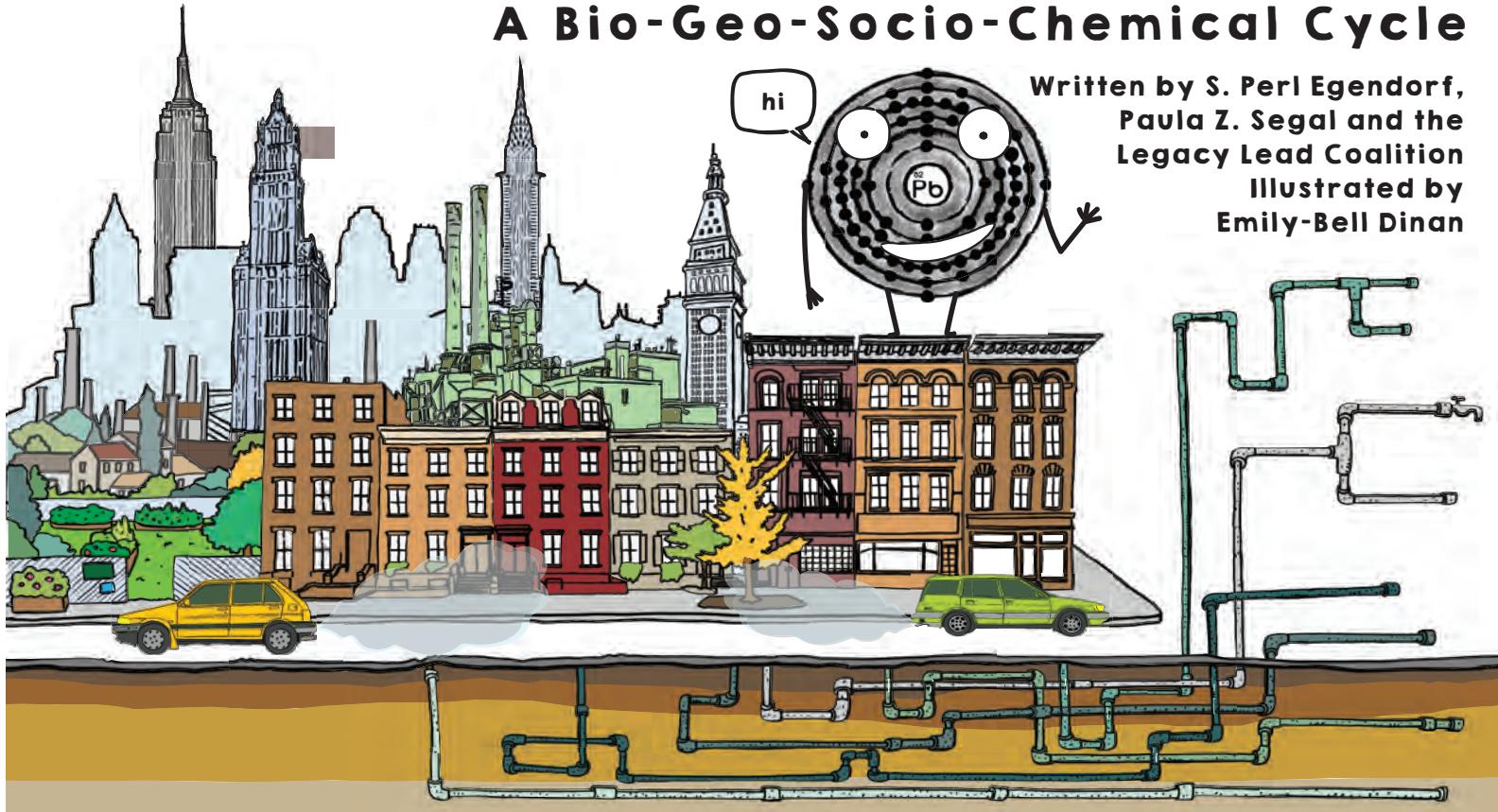


# THE LEGACY OF LEAD

## A Bio-Geo-Socio-Chemical Cycle



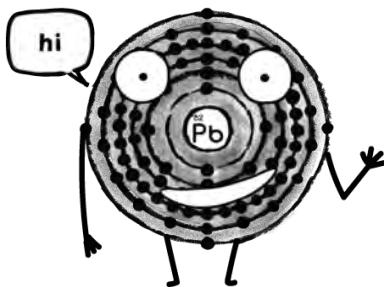
Written by S. Perl Egendorf,  
Paula Z. Segal and the  
Legacy Lead Coalition  
Illustrated by  
Emily-Bell Dinan

THE LEGACY OF LEAD A Bio-Geo-Socio-Chemical Cycle © 2023

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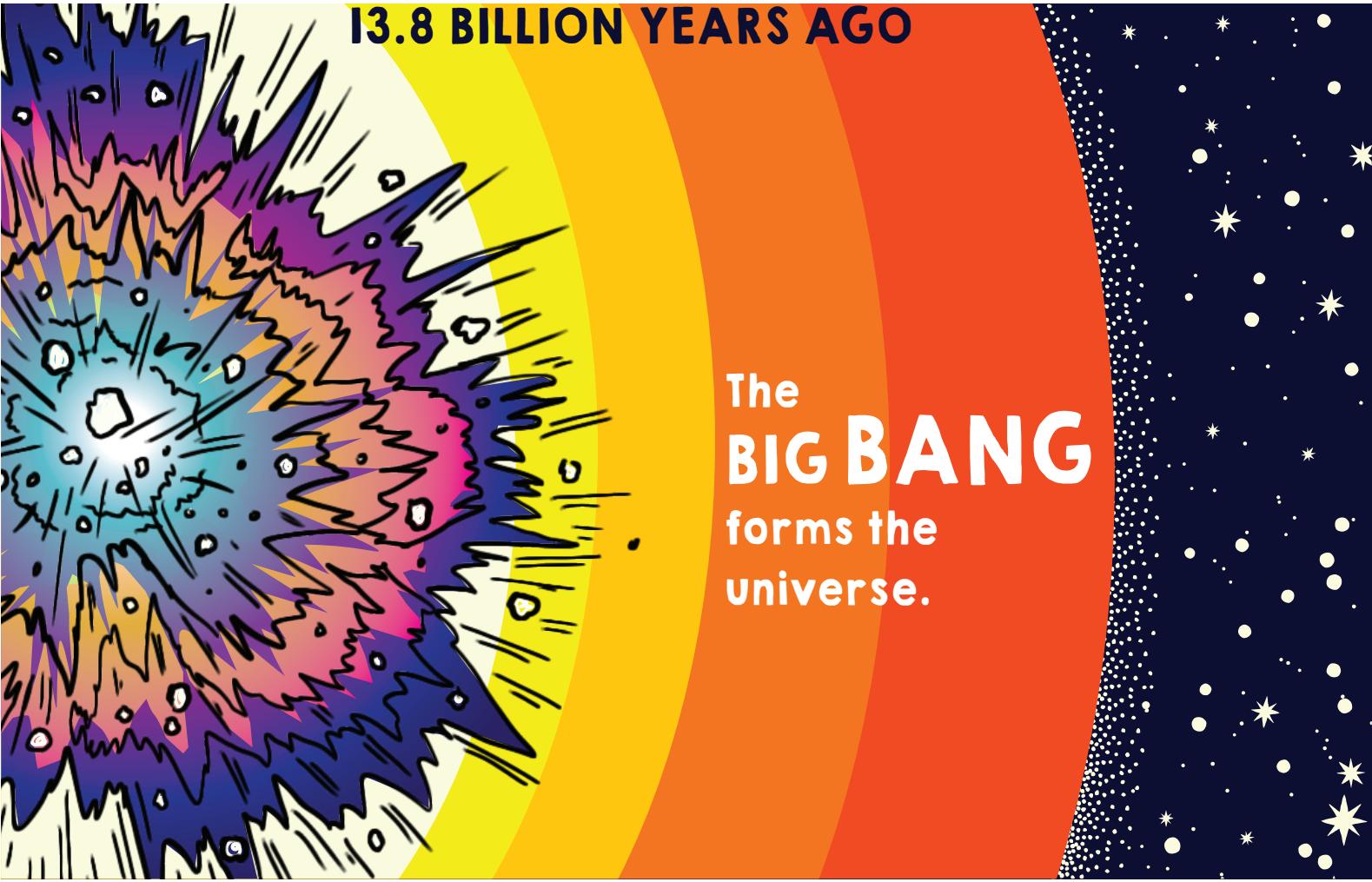
# THE LEGACY OF LEAD

## A Bio-Geo-Socio-Chemical Cycle



**Written by S. Perl Egendorf, Paula Z. Segal and the Legacy Lead Coalition Coalition**

**Illustrated by Emily-Bell Dinan**



13.8 BILLION YEARS AGO

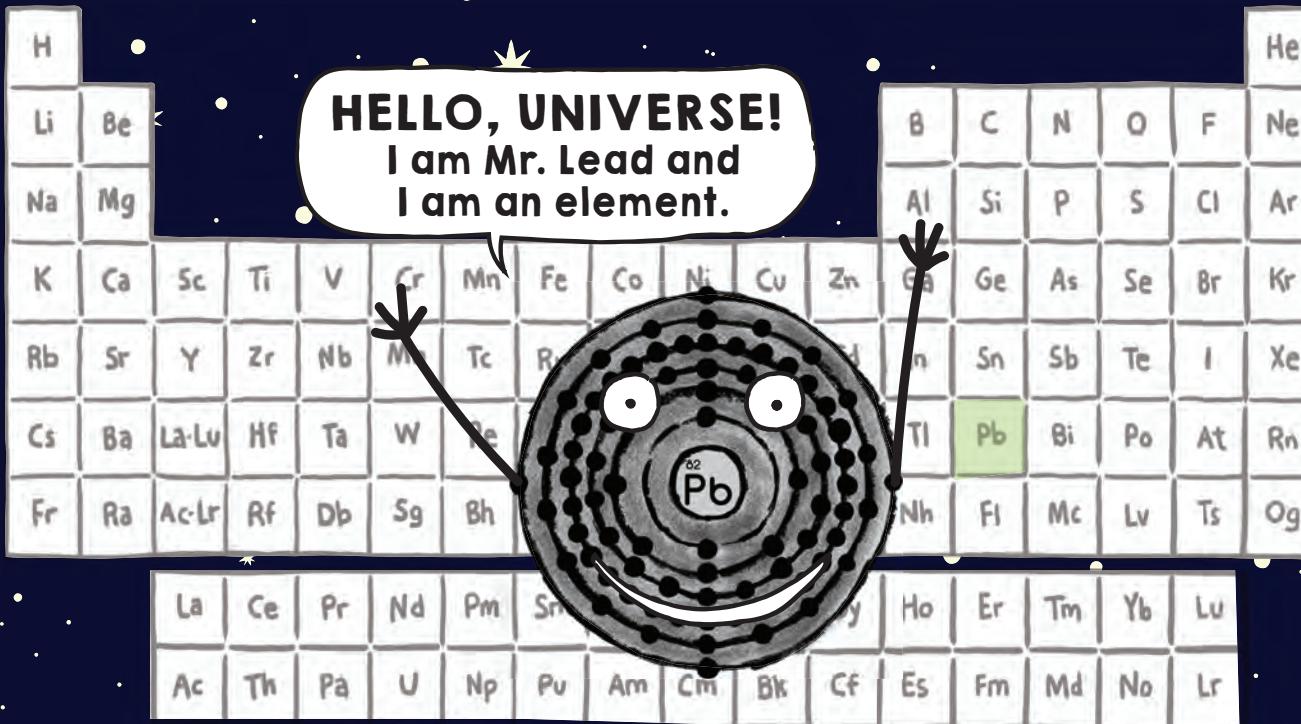
The  
**BIG BANG**  
forms the  
universe.

# Countless generations of STARS die

## - forming **HEAVY ELEMENTS.**

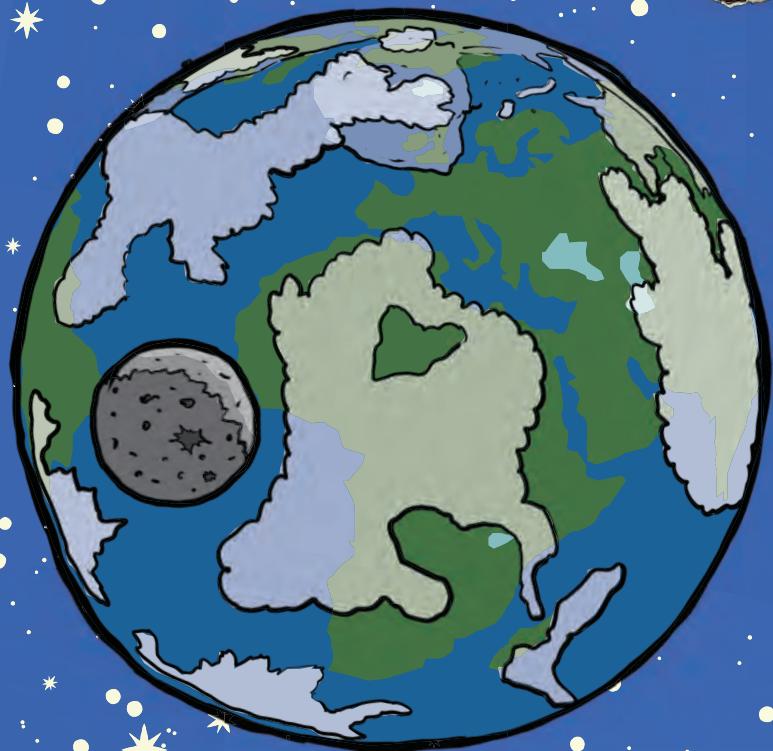
# HELLO, UNIVERSE!

I am Mr. Lead and  
I am an element.





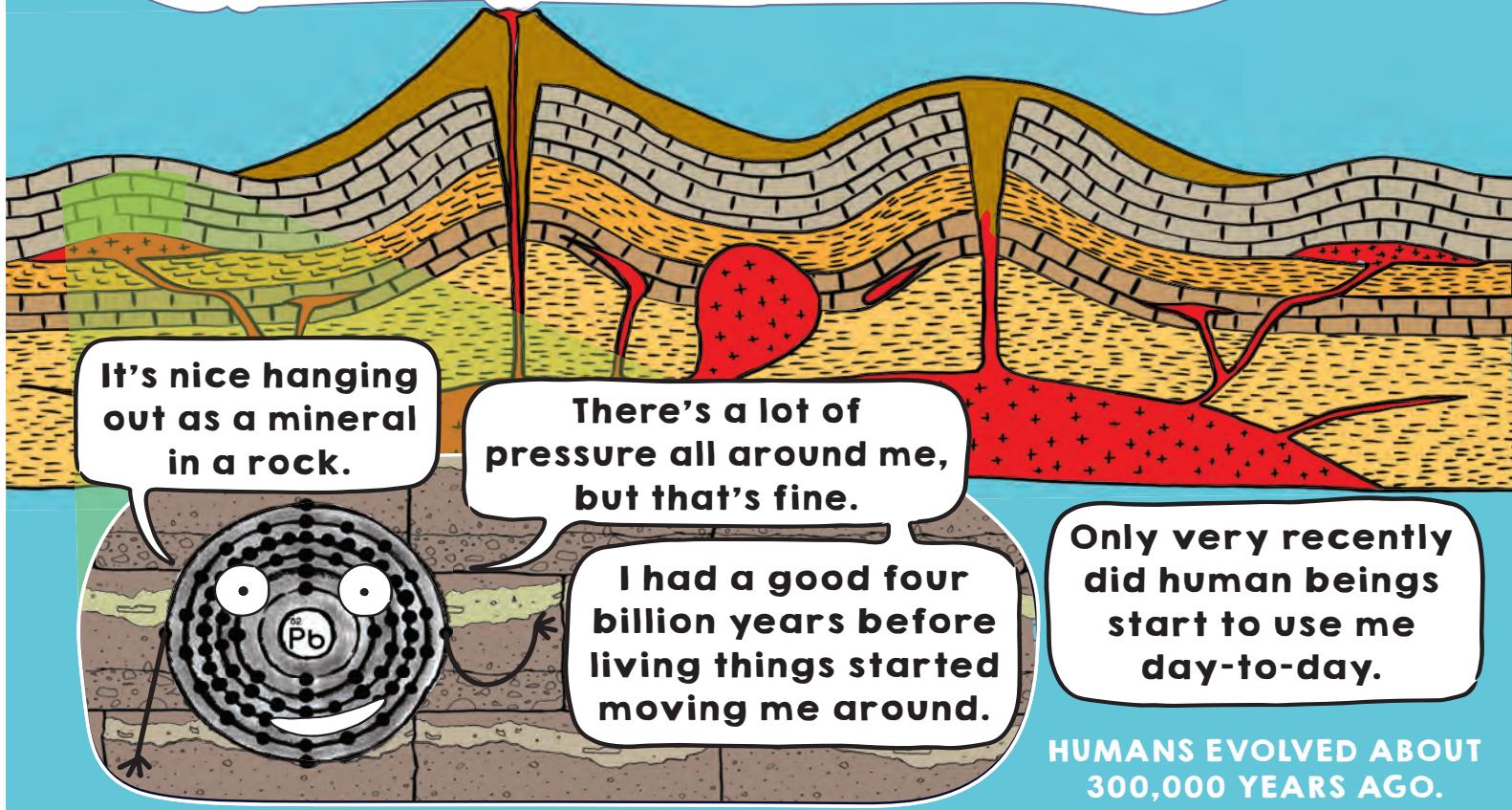
4.56 BILLION  
YEARS AGO



• Earth forms.



**Lead (Pb) is found within rocks in the Earth's crust at about 20 parts per million (a VERY small amount!)**





# 8,000 YEARS AGO

lead was found in rocks.

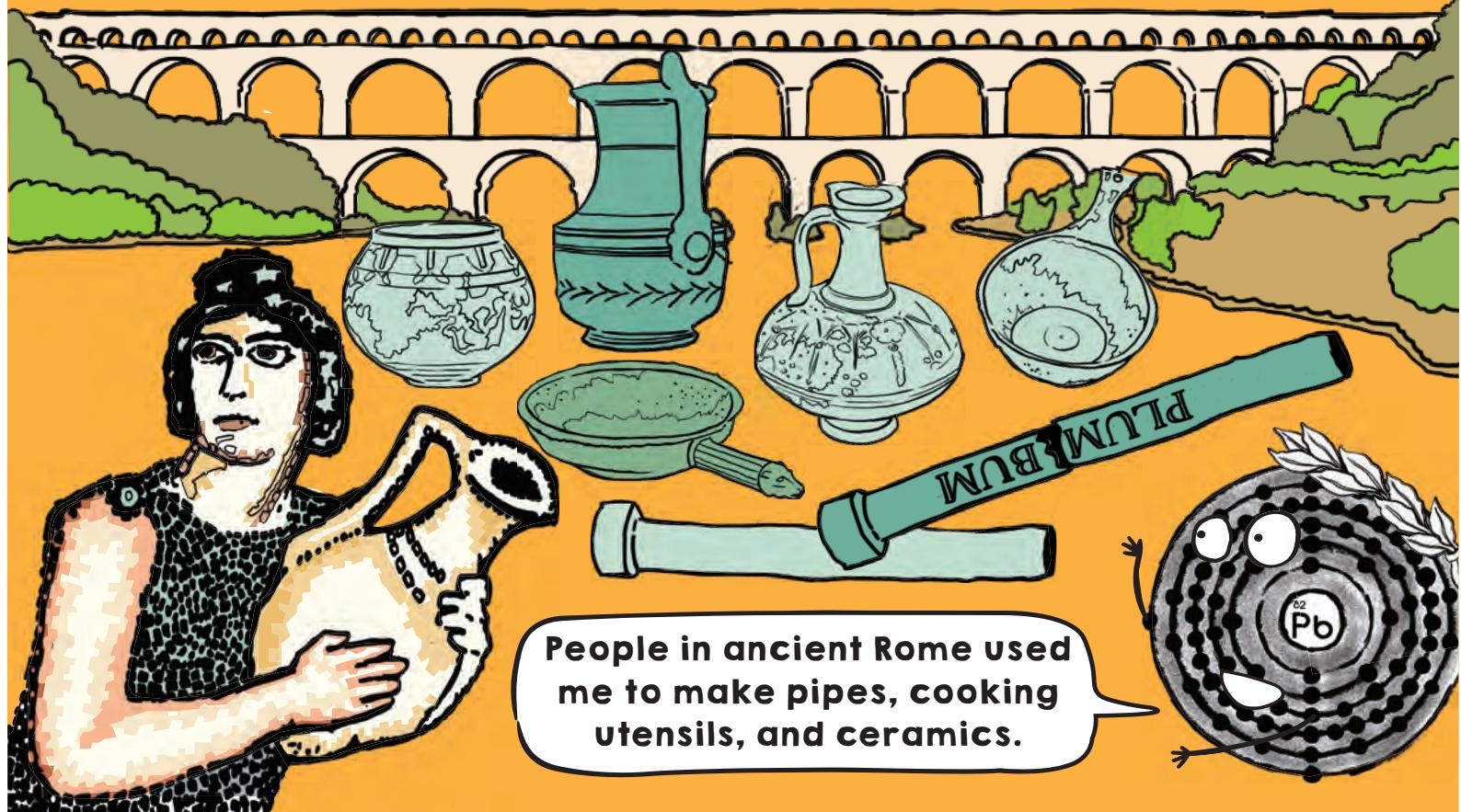


People began mining and smelting lead.



# 2,000 YEARS AGO

Romans used a tremendous amount of lead.





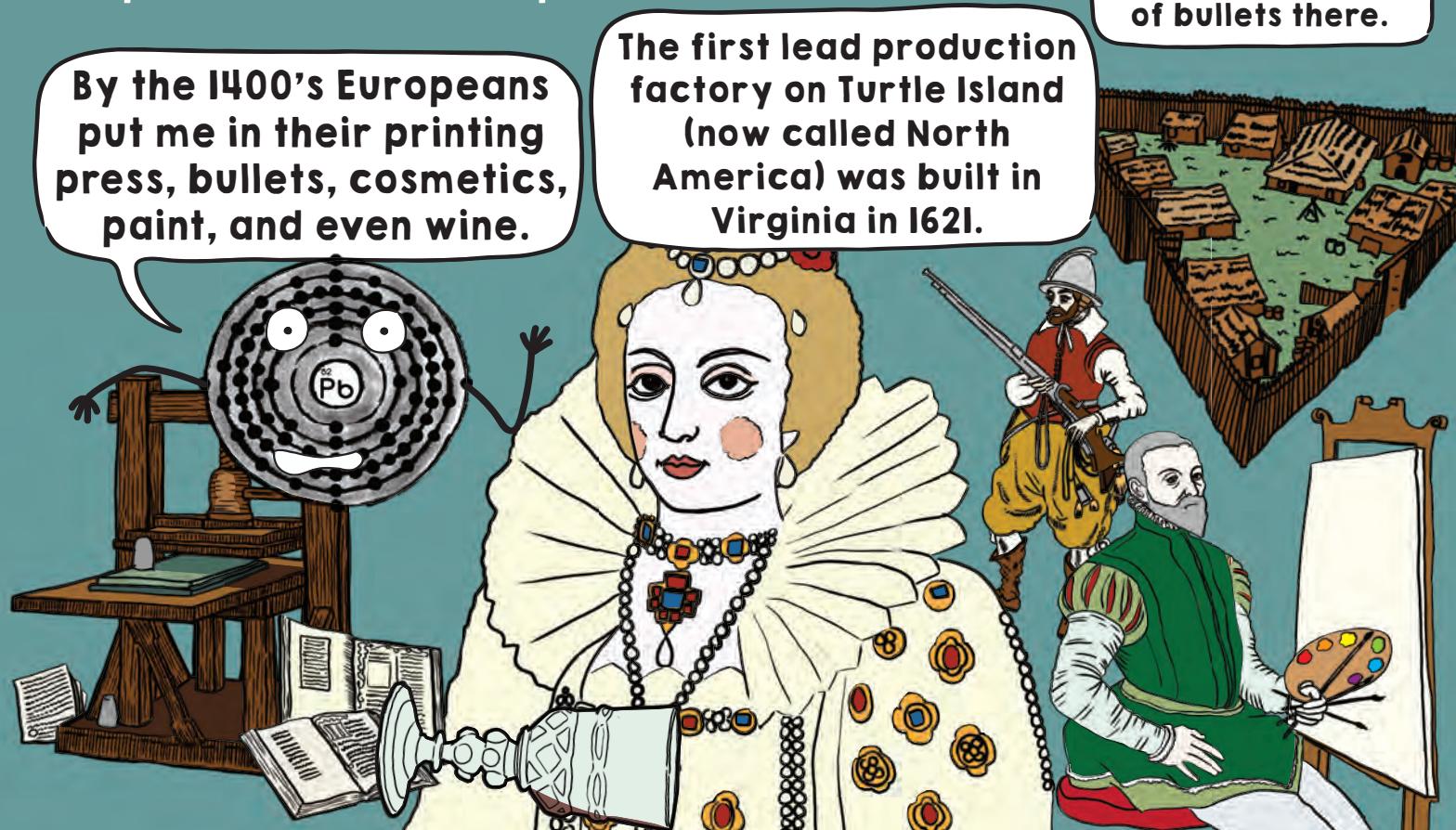
# BY THE 1400s

Europe colonized and expanded.

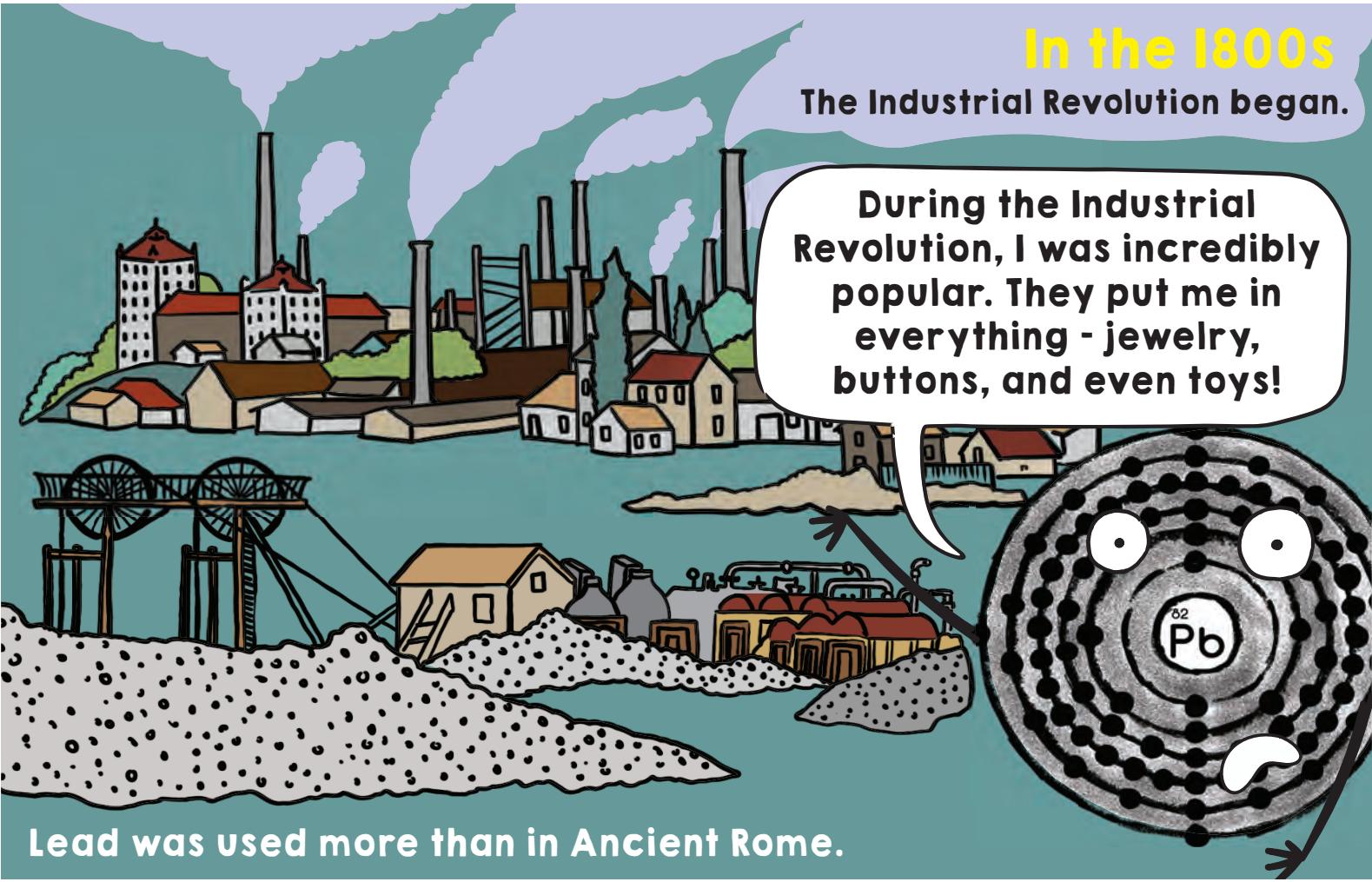
By the 1400's Europeans put me in their printing press, bullets, cosmetics, paint, and even wine.

The first lead production factory on Turtle Island (now called North America) was built in Virginia in 1621.

They made a LOT of bullets there.







In the 1800s

The Industrial Revolution began.

During the Industrial Revolution, I was incredibly popular. They put me in everything - jewelry, buttons, and even toys!

Lead was used more than in Ancient Rome.

$^{62}\text{Pb}$

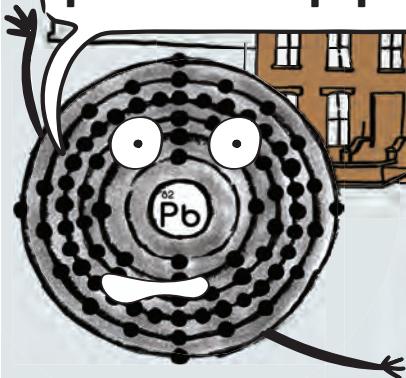
In the 1850s  
cities started

**GROWING!**

Lead was used in the building  
materials that made cities.

... it took a LOT of paint  
and a LOT of pipes to  
make cities in the  
United States

I was used in  
paint and pipes...



1921

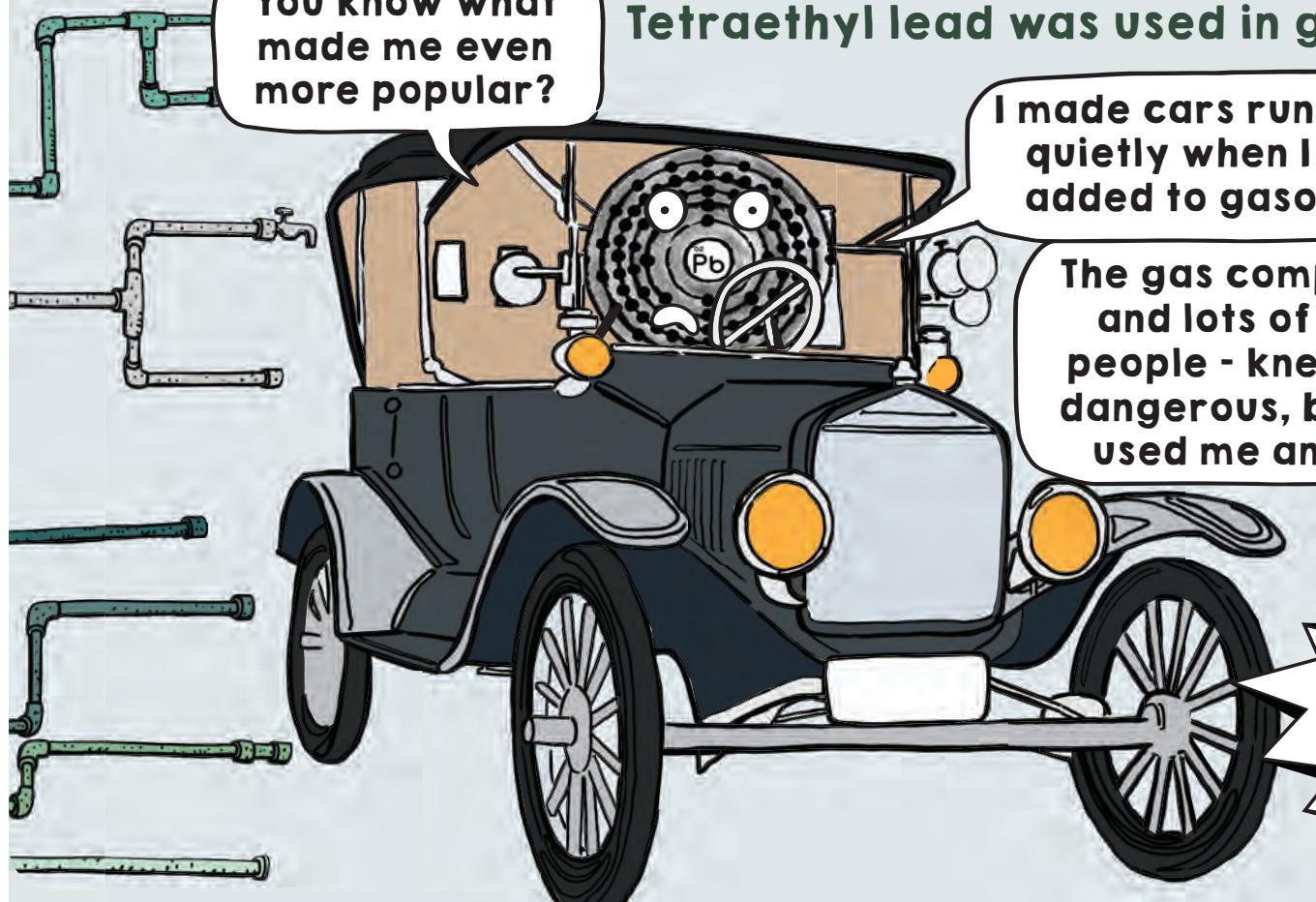
## Tetraethyl lead was used in gasoline.

You know what  
made me even  
more popular?

I made cars run more  
quietly when I was  
added to gasoline.

The gas companies -  
and lots of other  
people - knew I was  
dangerous, but they  
used me anyway.

V  
R  
O  
O  
M

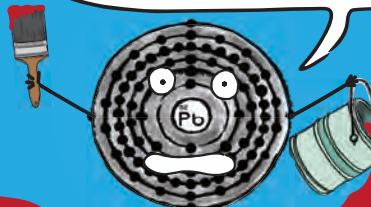


In 1922, over 20 countries (together as “the League of Nations”) banned lead-based paint. The USA DECLINED to adopt the rule.



The Lead-Based Paint Poisoning Prevention Act was passed in 1971.  
Lead was finally banned from paint in 1976.

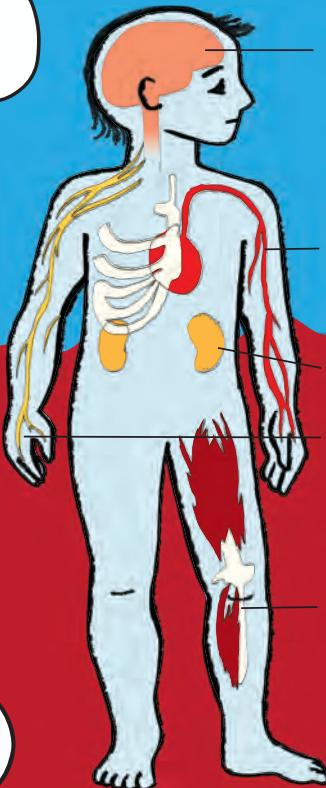
People could not ignore the truth about me forever.



If I enter your bloodstream in even TINY amounts, I can affect your brain and all of your body's systems.

Children are particularly affected by me.

I can make it hard to learn and pay attention.



BRAIN: Behavior problems, hearing and speech challenges, learning disabilities

BLOOD: Anemia

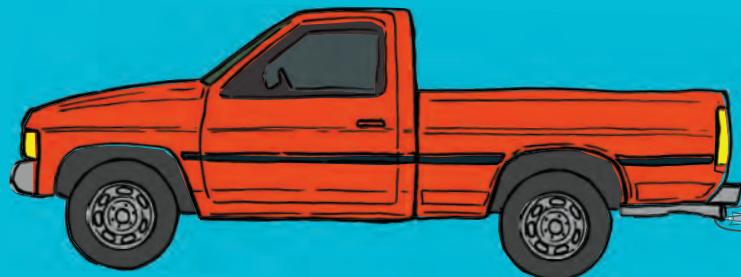
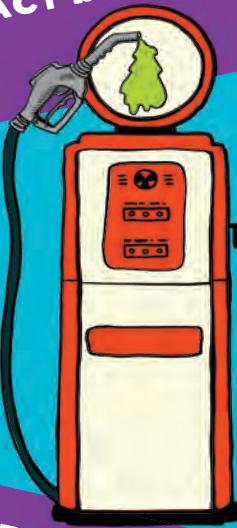
KIDNEYS: Impaired function

NERVOUS SYSTEM: Muscle weakness and issues with the sense of touch

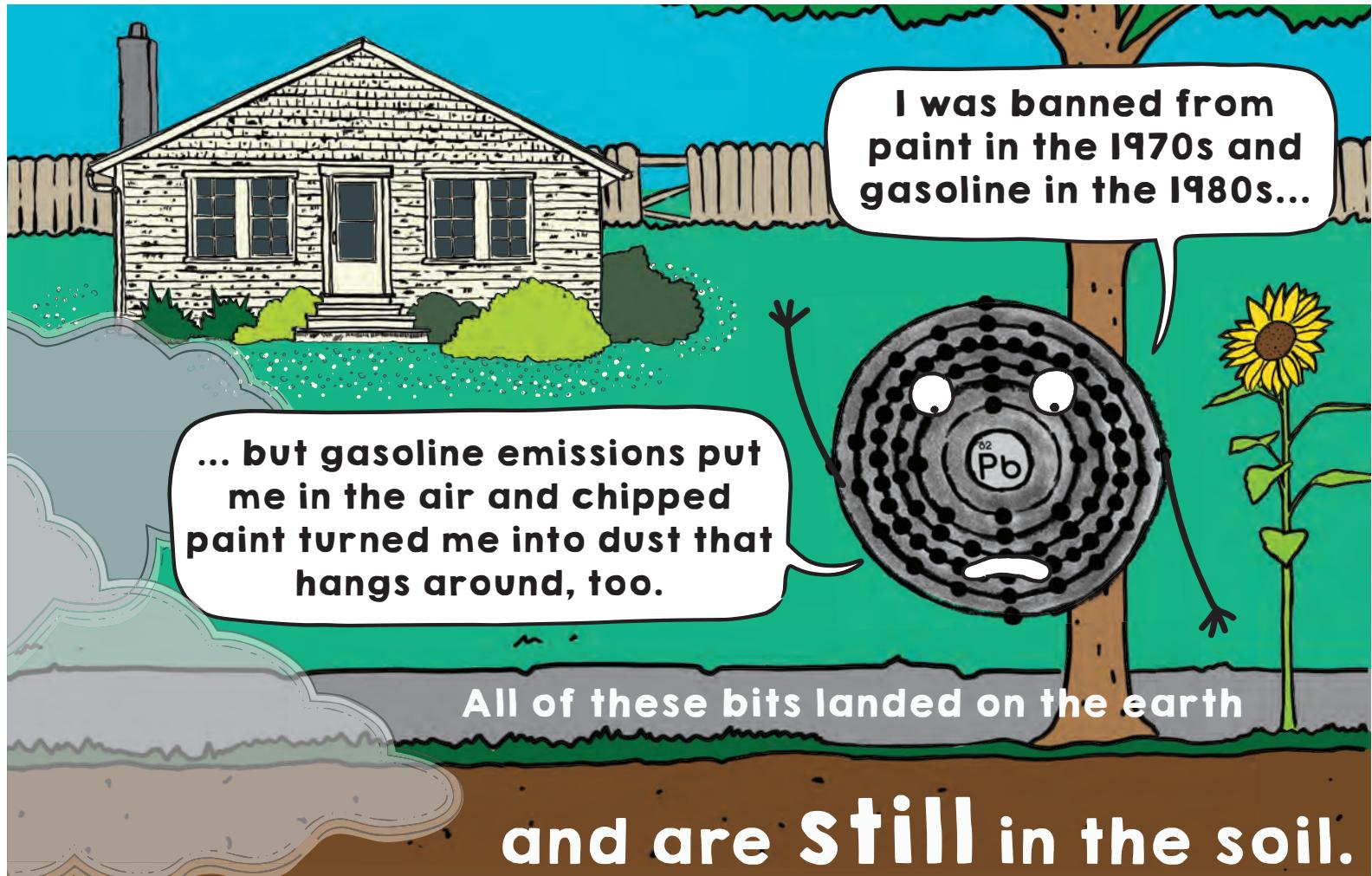
BODY: Decreased bone and muscle growth

1986

Amendments to the Clean Air  
Act banned lead from gasoline.



The Act required  
lead to be phased out of  
gasoline by the  
year 2000.

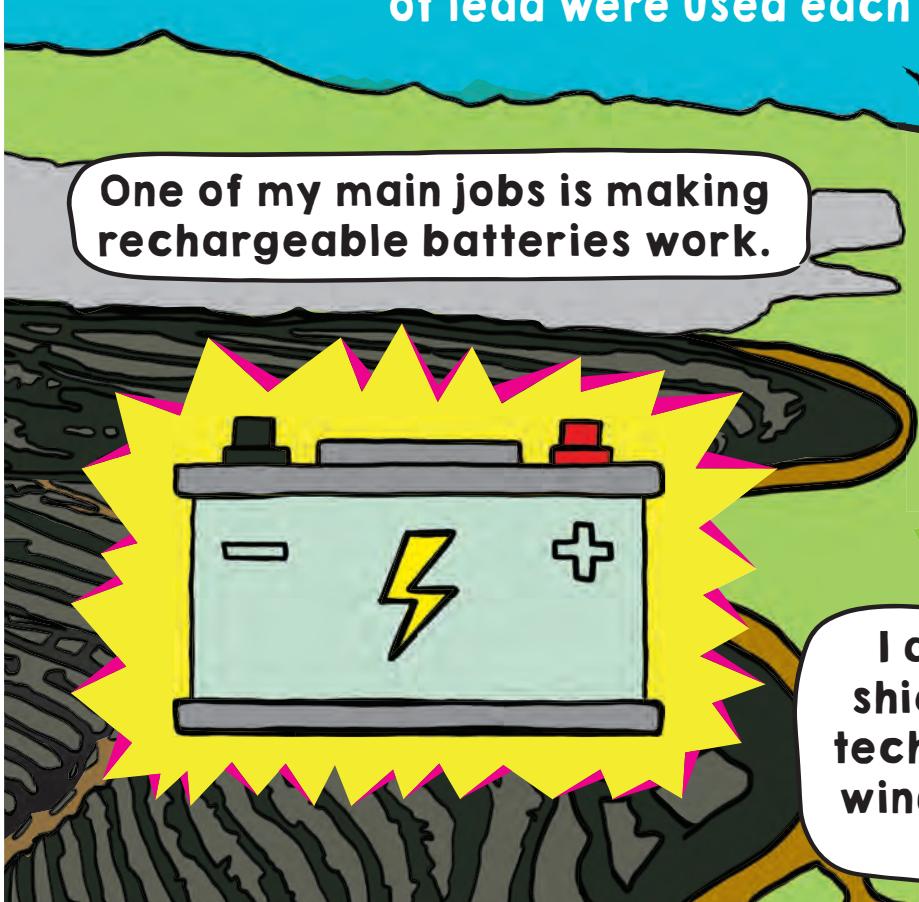


The world market for refined lead is around \$15 billion each year.

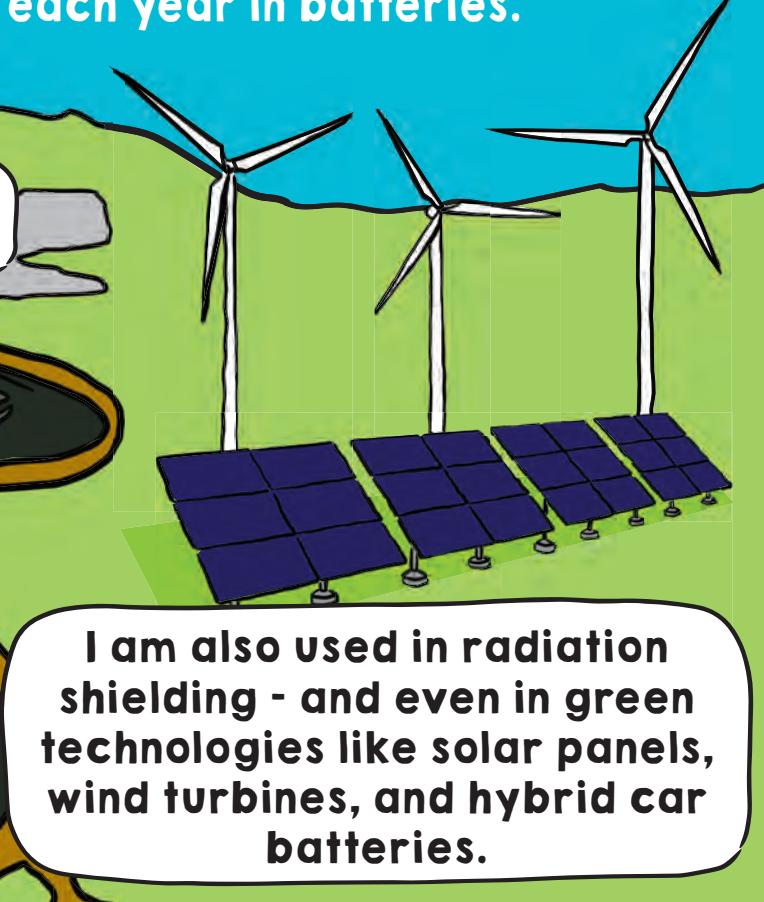
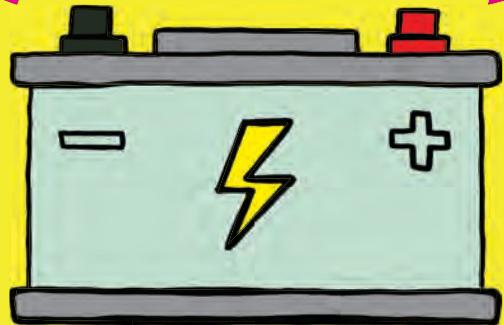
I am **STILL** a big deal.

More than 3 million tons of me are mined every year, and over 10 million tons of me are used every year.

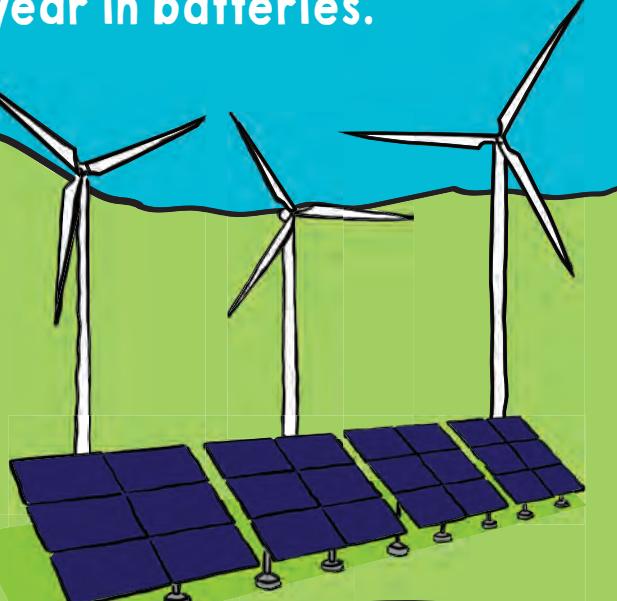
In the 2010s, more than 5 million tons  
of lead were used each year in batteries. **2010s**



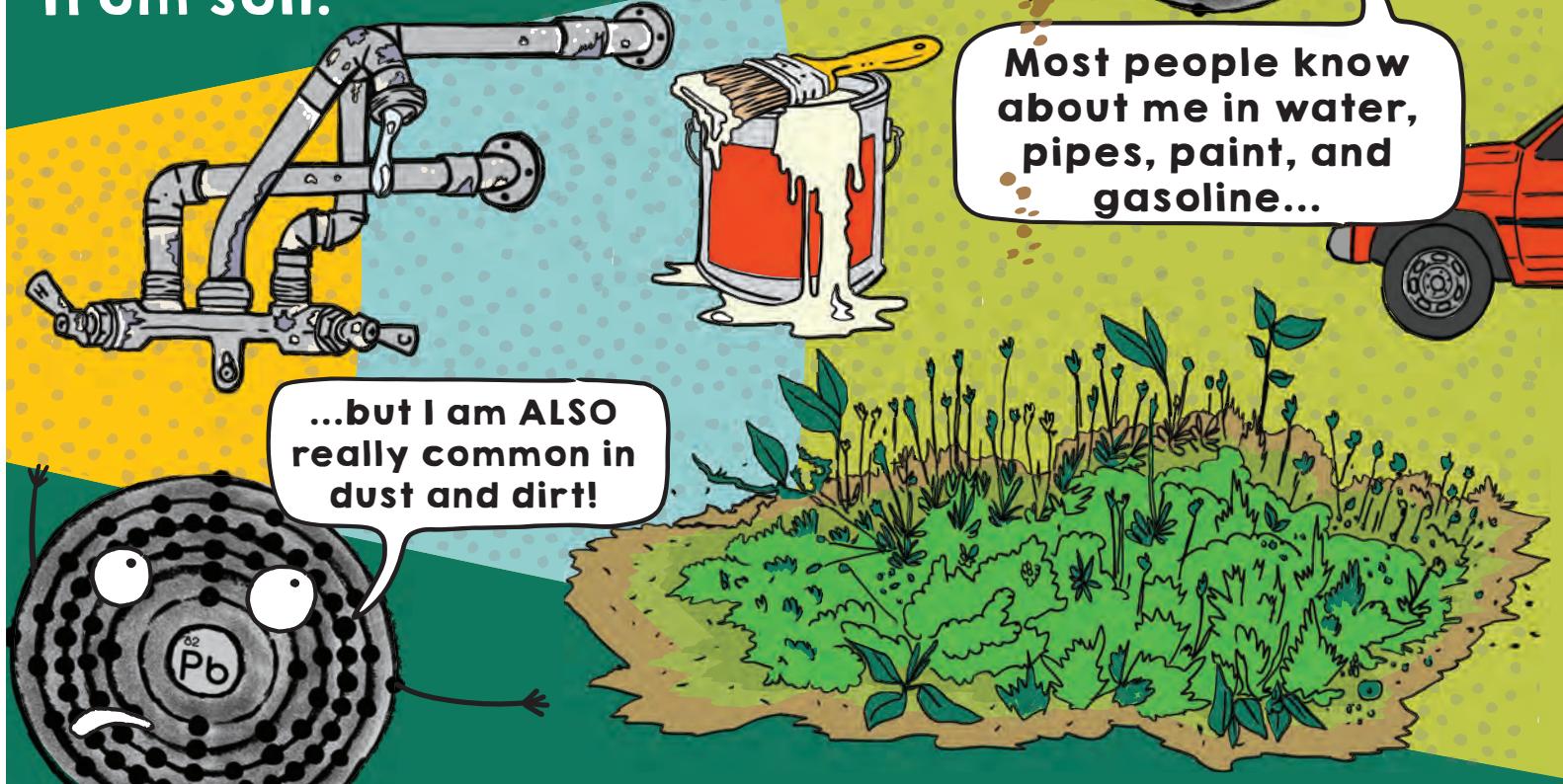
One of my main jobs is making  
rechargeable batteries work.



I am also used in radiation  
shielding - and even in green  
technologies like solar panels,  
wind turbines, and hybrid car  
batteries.



# Lead cannot be broken down or effectively removed from soil.



# The legacy of lead PERSISTS!

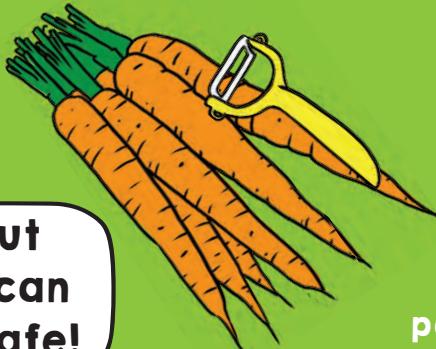


# PEOPLE ARE REMEDIATORS!

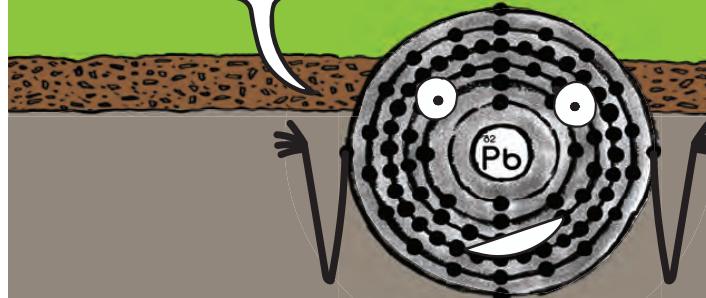
Wash your hands after gardening and playing.



Wash your harvest and peel root vegetables.



I may seem scary, but there is so much you can do to keep yourself safe!



Mulch garden paths.



1) Be informed

2) Be proactive

Leave dirty things outside (shoes, gardening tools, sports gear, toys, bikes).



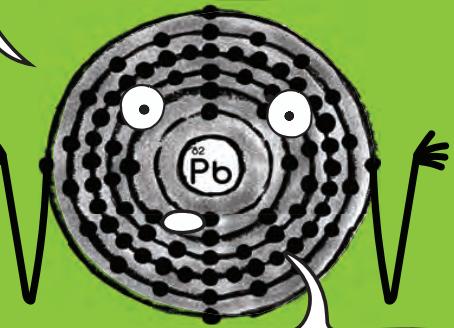
Grow in soil you know is safe.

Water and keep your plants healthy.

The thing is, I'm an element that came from rocks in small amounts.



Learn more about your soil and compost by getting it tested.

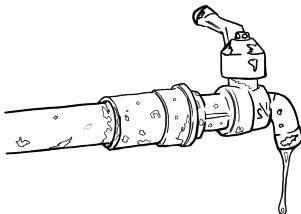


It was humans who brought me to the Earth's surface and put me in machines, buildings, soil, and dust.

People today can help bring me back home - back to the rocks below the surface.

Keep me covered and keep yourself safe.





# REFERENCES

**Gilbert, Steven (2014). Lead.** Available at: <http://www.toxipedia.org/display/toxipedia/Lead>

**International Lead Association (2012) Lead Action 2I: The Evolution of an Element.**  
Available at: <http://www.ila-lead.org/UserFiles/File/evolutionoftheElement.pdf>

**Fowler, Tristan (2008). A Brief History of Lead Regulation.** Available at:  
<https://scienceprogress.org/2008/10/a-brief-history-of-lead-regulation/>

**Newell, Richard G and Rogers, Kristian (2003) The U.S. Experience with the Phasedown of Lead in Gasoline.**  
Washington DC: Resources for the Future. Available at: <http://web.mit.edu/ckolstad/www/Newell.pdf>

**Richard G. Newell and Kristian Rogers (2003). The U.S. Experience with the Phasedown of Lead in Gasoline.**  
Resources for the Future. <http://www.rff.org>



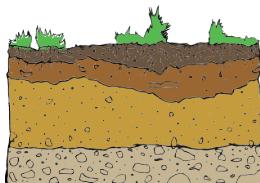
# ACKNOWLEDGMENTS

**Legacy Lead was made possible by the partnership of community organizations, public agencies, and research institutions:**

**462 Halsey Community Farm, 596 Acres, Bronx Green Up, Brooklyn Botanic Garden, Brooklyn College, Brooklyn Queens Land Trust, City University of New York Advanced Science Research Center, Cornell Cooperative Extension, Columbia University, Common Ground Compost, East New York Farms!, Ecoschools, the Greenpoint Bioremediation Project, GreenThumb, Just Soil, New York Lawyers for Public Interest, New York Restoration Project, Newtown Creek Alliance, North Brooklyn Neighbors, the NYC Compost Project (NYCCP) Hosted by Big Reuse, the NYCCP Hosted by Brooklyn Botanic Garden, the NYCCP Hosted by the Lower East Side Ecology Center, the NYCCP Hosted by Queens Botanical Garden, the NYC Department of Health, the NYC Mayor's Office of Environmental Remediation, the NY State Department of Health, and Smiling Hogshead Ranch.**

**Special thanks to Howard W. Mielke, our “Godfather of Lead in Soil,” the Cornell Atkinson Center for Sustainability, and Lecco Morris for copy editing eagle eyes.**

# WHAT CAN WE DO ABOUT LEAD (Pb) IN SOIL?



The Legacy Lead Coalition

**Q: Can we add soil amendments to make lead less toxic or bioavailable?**

**YES, BUT THIS IS TRICKY**

Amendments like phosphate and compost can make Pb less toxic, but it is difficult to test for these changes (i.e. expensive and there is no agreed upon testing method).

Phosphate can make other elements like arsenic more available to plants and people.

Amendments can help improve soil texture and reduce dust, which is great!

**Q: Can we remove lead from soil? (Can plants help us do this, aka phytoremediation?)**

**NO, NOT SAFELY**

Lead binds tightly to soil particles.

Plants cannot extract lead from soil effectively.

Adding chelating agents can make lead more mobile (but then it leaches to groundwater, creating other issues).

**Q: Can we cover contaminated soil to limit exposure?**

**YES!**

Contaminated soil stays down below, and capping with new soil and establishing plant cover keeps it in place.

Landscape fabric can be used as a permeable barrier. But even without barriers, the majority of plant roots will not take up Pb from underlying soil.

As long as the new soil is not mixed with the old, exposure is limited.

Information about contaminated soil should be passed on to future land users.

Monitoring for new contaminant sources (dusts, peeling paint, etc.) should be continued.

**Q: Can we dig up and haul out contaminated soil?**

**YES!**

While this is the most effective way to remove contaminated soil, it is expensive, logistically challenging, and places the burden somewhere else (usually a landfill).

Finding new soil to replace excavated soil is also important.

## REFERENCES

Egendorf et al. (2018). Constructed soils for mitigating lead (Pb) exposure and promoting urban community gardening: The New York City Clean Soil Bank pilot study. *Landscape and Urban Planning*, 175, 184–194.

van der Ent et al. (2013). Hyperaccumulators of metal and metalloid trace elements: Facts and fiction. *Plant and Soil*, 362 (1–2), 319–334.

Henry et al. (2015). Bioavailability-Based In Situ Remediation To Meet Future Lead (Pb) Standards in Urban Soils and Gardens. *Environ Sci Technol*, 49, 8948–8958.

Laidlaw et al. (2017). Case studies and evidence-based approaches to addressing urban soil lead contamination. *Applied Geochemistry*.

Mielke (2016). Nature and extent of metal-contaminated soils in urban environments (keynote talk). *Environmental Geochemistry and Health*, 38(4), 987–999.

Walsh et al. (2018). Sediment exchange to mitigate pollutant exposure in urban soil. *Journal of Environmental Management*, 214, 354–361.

# TAKE CARE OF OUR LEGACY LEAD!

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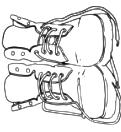
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Wash your harvest and peel root vegetables.



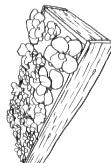
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Mulch garden paths.



Grow only in soil you know is safe.



Water and keep plants healthy.



Learn more about your soil and compost by getting it tested.



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Thank you for remediating our city!

