NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

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MEETING ANNOUNCEMENT

DATE: **Wednesday, April 26, 2023**

LOCATION: **Orinda Masonic Hall - and - Online using Zoom**

Note: Zoom meeting attendees should see Page 2 for "Zoom Meeting Instructions"

TIME: **7:15 pm to 8:30 pm (Social time 6:30 to 7:15 pm)**

SPEAKER: ***Larry Toy, PhD, retired***

TOPIC: ***"The James Webb Space Telescope – A New Look at the Universe"***

Abstract:

The James Webb Space Telescope in its short time in space has given us unprecedented views of the universe. The telescope took 25 years to design and build and was launched on Christmas Day, 2021. It is six times the size of the Hubble Space Telescope and already is revealing previously hidden objects and details from our local solar system to the most distant objects in the universe. This is a brief history of the why and how of its creation along with its unique location in space and how it stays there. Included will be a little history of astronomy from early in the last century (including some personal anecdotes) which expanded our knowledge of the scale of the universe. Finally, we will see some extraordinary photos and discuss what they mean.

Biography:

Larry received his bachelor's degree from Harvard and masters and PhD from UC Berkeley, all in astronomy. He spent much of his career teaching astronomy at Chabot College and was honored as one of the first four outstanding faculty selected from the 15,000 faculty of the California Community Colleges. He was a founding board member of the Chabot Space and Science Center in the Oakland Hills. For the final decade of his career, Larry served as the founding president/CEO of the Foundation for California Community Colleges. He also served on the California Council on Science and Technology. He served as president of Lamorinda Village for the past three years.

NCGS 2022 – 2023 Calendar

May 31, 2023 – Dinner Meeting – 6:00 pm
Rob Gailey, Consulting Hydrogeologist
Next Steps in Managing Groundwater Resources in CA

June 28, 2023 7:00 pm
Andrew Alden
Deep Oakland: How Geology Shaped a City

NEW Zoom Meeting Instructions – Advance Registration Required

Now that Contra Costa County Health Department has cleared us to meet in person, we are holding hybrid monthly meetings – in person and via ZOOM. The Zoom option is available for those not wishing to come to our Orinda Masonic Hall meeting place.

We have switched to a registration system for those who would like to join the NCGS meetings by Zoom. Please click the following link:
https://us06web.zoom.us/meeting/register/tZwpdOqpqTwiEtUtA4ngckIb92AH4kKBYxtp

in order to self-register. A zoom link for the meeting will be automatically sent to you for your use on the night of the meeting. The meeting room will be opened by the host between 6:45 PM and 7:00 PM with the meeting itself scheduled to start at 7:15 PM. The program will start no later than 7:30 PM and end by 8:30 PM. As in the past, the meeting will be recorded and kept on the Cloud for member viewing over the following month. A link for that recording will be made available to members the day after the event.

K-12 news for ways to support Earth Science in our communities & schools

NCGS and other Earth Science organizations are seeking to revitalize K-12 and Teacher of the Year (TOTY) awards. Our Society continues to lead in speaker programs and field trips. Let's see if we can do more with our other programs as well!

K-12 Science/Geology Outreach ALERT

Science is back in Fashion!! With the slam from COVID issues and confusing election information, support for schools is moving up in priority. Many professional societies (AGU, AAPG, PSAAPG and SPE included) are making an effort to get us to work with our communities and schools. Are you willing to HELP?

For K-12 Science programs, West Coast societies plus AAPG want to increase our efforts in working with K-12 Schools to provide support and reward teachers for stimulating programs in the Earth Sciences. NCGS has been working with Math Science Nucleus, BAESI, Science Fairs, individual schools and some Scout groups for many years. However, as we age, we have been losing our volunteer NCGS members as well as some schoolteachers and community organizations that have provided leadership and support for decades.

We currently have six community organizations/schools seeking our support: needing volunteers for field trips or trade shows/classroom lectures/exercise-experiments; as well as books, rock samples, docents, etc. Do you have teachers that should be considered for Teacher of the Year?

NCGS, PSAAPG, SCGS, AAPG, and SPE will be coordinating our efforts for 2023. I will keep you posted every month through the NCGS Newsletter. I'm currently talking with 5 organizations as well as several schools and teachers to determine their needs and line up our support capabilities. I thank our Executive Committee and all of you that have been busy the last few months communicating with K-12 teachers and community groups.

It is time to commit to K-12 Activities for 2023.

Below is a list of opportunities to help our communities – we ask you to please help. If you are interested in joining our effort through volunteering or donations, please contact Paul Henshaw, at drphenshaw@comcast.net.

K-12 Science Education Opportunities:

1) Develop AAPG-PSAAPG-NCGS Co-ordination
   Work with Coordination Committee
2) Math Science Nucleus: https://msnucleus.org
   Positions: Docents & 1 paid position
3) CCC Science Fair - Bay Area LEEDS (Linking Education & Economic Development Strategies): Judging positions
4) Cub Scouts Interest in K-12 Program
   Earth Science support as needed
5) Eden Area Regional Occupation Program in Hayward:
   Position – Work-Based Learning Specialist
6) School in Hayward that might need some lecturers

As new opportunities arise, we will update this list. If you wish to have NCGS consider additional organizations, please contact us at drphenshaw@comcast.net.

View the March Presentation

We held another fine meeting in March, live and via Zoom. We hope that all who wanted to see the talk by Dr. John Karachewski, PhD, on ***California Hydroscapes,*** were able to, without significant interruption or other issues. If you missed it or would just like to see it again, please use the following link and password:

https://us02web.zoom.us/rec/share/Vz7iK5wpWDdwD4_gEPp6G-VwOMRNn0Fl--esjhHwVjCKoScA07UJephDXZVBVm2D.HPlhK00KJHu2HI6B

Passcode: 7kaRe1+7

(**Note**: We suggest that you type in the password, rather than cutting and pasting it in.)

The Northern California Geological Society's

RICHARD CHAMBERS MEMORIAL SCHOLARSHIPS

2022-2023 AWARDS

The NCGS is pleased to announce that it has awarded two $1,500 scholarships to graduate students pursuing research in northern California. The availability of the Richard Chambers Memorial Scholarship is announced to all Colleges and Universities having graduate programs in northern California. These scholarships are funded from the Richard Chambers Memorial Scholarship fund and donations made by NCGS members and others for scholarships. These two students were chosen from a collection of well-prepared applications made to the NCGS during the fall of 2022. Serving on the NCGS Scholarship Committee were Phillip Garbutt (chair), Andrew Alden, Greg Croft, Paul Henshaw, Don Lewis, Don Medwedeff and Stephen Self. The recipients are:

Regina Khoury, Cal Poly Humboldt, for a master's research proposal titled ***"Petrologic Constraints on the Pre-Eruptive Storage Conditions of Magmas Erupted During the ~12ka Flare Up of Medicine Lake Volcano, CA."*** Her advisor is Dr. Brandon L. Browne.

Sarah Leidinger, Cal Poly Humboldt, for a master's degree research proposal titled: ***"Bathymetry and carbon accumulation rate of a rare Northern California coastal peatland."*** Her advisor is Dr. Laura Levy.

From the Newsletter Editor:

Field Trip Photos Sought!

Ray Sullivan had a great idea several months ago when he shared several photos with us all. Now I would like to put out a request to the membership. Do you have any photos of memorable field trips that you might share with the society? If so, please send them to me at msorensen64@earthlink.net.

Editor's Note: We have not received any responses on last month's mystery rock, and so will post this for another month.

Mystery Rock!

Mary Rose Cassa offers these comments and questions about the specimen below:

I came across this rock recently in a box that was stored away. The rock came from my great uncle's collection in New Jersey. He traveled widely and even took geology at Yale about 1930. I suspect he purchased the specimen while traveling.

I tested it with strong vinegar (I don't have any HCl) and it doesn't fizz. The "crystals" look to be dodecahedral. The specimen has sort of a 3-sided cross-section. One side has the larger "crystals; the other two sides have much smaller "crystals." A broken cross-section of a "crystal" appears to "radiate" from a central point.

I suspect the original rock was a carbonate or evaporite or garnet that has been replaced; i.e., a pseudomorph. But from what TO what?

I'm thinking it's an iconic type of rock that shows up in many collections. Any suggestions?

Local-themed Geo-Website

Steven Edwards, Ph.D. and **Director Emeritus** of the Regional Parks Botanic Garden in Berkeley, has developed a website centered on California geology and plants. Steve has gathered some beautiful photographs of, among other things, wildflowers and petrographic thin sections – he secured some expert help from John Wakabayashi and Howard Day in interpreting thin sections. There are also essays on botany and conservation, poetry, and lithic replicas, landscapes, and animals.

You can find the site at http://californiageology.net, or it can be googled at californiawildflowers.net (which leads to the same site).

NCGS Outreach Opportunities

Watch this space and watch for any emailed messages from the secretary.

UC Berkeley Earth & Planetary Science Weekly Seminar Series

There are at least two intriguing seminars coming up: On Thursday, April 20, 2023, Philipp Ruprecht of the University of Nevada Reno will speak on the topic ***Probing the crust: From Nevada's youngest eruption to Eocene magmatism in the Great Basin***. On Thursday, April 27, Kristina Faul Mills will speak on the topic ***Engaging diverse undergraduates in climate change research: from drought-impacted San Francisco Bay watershed geochemistry to North Atlantic Pleistocene paleoceanography.*** Both seminars will be held at 3:45 pm at 141 McCone Hall. Send an email to eps_frontoffice@berkeley.edu to join the department's email list. For updated listings of upcoming seminars, go to https://eps.berkeley.edu/seminars-courses/eps-seminars.

USGS Evening Public Lecture Series

The USGS evening public lecture series events are free and are intended for a general public audience that may not be familiar with the science being discussed. Pre-Covid, talks were held at USGS; the talks are now online. Talks are scheduled through August. On April 27 at 6:00 PM, Jonathan Godt, USGS Landslide Hazards Program Coordinator, will speak on ***Gravity Never Sleeps – Landslide Hazard and Risk Reduction.*** Check the website to join the live stream, at: www.usgs.gov/pls/. To be added to the email notification list for future USGS Public Lecture Series events, please email: wmcesic@usgs.gov.

Have You Renewed Your Membership?

Please see page 13 for a blank registration form, fill it out with your check and send to our Treasurer, Don Medwedeff. Note: Please do not pay for more than 3 years in advance, as it introduces bookkeeping issues.

WE'RE ON FACEBOOK!

CHECK OUT THE MOST RECENT POST: @NCGEOLSOC

ALSO, VISIT TWITTER @NORCALGEOSOC

Check out our NCGS Website at:

http://ncgeolsoc.org/

We have posted many older field trip guidebooks for free downloading, and we describe the process for purchasing newer guidebooks. The website includes a list of upcoming meetings, information on our scholarship program, a list of useful web links, and list of NCGS officers.

NCGS Board Meetings

Board meetings (online for now) are open to all NCGS members. If you'd like to attend, please contact President Noelle Schoellkopf at NoellePrince @ sbcglobal.net. Board meetings generally are on Saturday mornings in Jan., Apr./May, and Aug./Sep. Upcoming meeting: **Saturday, May 13 (9 am)**, location to be determined.

The Irony of Iron (continued)

Errata for the March newsletter's Irony of Iron article, Part 2 Isotopes and Abundances Paragraph

Isotopes: Iron has four naturally occurring stable isotopes: iron-54 (^{54}Fe) comprising 5.845% of the isotopes [however, it's possibly radioactive with a half-life ($t_{½}$) greater than (>) $4.4×10^{20}$ years to 3.1 x 10^{22} years, depending on the researcher], ^{56}Fe at 91.754%, ^{57}Fe at 2.119%, and ^{58}Fe at 0.286%. There are 24 known radioactive isotopes with varying $t_{½}$. Of these, the most stable are ^{60}Fe with a $t_{½}$ of 2.6 x 10^{6} years and ^{55}Fe with a $t_{½}$ = 2.7 years) (***WebElements***, 2023).

Abundances: Solar system abundances are mostly defined by the Sun, which has 99.86% of the system's entire mass. Note in Figure 1-2, that H and He are the most abundant with heavier elements comprising less than 2%. These include O at 0.80%, C at 0.36%, and Fe (~0.16%) as the fifth most common solar element. The Sun is still not hot enough to produce Fe through stellar nucleosynthesis, currently is fusing hydrogen in its core at 15 x 10^{6} K. However, it's a "metal-rich" star and has incorporated metals from the original solar nebula (Motzer, 2020).

Note from the Newsletter Editor: Parts 3 and 4 in a series that began in the March issue, contributed by Bill Motzer, an accomplished geochemist and longtime NCGS member

The Irony of Iron
Part 3 – Formation of Iron in the Universe

by

William E. (Bill) Motzer, PhD, PG, CHG

In Part 2, I discussed some iron element fundamentals, abundances, and concentrations in the Universe, Sun, meteorites, Earth's crust, mantle and core, the ocean, freshwater, and the human body. How such iron concentrations got there is rather intriguing, but we need to start at a beginning with the following summarized from Cowan and Thielemann (2004), Raucher and Patkos, (2011), and Johnson (2019).

Stellar Nucleosynthesis (SN): iron is created within stars as a result of SN. Iron's formation and distribution throughout the Universe occurs in either super massive exploding stars or white dwarf exploding stars (**Figure 1-3**). Several astrophysical processes are theorized for nucleosynthesis to occur within stars, with the chain of nuclear fusion processes commonly called hydrogen "burning" (i.e., by deuterium fusion, the proton–proton chain reaction, and the carbon-nitrogen-oxygen or CNO cycle), and subsequent helium (He)-, carbon (C)-, neon (Ne)-, oxygen (O)- and silicon (Si)-burning (**Table 1-3**). These processes create elements up to and including iron (Fe) and nickel (Ni). However, in super massive stars, such as red giants, once Si-burning is completed and Fe and Ni forms in its core, stellar nucleosynthesis ceases. Subsequent gravitational collapse then occurs with the star's upper layers descending inward toward the core with associated heating before exploding as a Type II supernova (**Figure 2-3**). This collapse almost immediately results in an explosion with a compressional shock wave rebounding outward. The shock front briefly increases temperatures by approximately 50 percent. This causes furious burning (fusion) for about one second thereby finally resulting in explosive nucleosynthesis or supernova nucleosynthesis by the r-process (rapid-neutron capture process), the final end-stage of stellar nucleosynthesis.

Such super massive stars are least eight times and not more than 40 to 50 times, the Sun's mass of approximately $2×10^{30}$ kg, typically averaging about 25 solar masses (**Table 1-3**). They are rather short-lived stars with ages of approximately 10^{7} years and are also believed to have been some of the first stars formed after the Big Bang.

Supernova Remnants (SNR): Type II supernova generally are differentiated from other supernova types and their remnants by occurrence of hydrogen in their spectra. They are usually observed in galactic spiral arms and in H-II regions, (i.e., regions of interstellar partially ionized atomic hydrogen, typically occurring as gaseous molecular clouds where star formation has recently occurred. Sizes range from one to hundreds of light years in diameter with densities ranging from a few to about a million particles per cm^{3}). One such SNR is the Orion Nebula, now known to be an H-II region. Other SNR with iron in their spectra includes Cassiopeia A (**Figure 3-3**). It's these SNR that have scattered iron and other elements across the Universe, accumulating in galaxies, stars, and ultimately in our solar system (Nowakowski, 2023).

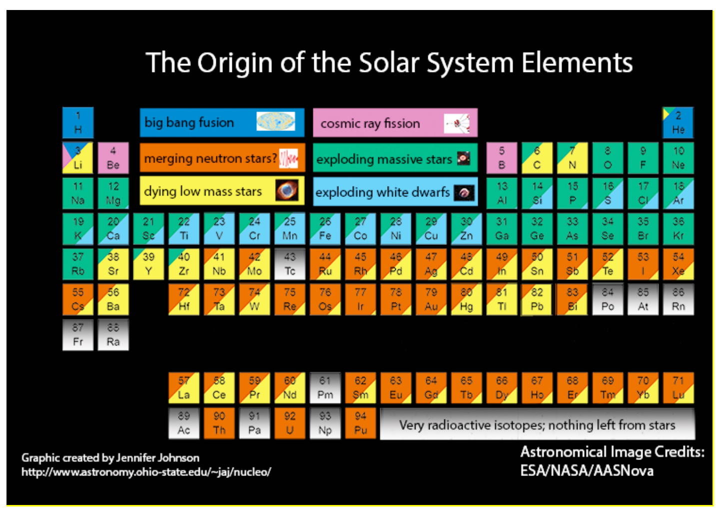

Figure 1-3: Elemental origins for the solar system in the Periodic Table. Note that iron (Fe; Z=26) forms exploding massive stars (e.g., red giants) and exploding white dwarfs.
Source: NASA and Johnson (2019).

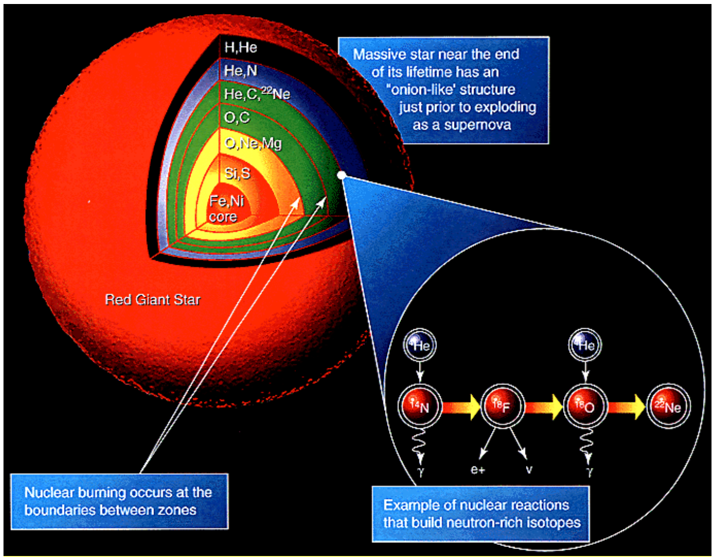

Figure 2-3: Nucleosynthesis in a supergiant red star just before stellar collapse and subsequent explosion as a supernova.
Source: Lochner, et al. (2005) with NASA (2005) image.

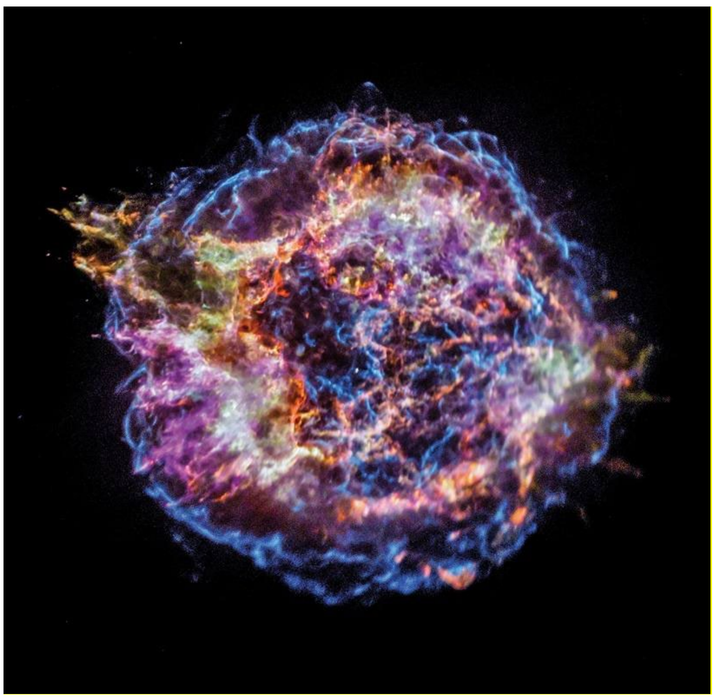

Figure 3-3: X-ray spectral image transposed to visual light of the Cassiopeia A collapse-core supernova remnant (SNR): silica (Si) shown in red, sulfur (S) in yellow, calcium (Ca) in green, iron (Fe) in purple, and the blast-boundary in blue. In May 2023, NASA and the JAEA (Japanese Aerospace Exploration Agency) intend launching the *X-Ray Imaging and Spectroscopy Telescope*, to observe iron x-ray spectra with increased resolution.
Source: Johnson (2019) and Garisto (2023).

Table 1-3: Super Massive Red Giant Nucleosynthesis Processes and Products

Process	Main Fuel	Main Products	Secondary Products	Typical Star: 25 Times Solar Mass		
				Temperature (K)	Density (g/cm^3)	Duration
H-burning	H	He	N	7 x 10^7	10	10^7 years
Triple alpha*	He	C, O	Ne	2 x 10^8	2,000	10^6 years
C-burning	C	Ne, Mg, Al	Na	8 x 10^8	10^6	1,000 years
Ne-burning	Ne	O, Mg	Al, P	1.6 x 10^9	10^7	3 years
O-burning	O	Si, S	Cl, Ar, K, Ca	1.8-2.0 x 10^9	10^7	0.3 years
Si-burning	Si	Ni (decays to Fe)**	Ti, V, Cr, Mn, Co, Ni	2.5-3.3 x 10^9	10^8	5 days

Notes: * The triple alpha process is a nuclear fusion reaction where three helium nuclei (alpha particles) fuse to form a carbon nucleus, thereby releasing energy. Triple alpha processes typically occur in stars where large amounts of He have accumulated as the product of proton-proton chain and CNO reactions.

** This is known as the iron limit. Iron-56 (^{56}Fe) is abundant in stellar processes with a binding energy of 8.8 MeV per nucleon. Its binding energy is only exceeded by ^{58}Fe and ^{62}Ni, which is the most tightly bound of the nuclides.

Source: Lochner et al. (2005).

References

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Garisto, D., 2023, *Experiment Resolves Long-Standing Iron-Spectrum Discrepancy*: **Physics Today**, February 2, 2023 issue: https://physicstoday.scitation.org/do/10.1063/PT.6.1.20230202a/full/

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Nowakowski, T., 2023, *Astronomers Identify 20 Ultraviolet-Emitting Supernova Remnants in the Andromeda Galaxy*: February 2, **Phys.org News**: https://phys.org/news/2023-02-astronomers-ultraviolet-emitting-supernova-remnants-andromeda.html.

Raucher, T. and Patkos, A., 2011, *Origin of the Chemical Elements:* in *Handbook of Nuclear Chemistry*, by A. Vertes, S. Nagy, Z. Klencsar, R. G. Lovas, and F. Rosch, ISBN 978-1-4419-0719-6. Springer Science+Business Media B.V., 2011, p. 611: https://ned.ipac.caltech.edu/level5/Sept16/Rauscher/Rauscher_contents.html.

The Irony of Iron: Part 4 – Terrestrial Planetary Core Formation

Life, as we know it, is largely composed of the six most important elements contained biological molecules (i.e., living organisms and the human body). These often are carbon (C), hydrogen (H), nitrogen (N), oxygen (O), phosphorous (P) and sulfur (S), abbreviated as the mnemonic acronym CHNOPS. Note that iron is not included; however, if not for iron, life might not have developed and evolved on Earth.

The terrestrial (rocky) inner planets all have similar structures: a central metallic, mostly iron-rich core generally surrounded by a silicate mantle and a stable outer crust. A metallic (iron-nickel [Fe-Ni]) core is important because it can generate a planet's magnetic field by a dynamo effect. Terrestrial planets also possess more carbon-rich secondary atmospheres either derived by internal volcanism or by cometary and perhaps even asteroid impacts, as opposed to the gas giants (i.e., Jupitar and Saturn) that have primary atmospheres of mostly H and helium (He) captured directly from the original solar nebula (Motzer, 2012).

The terrestrial inner planets contain large iron cores relative to their diameters (Figure 1-4). Mercury and Venus are believed to have Fe-Ni cores. Based on the 2018 Mars InSight Landers's seismograph, Mars most likely has a core composed of liquid iron-sulfur mixed with some nickel. Inner planetary large cores are believed to have resulted from either early planetary collisions (Figure 2-4) and asteroid bombardment (Olds, 2019; Olds, 2020; Motzer 2020).

Large iron cores are necessary to produce sustained terrestrial planetary magnetic fields. However, from planetary probe detections, Mercury has a weak magnetic field, possibly generated from slow rotation and Venus has a very weak and unstable magnetic field due to it slow rotation (243 days) and because it lacks internal thermal convection from a nonrotating molten interior metallic core. Mars may have generated a magnetic field billions of years ago; however, it shut down leaving only some magnetic fragments in magnetized minerals in rock. Earth is the only terrestrial planet having a sustained magnetic field, largely due to the Earth-Lunar system operating as a duel or double planetary system. The Earth-Lunar barycenter is about 1,700 km below Earth's surface or 4,671 km from Earth's center. It's this offset that produces a rotating core dynamo resulting in Earth's sustained magnetic field, which diverts ionizing radiation from the Sun and stellar cosmic rays, thereby protecting CHNOPS life. Thus, without iron, there would be no life on Earth.

References:

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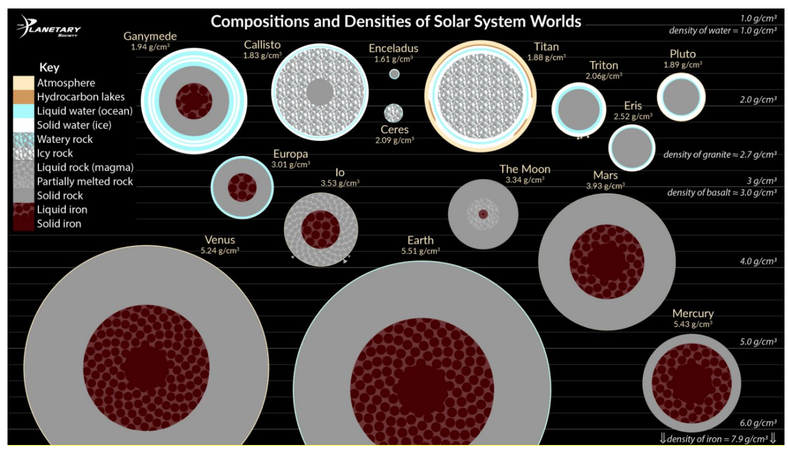


Figure 1-4: Terrestrial planetary and other solar system asteroid, dwarf planet, and moon core comparisons showing core sizes relative to planetary diameters. **Source**: Murray (2020).

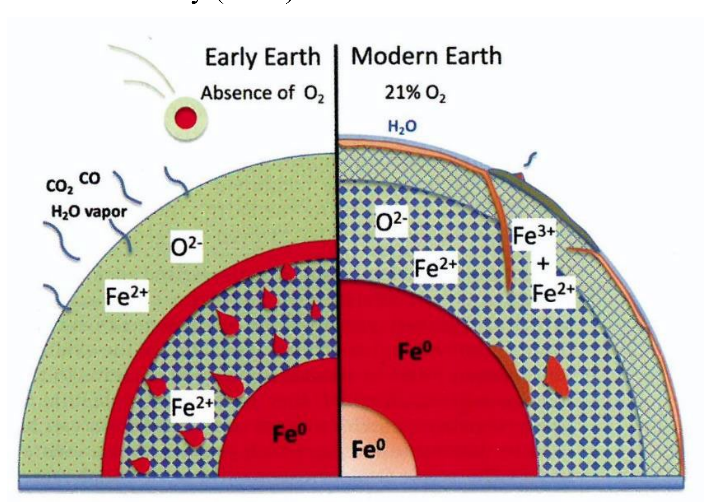


Figure 2-4: Cross sectional model of Earth's interior showing possible iron core evolution. Additional iron was supplied by Earth's collusion with a large Mars-like planetoid dubbed *Theia* about 4.4 billion years ago and additional at large asteroid impacts. **Source:** Stagno and Fey (2020).

Ice sheets can collapse faster than previously thought possible

ScienceDaily: April 5, 2023
Source: Newcastle University

Ice sheets can retreat up to 600 meters a day during periods of climate warming, 20 times faster than the highest rate of retreat previously measured.

An international team of researchers, led by Dr Christine Batchelor of Newcastle University, UK, used high-resolution imagery of the seafloor to reveal just how quickly a former ice sheet that extended from Norway retreated at the end of the last Ice Age, about 20,000 years ago.

The team, which also included researchers from the universities of Cambridge and Loughborough in the UK and the Geological Survey of Norway, mapped more than 7,600 small-scale landforms called 'corrugation ridges' across the seafloor. The ridges are less than 2.5 m high and are spaced between about 25 and 300 meters apart.

These landforms are understood to have formed when the ice sheet's retreating margin moved up and down with the tides, pushing seafloor sediments into a ridge every low tide. Given that two ridges would have been produced each day (under two tidal cycles per day), the researchers were able to calculate how quickly the ice sheet retreated.

Their results, reported in the journal *Nature*, show the former ice sheet underwent pulses of rapid retreat at a speed of 50 to 600 meters per day. This is much faster than any ice sheet retreat rate that has been observed from satellites or inferred from similar landforms in Antarctica.

"Our research provides a warning from the past about the speeds that ice sheets are physically capable of retreating at," said Dr Batchelor. "Our results show that pulses of rapid retreat can be far quicker than anything we've seen so far." Information about how ice sheets behaved during past periods of climate warming is important to inform computer simulations that predict future ice-sheet and sea-level change.

"This study shows the value of acquiring high-resolution imagery about the glaciated landscapes that are preserved on the seafloor," said study co-author Dr. Dag Ottesen from the Geological Survey of Norway, who is involved in the MAREANO seafloor mapping programme that collected the data.

The new research suggests that periods of such rapid ice-sheet retreat may only last for short periods of time (days to months).

"This shows how rates of ice-sheet retreat averaged over several years or longer can conceal shorter episodes of more rapid retreat," said study co-author Professor Julian Dowdeswell of the Scott Polar Research Institute, University of Cambridge. "It is important that computer simulations are able to reproduce this 'pulsed' ice-sheet behavior."

The seafloor landforms also shed light into the mechanism by which such rapid retreat can occur. Dr Batchelor and colleagues noted that the former ice sheet had retreated fastest across the flattest parts of its bed.

"An ice margin can unground from the seafloor and retreat near-instantly when it becomes buoyant," explained co-author Dr Frazer Christie, also of the Scott Polar Research Institute. "This style of retreat only occurs across relatively flat beds, where less melting is required to thin the overlying ice to the point where it starts to float."

The researchers conclude that pulses of similarly rapid retreat could soon be observed in parts of Antarctica. This includes at West Antarctica's vast Thwaites Glacier, which is the subject of considerable international research due to its potential susceptibility to unstable retreat. The authors of this new study suggest that Thwaites Glacier could undergo a pulse of rapid retreat because it has recently retreated close to a flat area of its bed.

"Our findings suggest that present-day rates of melting are sufficient to cause short pulses of rapid retreat across flat-bedded areas of the Antarctic Ice Sheet, including at Thwaites," said Dr. Batchelor. "Satellites may well detect this style of ice-sheet retreat in the near-future, especially if we continue our current trend of climate warming."

Other co-authors are Dr. Aleksandr Montelli and Evelyn Dowdeswell at the Scott Polar Research Institute of the University of Cambridge, Dr. Jeffrey Evans at Loughborough University, and Dr. Lilja Bjarnadóttir at the Geological Survey of Norway. The study was supported by the Faculty of Humanities and Social Sciences at Newcastle University, Peterhouse College at the University of Cambridge, the Prince Albert II of Monaco Foundation, and the Geological Survey of Norway.

Journal Reference: Christine L. Batchelor, Frazer D. W. Christie, Dag Ottesen, Aleksandr Montelli, Jeffrey Evans, Evelyn K. Dowdeswell, Lilja R. Bjarnadóttir, Julian A. Dowdeswell. **Rapid, buoyancy-driven ice-sheet retreat of hundreds of metres per day**. *Nature*, 2023; DOI: 10.1038/s41586-023-05876-1.

The Biggest Penguin That Ever Existed Was a ‘Monster Bird’

Fossils found in New Zealand highlight an era after the dinosaurs when giant flightless birds prowled the seas for prey

Source: The New York Times, Feb 9th 2023

By Jack Tamisiea
Published Feb. 8, 2023; updated Feb. 9, 2023

New Zealand has been a haven for earthbound birds for eons. The absence of terrestrial predators allowed flightless parrots, kiwis and moas to thrive. Now researchers are adding two prehistoric penguins to this grounded aviary. One species is a beefy behemoth that waddled along the New Zealand coastline nearly 60 million years ago. At almost 350 pounds, it weighed as much as an adult gorilla and is the heaviest penguin known to science.

Alan Tennyson, a paleontologist at Museum of New Zealand Te Papa Tongarewa, discovered the supersize seabird’s bones in 2017. They were deposited on a beach known for large, cannonball-shaped concretions called the Moeraki Boulders. The churn of the tide cracked open several of these 57-million-year-old boulders, revealing bits of fossilized bones inside.

Dr. Tennyson and his colleagues identified the fossilized remains of two large penguins. The humerus of one, at more than nine and a half inches long, was nearly twice the size of those found in emperor penguins, the largest living penguin. Other boulders yielded bones from a smaller, more complete penguin species that also appeared to be larger than a modern emperor penguin.

The researchers described the ancient birds Wednesday in the Journal of Paleontology. They named the larger penguin *Kumimanu* (a mash-up of the Maori words for “monster” and “bird”) *fordycei* and named the smaller penguin *Petradyptes* (“rock diver”) *stonehousei*.

By creating 3-D models of Kumimanu’s humongous humerus and comparing its size and shape with the flipper bones of prehistoric and modern penguins, the researchers estimate that the “monster bird” weighed a whopping 340 pounds — 15 pounds heavier than Lane Johnson, the right tackle anchoring the Philadelphia Eagles offensive line in the Super Bowl.

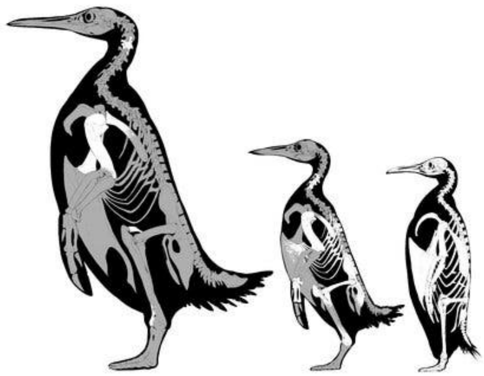
A cast of *Kumimanu’s* humerus, below, created from 3-D scans, alongside a humerus of an emperor penguin, above. Credit: Daniel Ksepka

According to Daniel Ksepka, a paleontologist at the Bruce Museum in Greenwich, Conn., and an author of the new study, the *Kumimanu’s* fragmented skeleton makes it difficult to pinpoint its height. Dr. Ksepka estimates that it stood around 5 feet 2 inches, giving it a stocky build. *Petradyptes* was not a lightweight, either. It weighed 110 pounds, making it heftier than modern emperor penguins, which top out at 88 pounds.

Both *Kumimanu* and *Petradyptes* plied the waters off New Zealand during a sweet spot in oceanic history, according to Dr. Ksepka. The asteroid impact that ended the dinosaur era had wiped out most marine reptiles while the ancestors of seals and whales were still on land. This meant there were few things that would mess with a black-bear-size penguin.

“If you’re a little one-pound penguin, a gull can just rip your head off,” Dr. Ksepka said. “But a 300-pound penguin is not going to worry about a sea gull landing near it because it would just crush it.”

Despite their prodigious size, *Kumimanu* and *Petradyptes* possessed primitive flippers reminiscent of modern seabirds like auks and puffins that fly and dive. Julia Clarke, a paleontologist at the University of Texas at Austin who studies the evolution of diving in birds and was not involved in the new study, said it would make sense for early penguins like *Kumimanu* and *Petradyptes* to retain several features left over from their ancestors’ airborne lifestyle.



A skeletal sketch comparing, from left, *Kumimanu*, *Petradyptes*, the two new fossil penguins, and an emperor penguin. Credit: Simone Giovanardi

The new species add evidence that prehistoric penguins became huge before they fine-tuned their flippers into paddle-like appendages. Heavier seabirds are able to dive deeper and longer than their lighter counterparts, Dr. Ksepka said. The extra paunch would also have helped these penguins stay warm in the water.

While *Kumimanu* was mighty, it didn't crowd out its smaller penguin cousins. "You have super large penguins eating the largest prey items and you also have mid-sized and smaller-bodied penguins, and they can all specialize within a crowded penguin environment," Dr. Clarke said.

Despite plenty of seafood and little competition, these penguins could probably grow only so big.

"I believe that *Kumimanu* is close to the upper limit of a flightless seabird and I do not expect substantially larger penguins to be found," said Gerald Mayr, a paleontologist at the Senckenberg Research Institute in Frankfurt who described the closely related 220-pound *Kumimanu biceae*. Dr. Mayr, who was not involved in the new study, notes that heavier birds would most likely crush their eggs into yolky smithereens.

As some of the earliest fossil penguins, *Kumimanu* and *Petradyptes* reveal just how quickly penguins packed on pounds after they stopped taking to the skies.

"Once you know you're not flying anymore," Dr. Ksepka said, "the sky's the limit."

Obsidian Cliff: Humanity's Tool Shed for the Last 11,500 Years

X-ray technology has allowed researchers a glimpse at the reaches of the Yellowstone landmark's prized stone and its importance to Indigenous people.

A black-and-white view of Obsidian Cliff, with trees growing atop and alongside it and Bear Lake in the foreground.

From *The New York Times*, March 20, 2023

Obsidian Cliff, made of volcanic glass used for milleniums as an extremely sharp tool for hunters' weapons. Credit: Art World/Alamy.

By Jim Robbins

YELLOWSTONE NATIONAL PARK, Wyo. — Near the north entrance, an imposing mountain of black glass rises against the blue sky.

Spanning more than five square miles, the dark, sometimes translucent mass was formed from a rhyolitic lava flow that oozed out of the magma chamber of Yellowstone Caldera beneath the park, and cooled rapidly in the bitter cold of a glacial maximum, about 180,000 years ago.

Known as Obsidian Cliff, the Yellowstone mountain is one of the country's highest quality deposits of "the sharpest natural substance on Earth," according to Douglas H. MacDonald, a professor of anthropology at the University of Montana and the author of "Before Yellowstone: Native American Archaeology in the National Park."

Obsidian is among the most prized tool stones in the world, and this particular deposit, nearly 100 feet thick, is exceptional because of its continual use by Indigenous people since the last ice age. Over the last 11,500 years or so, the stone has been fashioned into deadly knives, razor-sharp spear points, darts for atlatls, or spear-throwers, and arrowheads.

The cliff is "nationally significant because we had Native American groups from all over the country visiting it and collecting the stone and trading for it," Dr. MacDonald said.

For modern day researchers, the obsidian columns of Yellowstone have helped to reveal the travels and migration of people thousands of years ago. X-ray fluorescence technology has been used to identify the unique geochemical fingerprint of each separate deposit of obsidian, pinpointing the provenance of artifacts found elsewhere. Obsidian from here has been found across the continent.

A fingerprint for the most prized tool stone in paleoindian cultures transformed the field. It provides a window into the past, a flow through both space and time over thousands and, in some places, millions of years. It opens up unknown and unimagined connections and deepens the understanding of migration, networking and trade in populations around the world.

"We can figure out where people are moving on the landscape and from there how the tools themselves reflect their strategies and culture," said Elizabeth A. Horton, the archaeologist for Yellowstone, as she displayed obsidian knives and spear points from the park's archives. "How did they interact with this landscape? Where did people go to visit? What was at that location?"

The application of X-ray technology to archaeology arose in the 1960s "and changed everything," said M. Steven Shackley, director of the Geoarchaeological XRF laboratory in Albuquerque and author of "X-ray Fluorescence Spectrometry (XRF) in Geoarchaeology." "Before that you had to infer. They either just guessed or didn't do it."

In recent decades, the technology has become easier to use, more portable and far less expensive.

The smooth, sensuous black glass has been an important part of hunter-gatherer cultures for about two million years, going back to Homo habilis, one of the first human ancestors who made crude stone tools. (A very modern reference would include the fictional land of Westeros, the setting for the HBO series "Game of Thrones," where it was called dragon glass and made by "the fires of the earth.")

Researchers are using the approach to study both newly discovered artifacts and to re-examine existing collections. Archaeologists at Yale recently deployed the X-ray fluorescence technology on obsidian artifacts that were gathered at the university's Peabody Museum in the 1960s from two key sites in southwestern Iran.

The tools, which date back nearly 10,000 years, were originally believed to have come from two sources on the Deh Luran Plain in Iran. But the analysis showed that the volcanic glass came from seven places, including Nemrut Dağ, a dormant volcano that was more than 1,000 miles from the excavation sites in what is now southeastern Turkey and in Armenia. Those findings led to the realization that Neolithic social networks were much larger and settlements were more complex than originally thought.

"Tracing these obsidian artifacts from their sources to their end points offers insight into how they moved from hand to hand to hand over time," Ellery Frahm, an archaeological scientist at Yale and the lead author on the paper, said.

X-ray fluorescence can be done in the field with an instrument the size of a hand drill, reducing a process that used to take days or weeks to seconds.

The technique is being used widely across the American West, and Yellowstone has a number of projects underway.

The geochemical fingerprint of the cliff's volcanic glass has been found all around the West, as well as in Canada. Area tribes "all knew about it, all the archaeological sites in Montana that are important have some form or another of obsidian, and most of it comes from this place — Obsidian Cliff," Dr. MacDonald said. "All of the tribes in Montana, Wyoming and Idaho were going out of their way to get it."

One lingering mystery of Obsidian Cliff stumps scientists to this day: How, some 2,000 years ago, did hundreds of pounds of obsidian wind up at what is now Hopewell Culture National Historical Park in Ohio, about 1,700 miles east of Yellowstone. Researchers do not know if the material traveled through trading networks or was gathered by people who went on a special journey to the cliff. That's one of the major shortcomings of the X-ray analysis.

"If someone sends me an artifact, I can determine the origin of it with a good degree of confidence," Dr. Shackley said. "But determining how it got there is the kicker."

In the early 1890s, excavators digging in Mound 25 at the Hopewell location near Chillicothe, Ohio, found an altar with more than 100 burned and broken obsidian spear points, also known as bifaces. One point was more than 17 inches long and 6 inches wide and believed to have been designed for ceremonial purposes. About three-fourths the obsidian at Hopewell has been traced back to Obsidian Cliff using the X-ray tech.

"The largest of these bifaces are master works, really remarkable," said Timothy D. Everhart, a museum curator and archaeologist at the Hopewell park.

The allure of Obsidian Cliff's stone glass can be seen as well as felt in its efficient use as a sharp weapon. In a recent paper, researchers outlined its noteworthy elements — abundance, access, aesthetics and quality.

There is so much that the obsidian here could fill 3,000 stadiums the size of the Rose Bowl in California, Dr. MacDonald said.

The stone at Obsidian Cliff has few inclusions, which means it lacks the presence of mineral crystals that can weaken the stone's structure, and that contributes to the high quality of the Yellowstone obsidian and the easy transformation into sharper blades, Dr. MacDonald said.

"It comes in a variety of colors and is much more translucent than other sources," he added. "That increased its value." In addition to black, colors reported atop the cliff include brown, red, mahogany, gray and green. In Idaho, west of Yellowstone, Bear Gulch has a comparable high-quality obsidian, although it is jet black and less translucent. There are at least eight known obsidian quarry sites in Yellowstone and many others in the region.

All obsidian shares certain critical features that made it indispensable. It fractures conchoidally — into smooth, curved pieces. It was easy to knap, or to flake off, pieces into utilitarian shapes and didn't need to be tempered or treated with heat as some tool stones do. "You can pick it up off the ground and go right to work," said David Wescott, an editor of The Bulletin of Primitive Technology and a longtime knapper.

Sharpness, though, is the main draw.

"If you look at a surgical scalpel and a fresh obsidian flake under a microscope, the obsidian edge makes the surgical scalpel look like a dull ax," Dr. Frahm said. "It is razor sharp. It cuts very, very cleanly." In fact, some surgeons use obsidian scalpels.

It is so sharp that many people who work with it, including the staff members of the Yellowstone archaeology lab, keep a box of Band-Aids within reach.

The massive wildfires of 1988 in Yellowstone burned off trees and other vegetation and allowed archaeologists a virtually unobstructed view of the ground on top of the cliff. One archaeological survey found 59 different places where obsidian was quarried in some fashion.

In another survey in 2014 Dr. MacDonald and his team found millions of artifacts on the cliff, including arrow and spear points, along with billions of pieces of debitage, the stone flakes that remain after crafting points. Numerous obsidian boulders were smashed and broken open.

As the climate grows warmer in Yellowstone, many of the snow fields are receding and previously unknown artifacts are being revealed, sometimes on wood shafts that were preserved by the snow cover.

Obsidian Cliff is closed to pedestrians, but it is along one of the park's main roads and people can park at an interpretive kiosk. Collecting is forbidden, but it is permitted at other sites on federal land in other parts of the country.

Like Mr. Wescott, people still harvest the glassy stone to create obsidian tools or to hunt with atlatls and arrows with obsidian points. Knapping a 6-inch long, 2-inch wide spear point, Mr. Wescott said, "takes the better part of a day."

But 21st-century uses build on the long history of obsidian toolmaking that keeps reaching farther back into time. A group of European archaeologists recently published a paper on their discovery of a "stone tool workshop" with 575 obsidian ax heads at a single site in the Awash valley of Ethiopia, dated to 1.2 million years ago.

Obsidian objects have long been imbued with profound spiritual and mystical properties of other millenniums. The name of the Aztec god Tezcatlipoca was Lord of the Smoking Mirror, a reference to obsidian. An Aztec mirror displayed at the British Museum was used in the 16th century by John Dee, an adviser to Queen Elizabeth I, as a tool for divination. X-ray fluorescence tracked the source of the "spirit mirror" obsidian to Mexico to reveal its Aztec origins.

In ancient Mexico, powdered obsidian was mixed with quartz and sprinkled in someone's eyes to treat cataracts.

The Crow people of southern Montana, who gathered much of their stone for tools from Obsidian Cliff, still wear red obsidian arrowheads "for spiritual protection," said Timothy McCleary, the former archaeologist for the Crow tribe, who now teaches at Little Big Horn College on the Crow reservation. The arrowheads are passed down through families, he said.

"Someone might find themselves in a dangerous situation, and it protects them from any danger," he said. "Where I've seen it most commonly is on firefighters when they go to fight forest fires."

Obsidian Cliff, which is designated a National Historic Landmark, still figures in the lives of many tribes. "Anytime we go to Yellowstone, that's a really powerful place," said Louise E. Dixey, cultural resources director for the Shoshone-Bannock tribes in Idaho. "Prayers are always said there. We go back every year to remind our people where we came from and remind the non-Indian public that these are our original homelands."

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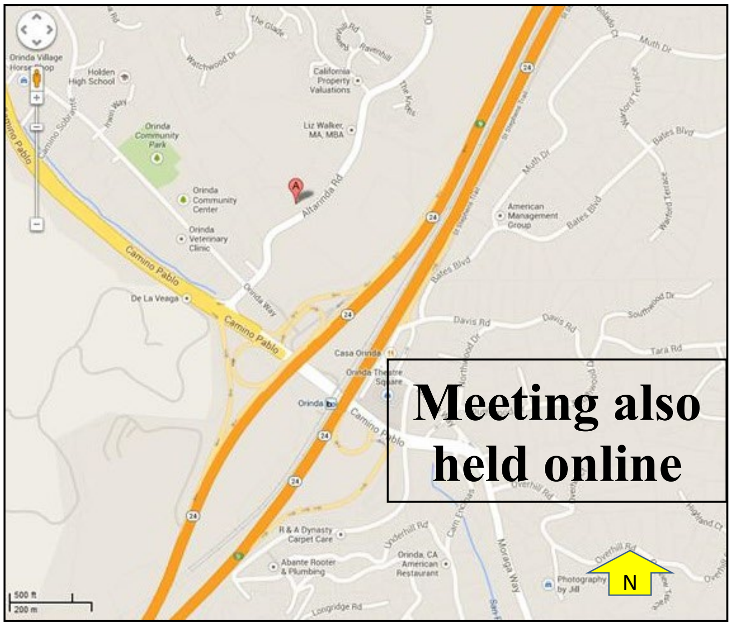

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