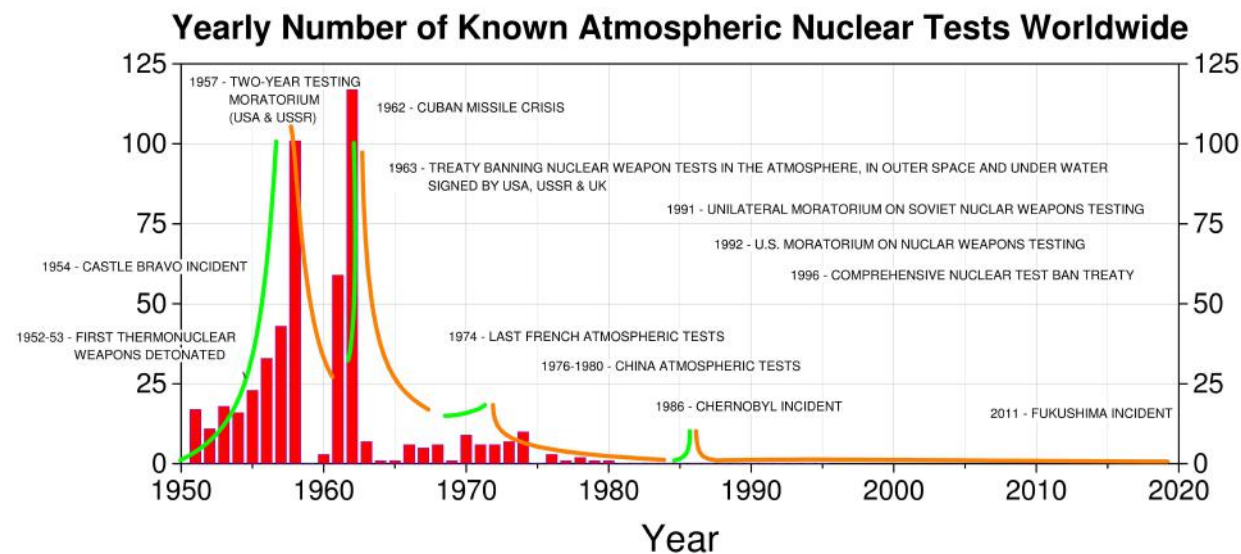
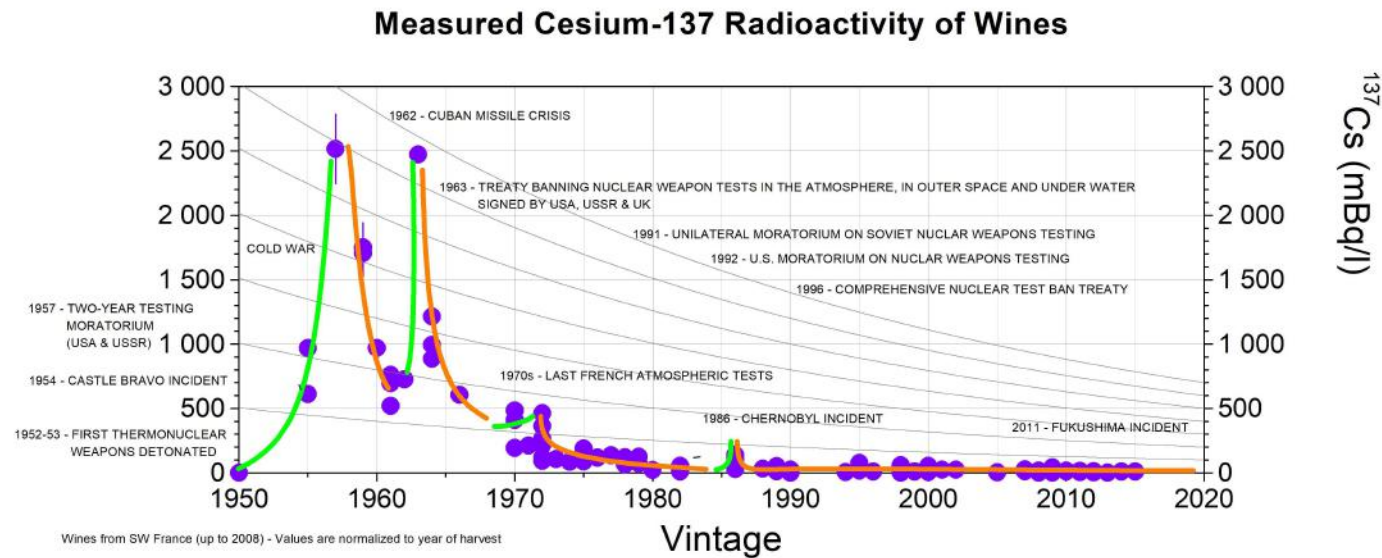


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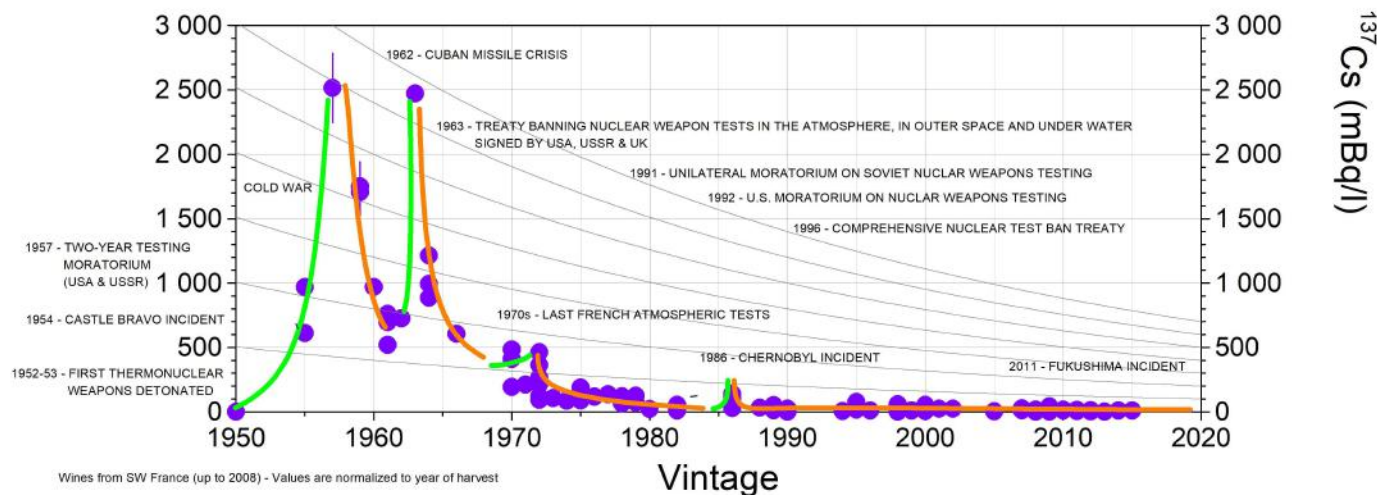
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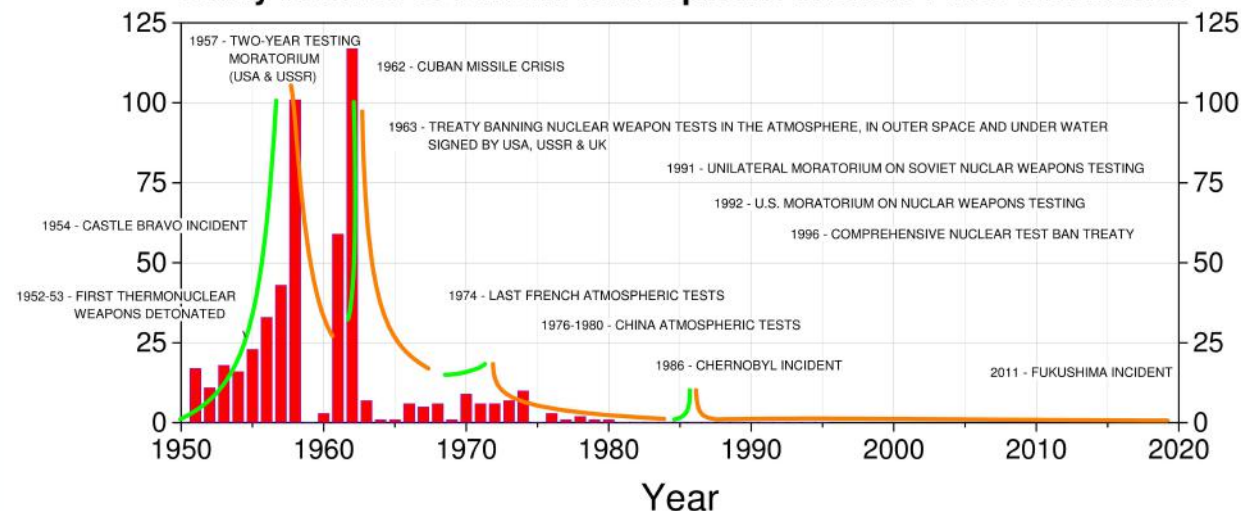
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**Measured Cesium-137 Radioactivity of Wines**

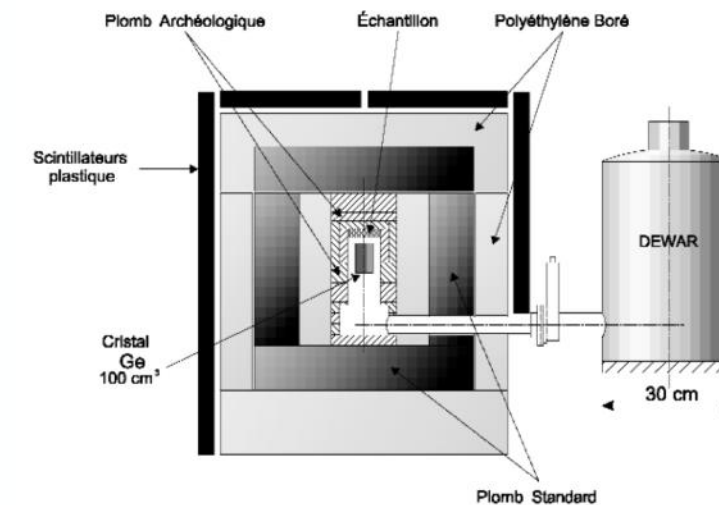
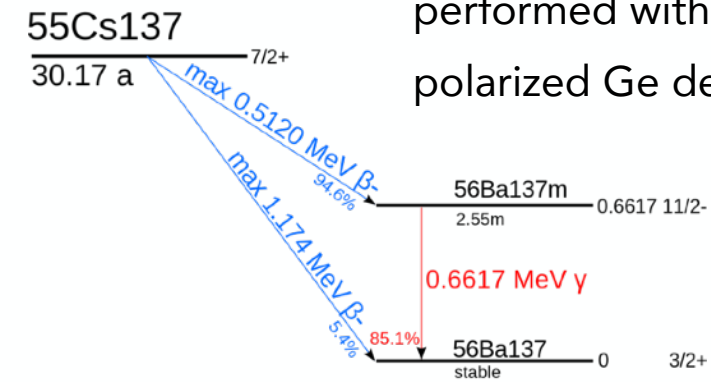


**Yearly Number of Known Atmospheric Nuclear Tests Worldwide**



S. Pravikoff, Michael & Marquet, Christine & Hubert, Philippe.  
(2018). Dating of wines with cesium-137: Fukushima's imprint.

Non-invasive  $\gamma$  spectroscopy  
performed with an inverse-  
polarized Ge detector



Sensitivity  
down to  
0.01 Bq/l!

P. Hubert, F. Hubert, V. Raffestin-Tort. La datation des vins; une application des mesures des très faibles radioactivités. Bulletin de l'Union des Physiciens 862 (2004) p. 381.

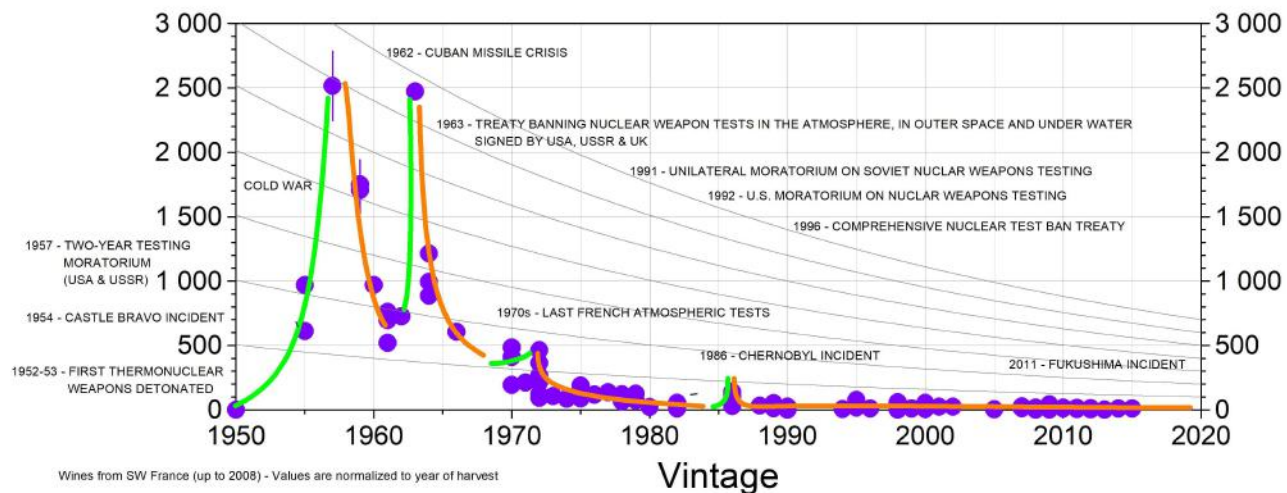
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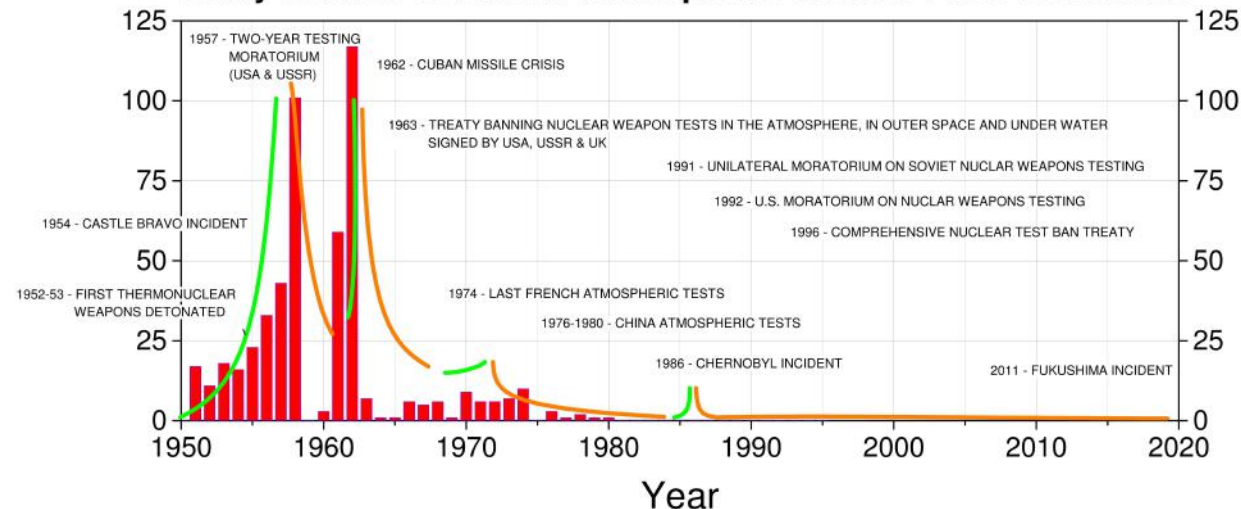
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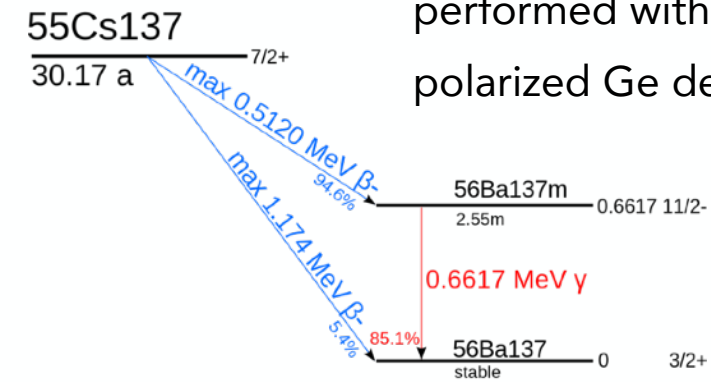


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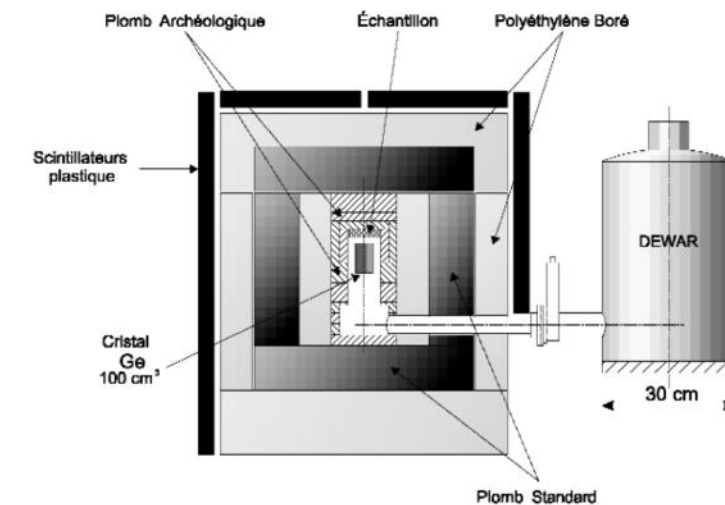


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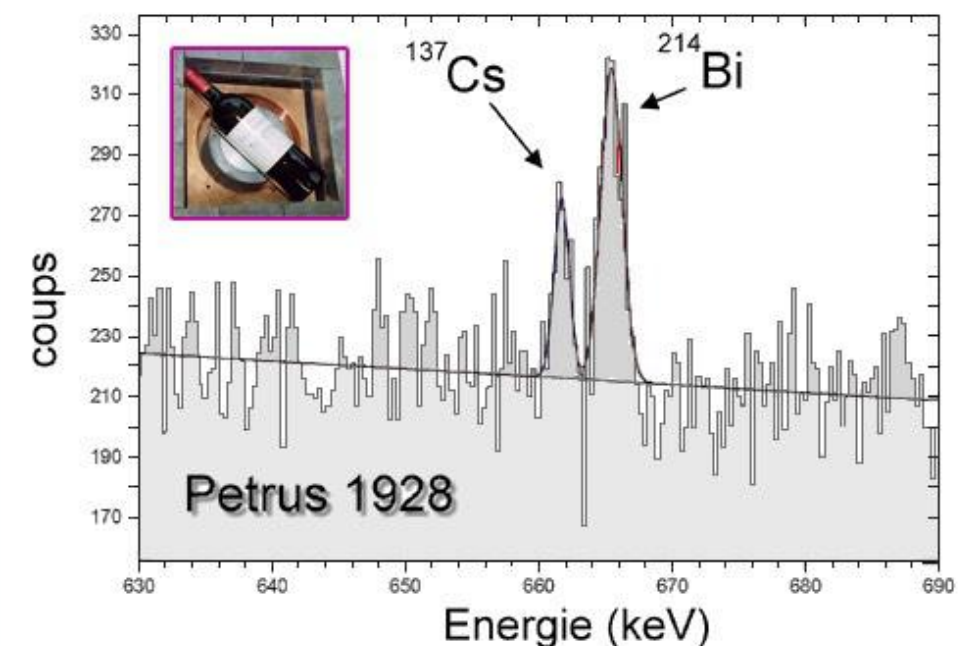
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$^{137}\text{Cs}$  (mBq/l)



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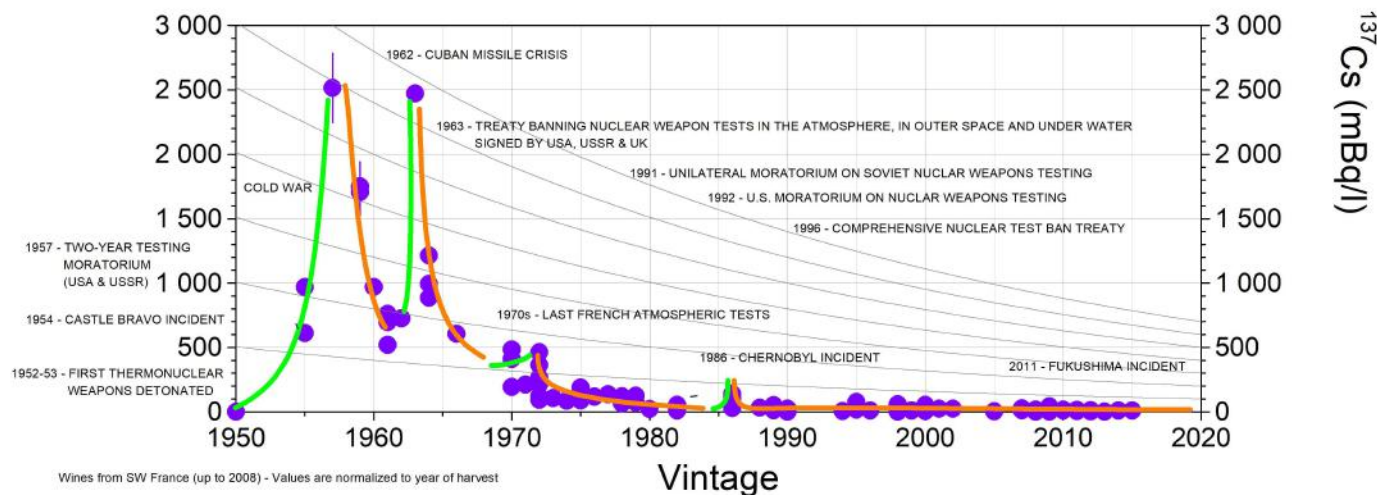
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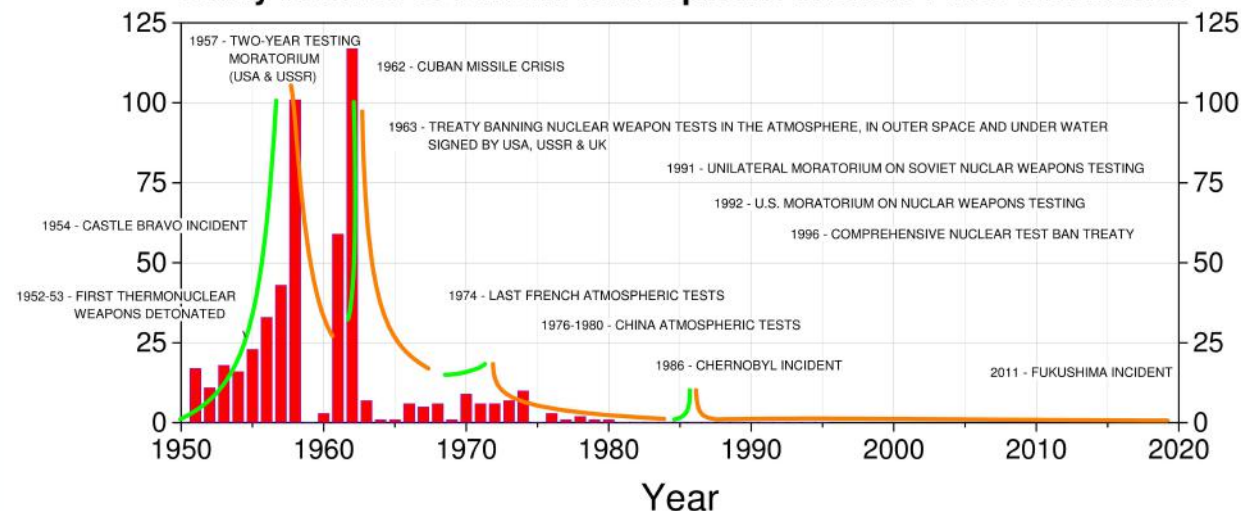
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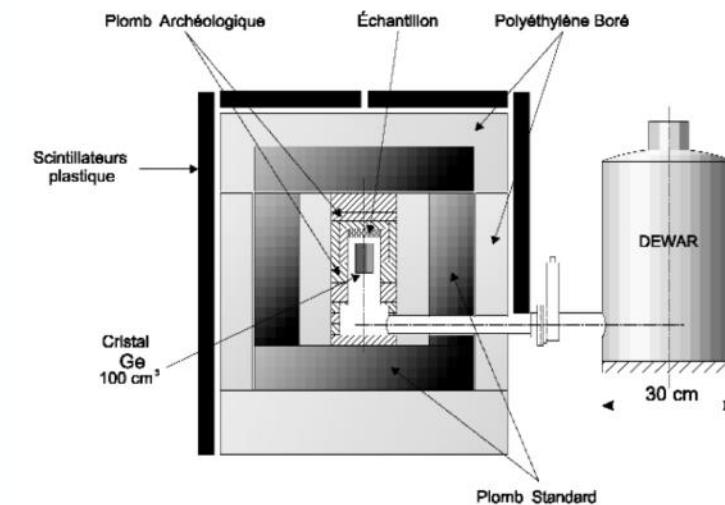
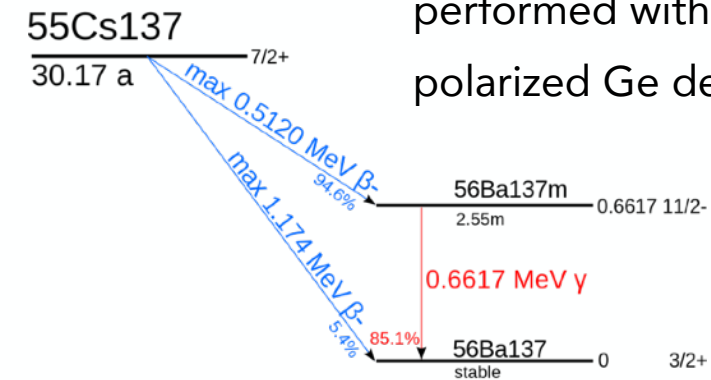


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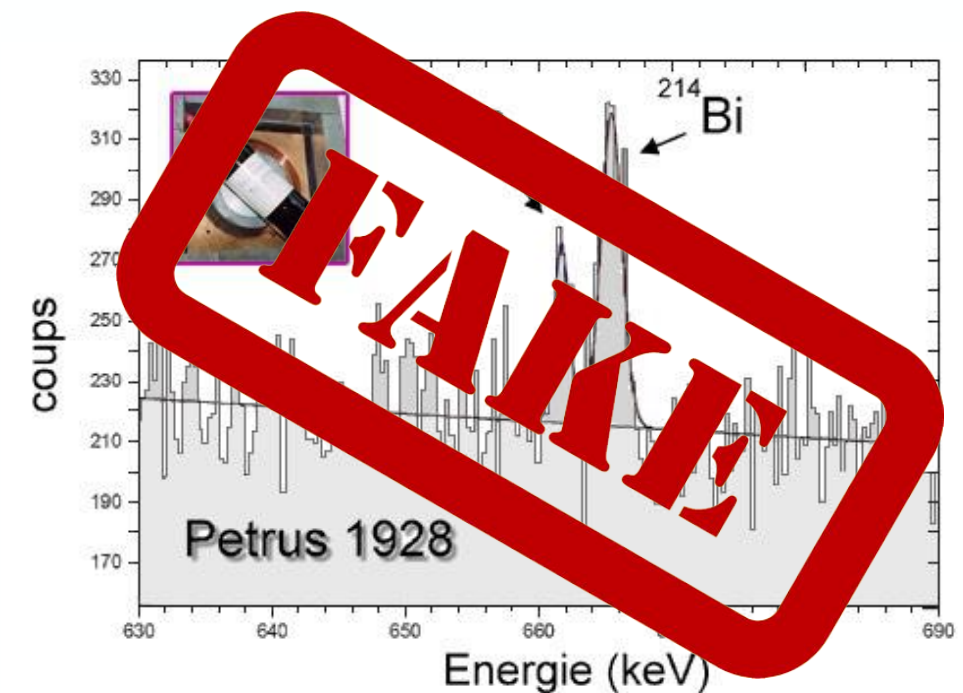


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# *An help from Physics*

The Fukushima incident (11/03/2011) resulted in a radioactive cloud that has crossed the Pacific Ocean to reach the USA west coast. As is the case in Europe following the Chernobyl accident, could we detect a variation in the  $^{137}\text{Cs}$  level in Napa Valley wines?



Fukushima plant, 2011



Opus One vineyard



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Destructive analysis:

- ▶ wine is poured into a crystallizer which is placed in an oven;
- ▶ the temperature gradually rises to  $100^{\circ}\text{C}$ , stay at this value for 1 hour, then rise again to  $500^{\circ}\text{C}$ , and stay at this value for 8 hours—then it turns down (from a 750 ml bottle 2–4 g of wine hash);
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Opus One vineyard

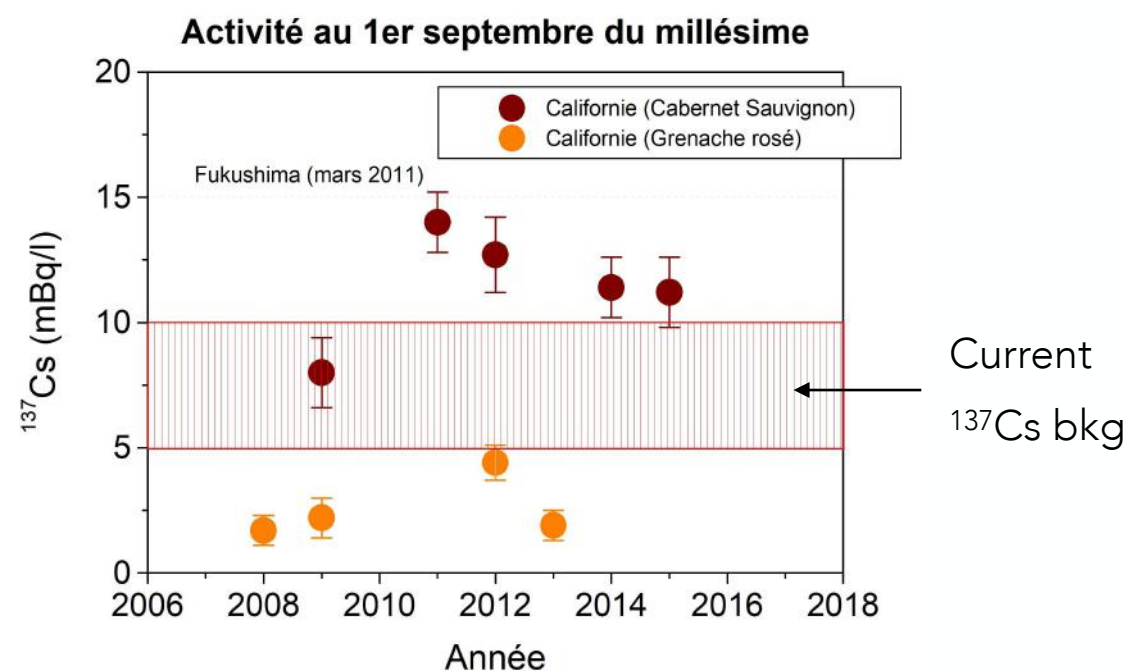


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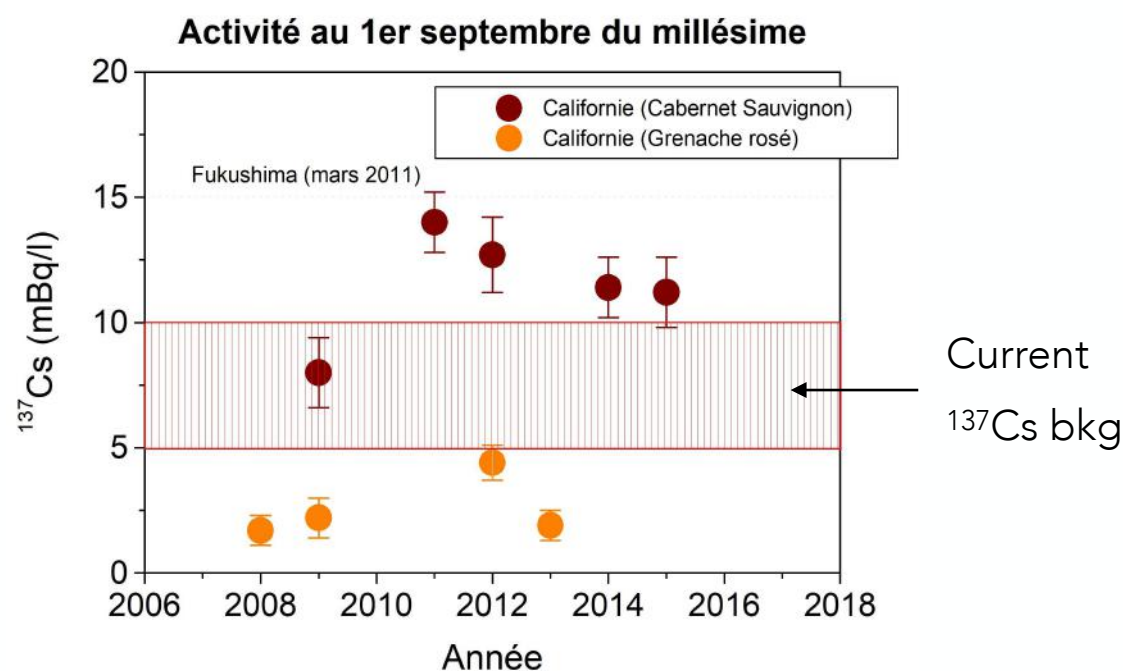


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- ▶ activity increased by a factor of 2
- ▶ white and rosé wines have significantly lower values than red wines

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*Cheers!*



All info and material: <https://tinyurl.com/y2ozafzq>