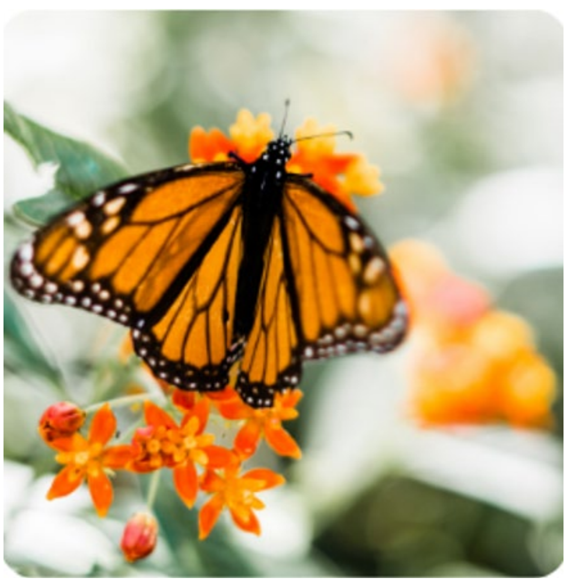
THE VORTEX

The American Chemical Society
California Section Newsletter

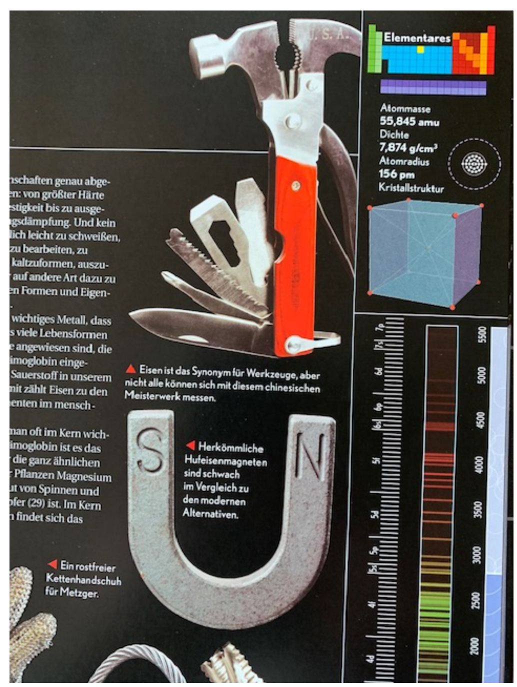
January 2022, Issue 1, Volume 84

This month's talk is on Fusarium Fungi.



This month's travel recommendation.

WHAT'S INSIDE



Iron, the new element discussion series for 2020.

Cover Photo credits:

(Top Left) Snip from University of Nebraska – Lincoln
https://cropwatch.unl.edu/fusarium-confirmed-wheat
(Left Center) Photo from Canva. Brown Minimalist Do You Know Instagram Post.png
(Right Bottom) A Visual Exploration of Every Known Atom in the Universe, Theodore Gray, 2009, Black Dog and Leventhal Publishers, New York. [actual name is Die Elemente. Bausteine unserer Welt, Übersetzung: Fackelträger Verlag GmbH, Köln].

New Format for The Vortex in 2022

Newsletter Editor Donald MacLean

The Vortex has a new format for 2022. When I took over the editor position, I was anticipating more submissions than occurred in 2021. I tried to keep the 5" x 8" format, and incorporate more photos, tables, and diagrams, but that idea proved too difficult to maintain. This year the 8.5 x 11" format will remain, but the Table of Contents will be moved to the front cover as the content will diminish. Page numbers are presented as whole numbers, even when there are more than one item per page.

Submissions welcome especially obituaries.

The Vortex is published monthly except July and August by the California Section, American Chemical Society. Opinions expressed by the editors or contributors to *THE VORTEX* do not necessarily reflect the official position of the Section. The publisher reserves the right to reject copy submitted. Subscription included in the annual dues payment. Nonmember subscription $25.

MAGAZINE OF THE CALIFORNIA SECTION, AMERICAN CHEMICAL SOCIETY

Editor:
Donald MacLean
Donald.maclean.acs@gmail.com

Article Contributors:
Nicki Davis
William Motzer

Office Administrator Manager:
Julie Mason
2950 Merced St. #225
San Leandro, CA 94577
510-351-9922
office@calacs.org

Editorial Staff:
Chair Message: Fanny Frausto
Outreach: Alex Madonik
Editor: Jim Postma and Linda Wraxall
Web Page Posting and Editor: Al Verstuyft

web site: http://www.calacs.org

The Fungus Among Us- Fusarium Mycotoxins in Water and Food

Tuesday – January 18, 2022 – 12:00 to 1:00 PM (Pacific)Online Zoom Event

Professor Daniel Snow investigates the measurement and surprising occurrence of *Fusarium* mycotoxins inour food and water. *Fusarium* is a large group of filamentous fungi widely distributed in soil and plants. Most are harmless, but some produce metabolites that are biologically active and even toxic. *Fusarium* fungi are ubiquitous in soil and plants, and toxin production is prevalent in corn and cereal grains.

Fusarium mycotoxins including trichothecenes, zearalenone and fumonisins, are generally produced during crop growth and storage. These water soluble, low molecular weight organic compounds are surprisingly stable, and are often passed from contaminated crops to animals and humans. They occur annually in crops, soil and water supplies. Individual compounds such as zearalenone are metabolized intoseveral derivatives each with different toxic and biological effects. Because they are water soluble, and occur in complex matrices, analytical methods must overcome a number of challenges for detection at environmentally relevant concentrations. The presentation will be followed by a Q&A.

RSVP here!

Zoom link to be shared with attendees the day of the event.

Our Distinguished Panelist:

Professor Daniel Snow University of Nebraska – Lincoln
Nebraska Water Center

The event is FREE and open to the community. More information at: calacs.org or email aliciaataylor@gmail.com

Cal ACS Membership Numbers

By Donald MacLean

The Cal ACS section membership numbers are declining but the section officers election votes casted have held constant the last 4 years. Number provided at the December Executive meeting show an interesting facet to the decline. Those who are involved in the section via voting have not left the California section of ACS if viewing 2018 onward.

Year	Section Members	Voted	Percent Voted	Change in members from previous year	Percent change from previous year
2021	2774	268	9.7%	278	9.1%
2020	3052	250	8.2%	58	1.9%
2019	3110	240	7.7%	206	6.2%
2018	3316	271	8.2%	117	3.4%
2017	3433	335	9.8%		

Note March 2021 – 2950 members

Snip from the ACS Local Section Map: https://www.acs.org/content/dam/acsorg/membership/ls/acs-local-section-map.pdf

The 2800 member California section includes the following countries: Alameda, Alpine, Butte, Contra Costa, Del Norte, Glenn, Humboldt, Lake, Lassen, Marin, Mariposa, Mendocino, Merced, Modoc, Mono, Napa, Plumas, San Francisco, Shasta, Sierra, Siskiyou, Solano, Sonoma, Stanislaus, Tehama, Trinity, and Tuolumne.

The counties around Sacramento are in the 900 member Sacramento section (Amador, Calaveras, Colusa, El Dorado, Nevada, Placer, Sacramento, San Joaquin, Sutter, Yolo, and Yuba).

The west SF Bay area is in the 2800 member (?) Silicon Valley section (formerly known as the Santa Clara Valley Section until 2017) was carved up from the California section in 1955. There are five counties in the SV section: Monterey, San Benito, San Mateo, Santa Clara, Santa Cruz.

The Irony of Iron
Part 1

by Bill Motzer

My last series of articles, *All That Glitters…?* (March through December 2021 Vortex) discussed the geology and geochemistry of gold and the California Gold Rush with environmental impacts that persist to this day. In this next series, I'll be discussing the chemical element iron (Fe, Z= 26) and its impact to human society. We normally don't think of iron in the same context as gold because there was no "iron rush" with mass migrations of peoples, no adornment as jewelry, and no accumulation of iron in personal portfolios, banks, and storage facilities such as Fort Knox. But iron has done more for the advancement of human civilization than gold. There was, and to a certain extent still is, an "iron age" (see *It's Elementary – Part 2*, October 2019 Vortex). In the Eastern Hemisphere, it began in the Ancient Near East and in South Asia at about 1,200 years before the common era (BCE), and lastly in Europe (Germany) at about 400 CE; however, an iron age did not occur with Western Hemisphere civilizations.

Here are some items that I'll discuss in future articles (but not necessarily in the following order):

- Iron is the only element from hydrogen through chromium that does not undergo further stellar fusion. Once a certain star type fuses its hydrogen and helium to higher elements (via nucleosynthesis) and ultimately iron, fusion ceases and for some stars a supernova event (SNE) occurs. These SNEs also create elements above iron and disperse them with iron throughout the Universe.
- Of all the planets in our Solar System, Earth has the highest overall density (5.51 g/cm^3). The reason for this may be in its rather large iron-nickel (FeNi) core. How Earth acquired such a large FeNi core is the focus of some rather interesting recent research. A recently discovered exoplanet (GJ 367b) by NASA's Transiting Exoplanet Survey Satellite (TESS), orbits a small red dwarf star 31 light-years from Earth. TESS's measurements indicated that this exoplanet is about 9,000 km in diameter with about 50 percent of Earth's mass, as measured the European Southern Observatory's High Accuracy Radial Velocity Planet Searcher (HARPS). Both measurements indicate a planetary density of about 8 g/cm^3, which is very close to that of pure iron (7.87 g/cm^3). Such planetary core formation has given us insights to our own planet's formation.
- Although iron is abundant in Earth's core and overall is Earth's second most abundant element, it's only the fourth most abundant element in Earth's crust. This may be an important geochemical construct because lower iron crustal concentrations resulted in less binding of water in iron minerals allowing the retention of Earth's surface water as oceans. Additionally, Earth's seawater now contained iron in bioavailable forms accessible to life. This didn't occur on Mars, which has a higher iron crustal concentration resulting in iron binding to water. The detection of goethite [Fe(OH)O] by the Mössbauer spectrometer may confirm this hypothesis. Therefore, on a geochemical basis, Mars did not retain its oceans.
- Early Earth's oceans had dissolved iron in the form of ferrous iron or Fe(II). When the great oxygenation event (GOE) occurred at approximately 2.5 to perhaps 2.0 billion years ago, iron began to precipitate, as

ferric iron or Fe(III) minerals, resulting in large iron ore deposits known as banded iron formations (BIF). In the U.S., BIF deposits occur in northern Wisconsin, northern Michigan, and Minnesota comprising much of the U.S. iron ore deposits.

- To exist, cellular life and particularly complex cellular life (i.e., chordates) requires water because their cells need it for normal metabolic chemistry. However, iron is also essential for such life, particularly in cellular reproduction to duplicate DNA, for proteins and enzymes, and for hemoglobin in our blood to transport oxygen throughout the body. Although some invertebrates don't need iron in their "blood" (they use copper or vanadium), and some fish also don't use iron, most complex living things do.
- The primary preferred analytical method to determine iron concentrations in geologic materials (rocks, sediments, and soil) has been by inductively coupled plasma atomic absorption emission spectroscopy (ICP-AES). Detection limits for routine rock samples are about 100 mg/kg or parts per million (ppm). A secondary method is by atomic absorption spectroscopy (AAS) and x-ray fluorescence spectroscopy (XRF) Other newer methods now exist for individual mineral analysis.

References:

K. Lam, et al., GJ 367b: A dense, ultrashort-period sub-Earth planet transiting a nearby red dwarf star, Science, 374 (6572), Dec 2021: 1271-1275.

Monarch Butterfly Viewing

By Donald MacLean

Pacific Grove Monarch Sanctuary (Monterey County)

Nature Preserve in Pacific Grove, California (Monterey county) is an out of the place butterfly sanctuary located in a residential area. Here the Monarch butterflies stay over winter on eucalyptus trees before migrating north in the summer then returning back in the fall. Bring binoculars. There is a short trial though the preserve where information on the Monarch life is presented. Better on warm days. Preserve contains pine, cypress & eucalyptus trees sheltering thousands of monarch butterflies Oct–Mar.

Snip of butterflies from Pacific Grove Monarch Sanctuary web site.

Address: 250 Ridge Rd, Pacific Grove, CA 93950
Hours: 8 am to 5 pm
Cost: Free

Natural Bridges State Beach, Santa Cruz (Santa Cruz County)

The Santa Cruz Monarch Butterfly Grove is located on the western town edge in the park at Natural Bridges State Beach. The visitor center at the park has information on the butterflies and their amazing migration. You'll see more of them in November, but they stay here from mid-October through mid-February. A walking path called the Monarch Butterfly Trail meanders through the grove of trees where they literally hang out. There is a convenient entrance at the corner of Delaware and Natural Bridges Drive.

In addition to the butterflies, there is a tide pool where tide pool creatures can be seen at Natural Bridges State Marine Reserve.

Snip image from http://parks.ca.gov/?page_id=541

Address: Delaware Ave and Natural Bridges Dr, Santa Cruz, CA 95060
Hours: 8 am to sunset
Cost: free if park on street. There is a $10 vehicle day-use fee.

A CAREER JOURNEY

by Linda Wraxall

In the last WCC meeting of 2021, Elaine Yamaguchi welcomed the speaker, Dr. Alicia Taylor, describing her as a young go-getter who, by volunteering in our local section, has greatly benefited us. As our current ACS chair, Dr. Taylor has transformed our Executive Meetings from raucous affairs lasting hours to an orderly state because she is considerate of everyone's time.

Dr. Taylor began by describing herself as more of a dabbler in chemistry than a chemist per se. In addition, she has not only lived all over the US in a short amount of time but has had jobs in academia, consulting, and government, and learned new skills along the way. Her first degree was a BS in Biology from the University of N.Texas and her first job was as a lab technician testing the quality of water samples by counting the number of fish that died in a given time! She found the pay was good but the work was depressing. Her second degree was also in biology and her lab tech work rose to testing blood samples. From this she learned about SOPs and lab work but it was also boring. Finally her Ph.D from UC Riverside and subsequent post-doctoral work at UC Berkeley landed her in environmental toxicology.

Like many before her, Dr. Taylor found that the schools did not prepare her for work in a lab where everything is time-oriented and documented and all the variables have to be removed. The benefit came from having to learn the protocols and SOPs and how labs operate. During her time at UC Riverside, nanotechnology was just coming in and interest was focused on how nano-materials affected the human gastro-intestinal system.

So her work there consisted of experimenting with fish embryos and untreated septic tank waste and, going from biology to environmental engineering, she also had to learn a new scientific language.

Looking for employment after her Ph.D. was very difficult and government job applications were complicated and confusing and slow. That was why she decided to go back to school for her post-doc which turned out to be just more years of grad school. It never occurred to her to join any professional scientific organizations. As an undergrad, she had only ever been aware of department-focused clubs and it was not until her Ph.D. professor paid for his students' first year memberships in ACS and made them go to the conferences, that the penny dropped. Meanwhile, Alicia worked as a consultant at a utility company for wetland conservation through the remediation of metals and hydrocarbons in plants. Out of her consulting work and, with the help of a good mentor, she was able to define her own role in the workplace by developing the "soft" skills needed. These skills include being able to communicate, speak clearly, and to distill experimental results in understandable form. She also came to realize the looking the part of a professional was also important.

Her next consulting job necessitated a move across country from California to Washington DC when her new-found abilities stood her in good stead during an all-day interview. She revealed that challenges in the world of consulting included having "hard" deadlines plus a lot of reading, writing, and giving presentations. She also had to find her "niche", which always involves some luck but networking paved the way. Alicia admitted that, being an introvert, networking was hard for her but she knew it was essential. Last year she finally got a government job with the Environmental Protection Agency (EPA) making consumer goods safer. - a career change in the middle of a pandemic – and she loves it! Examples of her work are often safety problems like the effect of chemicals released into the environment from vehicles tires on salmon (fish again!), the toxicity of copper on human health, and the biodegradation of veterinary medicines in soil.

Alicia wrapped up her talk by reiterating the necessity of having "soft" skills over technical skills: can you communicate clearly? Can you think critically? Can you accept constructive criticism? And can you be skeptical enough to critique someone else's work? She also recommended getting a paid internship for a real work experience without the stress and, of course, volunteering in a professional association!

Expansion of "What are the Risks of Radon" shown in CEN Issue

By Donald MacLean

In the August 30, 2021 issue of Chemical and Engineering News page 22 is a "What are the Risks of Radon?" Periodic Graphics for the Uranium-238 to Radon-222 decay chain. [1] The graphic starts with the parent U-238 and finishes 6 generation daughters later with Rn-222. The decay chain isotopes are under a house which migrates into the lower part of a house. The graphic presented the decay chain, how can radon be detected, how radon affects our health, and how much exposure is allowed per liter of air.

Herein is the whole decay chain with an explanation on how to figure how many alphas and betas are expected to be emitted.

Background

Radon is a radioactive, colorless, odorless, tasteless noble gas with atomic number 86. Radon's longest lived isotope is Rn-222. Rn-222 (3.82 days, uranium decay series) comes from the decay of U-238 and is in secular equilibrium with U-238, U-234, Th-230, and Ra-226. Two (or three if count Rn-218) other naturally occurring radon isotopes are Rn-219 (3.96 sec, actinium decay series) and Rn-220 (55.6 sec, thorium decay series). Environmental radon concentrations refer to Rn-222 concentration since the half-lives of the other naturally occurring radon isotopes are short compared to Rn-222. The health concern comes from internal alpha particles exposure as they deposit more energy (LET – Linear Energy Transfer) per distance traveled than beta particles. The absorbed dose is converted to dose equivalent [or radiation equivalent to man (REM)] using the quality factor, Q. Q for beta particles is 1, for alpha particles 20. [2] There is a distribution factor, DF, used in special cases like Ra-226 in water when drunk since Ra-226 is bone seeker and would cause a nonuniform distribution, which does not apply for radon.

H (sieverts or rems) = Dose (grays or rads) X Q X DF

There are four natural decay chains. [3] Note that the difference between the initial parent and final daughter is a multiple of 4 (238-206 = 32). Rn-222 belongs to the uranium series, therefore the source of Rn-222 is U-238.

1. Thorium decay series, 4n + 0 starts with Th-232 and ends Pb-208.
2. Neptunium decay series, 4n +1 starts with Np-237 and ends with Bi-209.
3. Uranium decay series, 4n +2 starts with U-238 and end with Pb-206.
4. Actinium decay series, 4n + 3 starts with U-235 and ends with Pb-207.

Table 1 shows the decay half-life, decay energy [noted in MeV (1 eV = 1.602 E-19 J], and decay type. Radon is the only gas in the decay chain. Table 2 shows the calculations for determining the number of alpha and beta particles emitted from parent (precursor) to daughter and beyond (product).

Table 1. Uranium series, 4n+2 (starts at U-236 ends at Pb-206) [4, 6]

Isotope	Half-life	Alpha or Beta Particle Energy (MeV) Comment
U-238	4.5 billion years	4.27 α U-238 to Th-234
Th-234	to Pa-234m - 24.1 d	0.27 β Th-234 to Pa-234m
Pa-234m	to Pa-234 -1.17 min to U-234 – 1.17 min	0.07 γ IT Pa-234m to Pa-234 2.27 β Pa-234m to U-234
Pa-234 or U-234	245,500 years U-234 6.7 h Pa-234 to U-234	4.86 α U-234 to Th-230 2.19 β Pa-234 to U-234
Th-230	77,000 years	4.77 α Th-230 to Ra-226
Ra-226	1600 years	4.87 α Ra-226 to Rn-222
Rn-222	3.82 days	5.59 α Rn-222 to Po-218 Gas – in secular equilibrium with products above.
Po-218	3.10 min	6.11 α Po-218 to Pb-214 0.26 β Po-218 to At-218
At-218 or Pb-214 Beta decay of At-218 would make Rn-218	At-218 - 1.6 sec Pb-214 - 26.8 min	6.87 α At-218 to Bi-214 1.02 β Pb-214 to Bi-214 2.88 β At-218 to Rn-218 then to Po-214
Bi-214	19.9 min	3.27 β Bi-214 to Po-214 5.62 α Bi-214 to Tl-210
Tl-210 or Po-214	Tl-210 - 1.30 min Po-214 – 164 µsec	5.48 β Tl-210 to Pb-210 7.83 α Po-214 to Pb-210
Pb-210	22.2 years	3.79 α Pb-210 to Hg-206 0.063 β Pb-210 to Bi-210
Hg-206 or Bi-210	Hg-206 - 8.15 min Bi-210 - 5.013 d	1.31 β Hg-206 to Tl-206 1.16 β Bi-210 to Po-210 5.04 α Bi-210 to Tl-206
Tl-206 from Hg-206 or (Po-210 or Tl-206) from Bi-210	4.199 min Tl-206 138.376 d Po-210	1.53 β Tl-206 to Pb-206 5.41 α Po-210 to Pb-206
Pb-206	stable	

Note how the half-lives after Rn-222 are short (days and minutes) except for Pb-210.

To calculate the number of alphas and beta particles emitted you must know the following.

A = neutrons + proteins (total nucleons)
Z = protons (atomic number)
Alpha particle loses A = 4, Z =2
Beta particle loses A=0, Z= -1 (gain a proton at expense of neutron)
IT = meta stable internal transition no loss A or Z.

Table 2. Calculating the number of alpha and beta in the decay chain.		
	U-238 to Pb-206	U-238 to Rn-222
Number of alphas lost: $\Delta A/4$	(238-206)/4 = 32/4 = 8	(238-222)/4 = 16/4 = 4
Number of units removed by alpha decay:	8 x 2= 16	4 x 2 = 8
Difference of Z parent and daughter:	92-82 = 10	92-86 = 6
Number of B- decays:	16-10 = 6	8-6 = 2

Radon is found in granite and shale. The half-life of the parent is at least 10-times greater than the daughter therefore the U-238 to Rn-222 is in secular equilibrium. There is no equilibrium between Rn-222 and Pb-206 since some daughters (products) have a half-life greater than the Rn-222 parent (precursors). There is secular equilibrium between Pb-210 and its daughters and granddaughters (products). In a closed system and with enough time, the U-238 decay rate and Pb-206 production rate will be equal but going in opposite directions.

The other 2 radon isotopes are also in secular equilibrium with their precursors, but their concentrations are low due to their short half-lives.

The graphic has 4 detection methods.

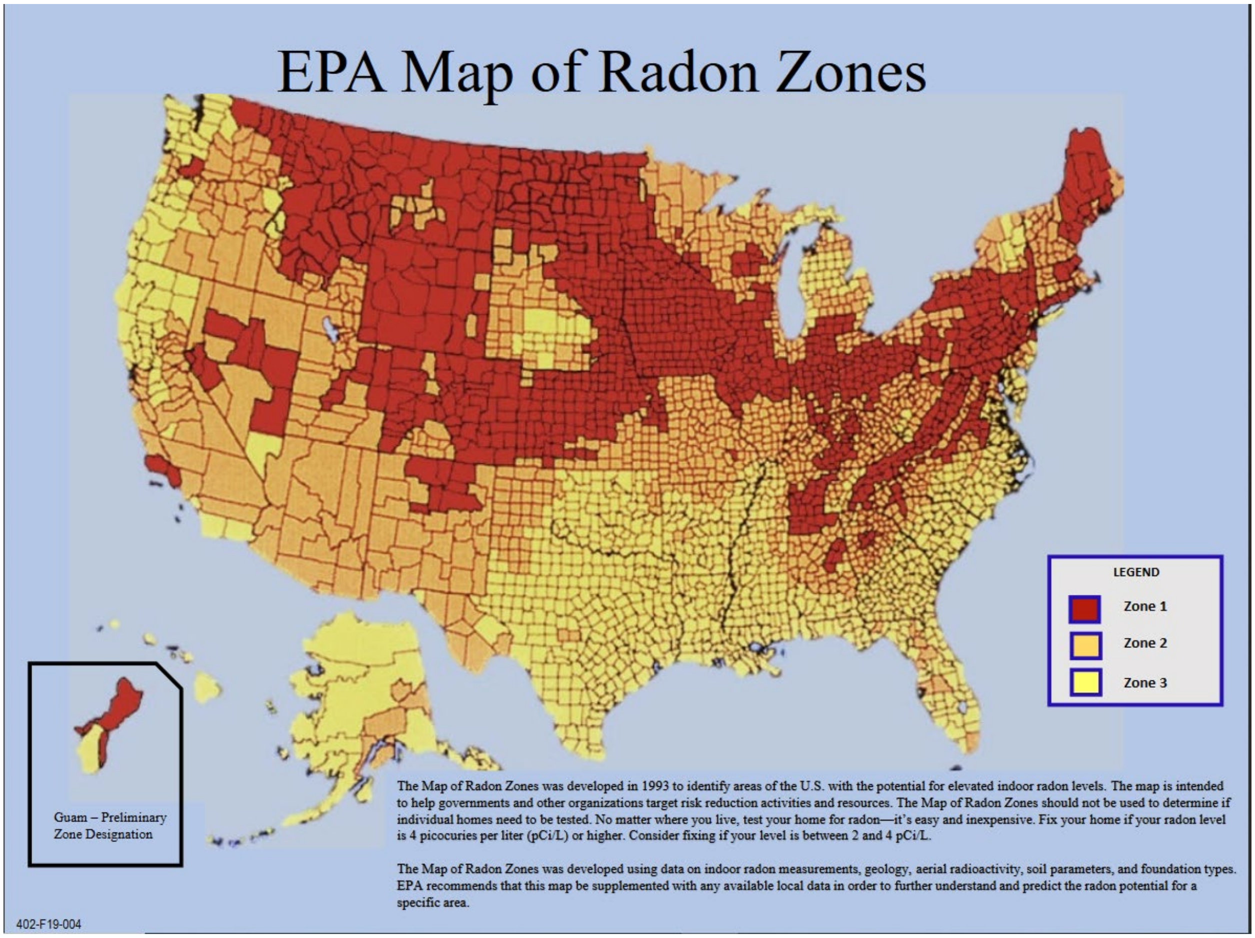
1. Alpha Track detectors – alpha particles create tracks in plastic material and tracks can be counted in a lab to determine radon concentration.
2. Activated carbon adsorption detector – absorbs radon, measure radiation emitted from the sealed detector.
3. Electron ion chambers – positive charged Teflon disk attracts negative charge, reducing the disks charge proportional to radon concentration.
4. Continuous radon monitors – records radon and its decay products.
   Show a picture

The US EPA has put out a national and state map based on county. There are 3 zones based upon indoor air concentration.

Zone 1 (red zones): Highest potential exposure risk; average indoor radon levels may be greater than 4 pCi/L (picoCuries per Liter).

Zone 2 (orange zones): Moderate potential exposure risk; average radon levels between 2 and 4 pCi/L.

Zone 3 (yellow zones): Lowest potential exposure risk; less than 2 pCi/L.



Snip copy of EPA Map by US counties. [5] Note the red zones are not in California except for Santa Barbara county and the west part of Los Angeles county. The high concentrations in the Midwest probably due to glacial deposits from elsewhere. The Canadian version is not created using county wide blocks.

Reference:

1. What are the Risks of Radon?, Chemistry and Engineering News, August 30, 2021: 22.
2. Introduction to Health Physics, second edition, Herman Cember, McGraw-Hill, New York, 1992.
3. Radiochemistry and Nuclear Methods of Analysis, William D. Ehnmann and Diane E. Vance, John Wiley and Sons, Inc., New York, 1991.
4. Chart of the Nuclides, Thirteenth Edition, General Electric Company, San Jose, California, USA, 1984.
5. https://www.epa.gov/sites/default/files/2015-07/documents/zonemapcolor.pdf.
6. https://en.wikipedia.org/wiki/Uranium-238