

# EARTH MOTHER VOL 2



# The Blueprint of Creation

Seed and Structure: How the Cosmic Egg Hatches into the Tree of Life

[SALAH-EDDIN GHERBI](#)

FEB 24, 2025

The Tree of Life is a source of fascinating topics, including the Cosmic Egg we have previously studied in depth in three different parts:

[Part I - The Vision of the Cosmic Egg](#)

[Part II - Cracking the Cosmic Egg](#)

[Part III - The Geometric Construction of the Cosmic Egg](#)



Seed and Structure: How the Cosmic Egg Hatches into the Tree of Life

- The *Cosmic Egg* represents the origin of the universe, often depicted as a container holding the potential of creation before it hatches or breaks open.
- The *Tree of Life* symbolizes the structure of existence, branching from a singular source and connecting all realms (heaven, earth, and underworld).

Both serve as a central axis in mythologies:

- The *Tree of Life* is often depicted as the axis mundi, the central pillar connecting dimensions.
- The *Cosmic Egg* is often the seed of the cosmos, from which the ordered universe emerges.

The *Tree of Life* and the *Cosmic Egg* share common symbolic themes, particularly about cosmic origins, creation, and interconnectedness. There is a sense of universality throughout the ancient civilizations:

- Hinduism: The *Brahmanda* (*Cosmic Egg*) and the *Ashvattha Tree* (*Tree of Life*).
- Egyptian Mythology: The *Cosmic Egg of Ra* and the *Ished Tree*.
- Norse Mythology: *Yggdrasil* (*Tree of Life*) and the *primordial Ginnungagap* (*a cosmic void akin to the egg before creation*).
- Christian Mysticism: The *Tree of Life in Eden* and the *Ovum Mundi* (*World Egg*).

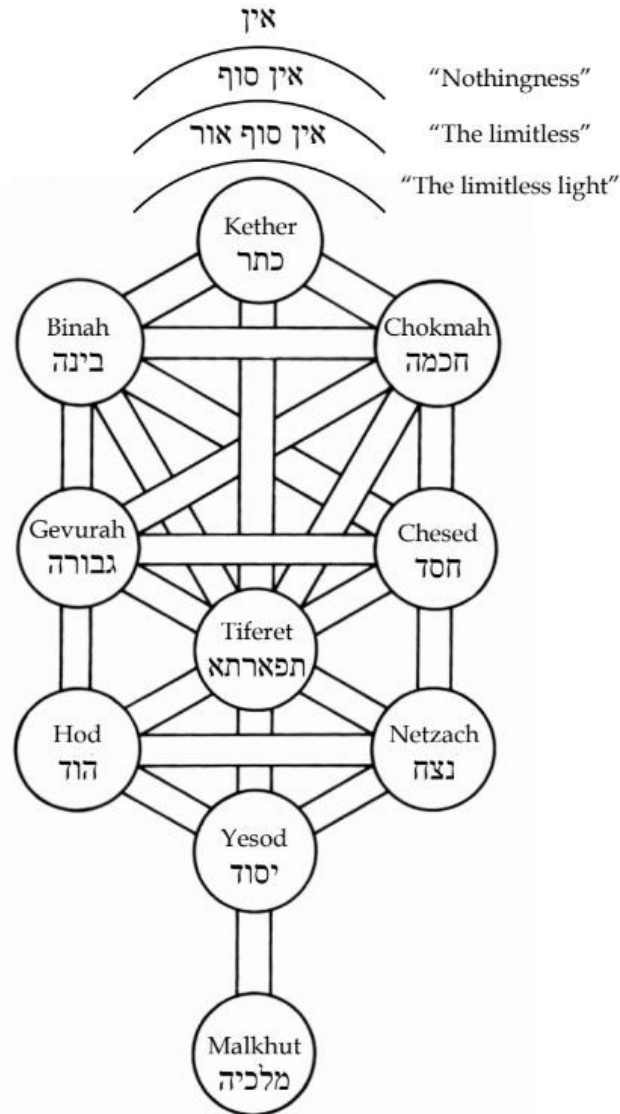
The Hebrew root of the Kabbalah is Kuf-Beit-Lamed, קבל, which is translated as “Capacitor, Condenser.” Every sub particle of matter, human being, planet, galaxy, and anything would act as a capacitor or condenser, storing energy from the infiniteness and limitless source of light (Ein Sof Aur).

The creative energy flow is conducted through a Divine Map, the *Tree of Life*, well known as the Kabbalah. It has ten Sephiroth, each

representing a jewel of wisdom, and three other mysterious and unknown Sephiroth above Kether כתר, which means “crown,” at the top, on the head of the Tree of Life. These three are described as follows:

- The first one is called אין אלק Ain in Hebrew, meaning “nothingness”. Undifferentiated consciousness in its purest original state, “I-less” or “ego-less.”
- The second one, below Ain, is called Ain Soph, סוף אלק, “the limitless.” Differentiated Consciousness with “I,” Self-Realisation, the Monad (Point) before Emanation.
- The third aspect of the Absolute is called Ain Soph Aur, סוף אלק אור, “the limitless light.” Emanating Consciousness. The fabric of consciousness as it exists during the perpetual and eternal unfolding of physical manifestation, the first emanation of the unknown, called Χρίστος ‘Christos’ “Christ.”

On the usual diagram of the Kabbalah, there are ten Sephiroth, but we don’t see the three others above Kether, as they are unknown. However, they are just as important as the others, considering that the Kabbalah is completed through the Seal of Unity (13 Sephiroth in total).



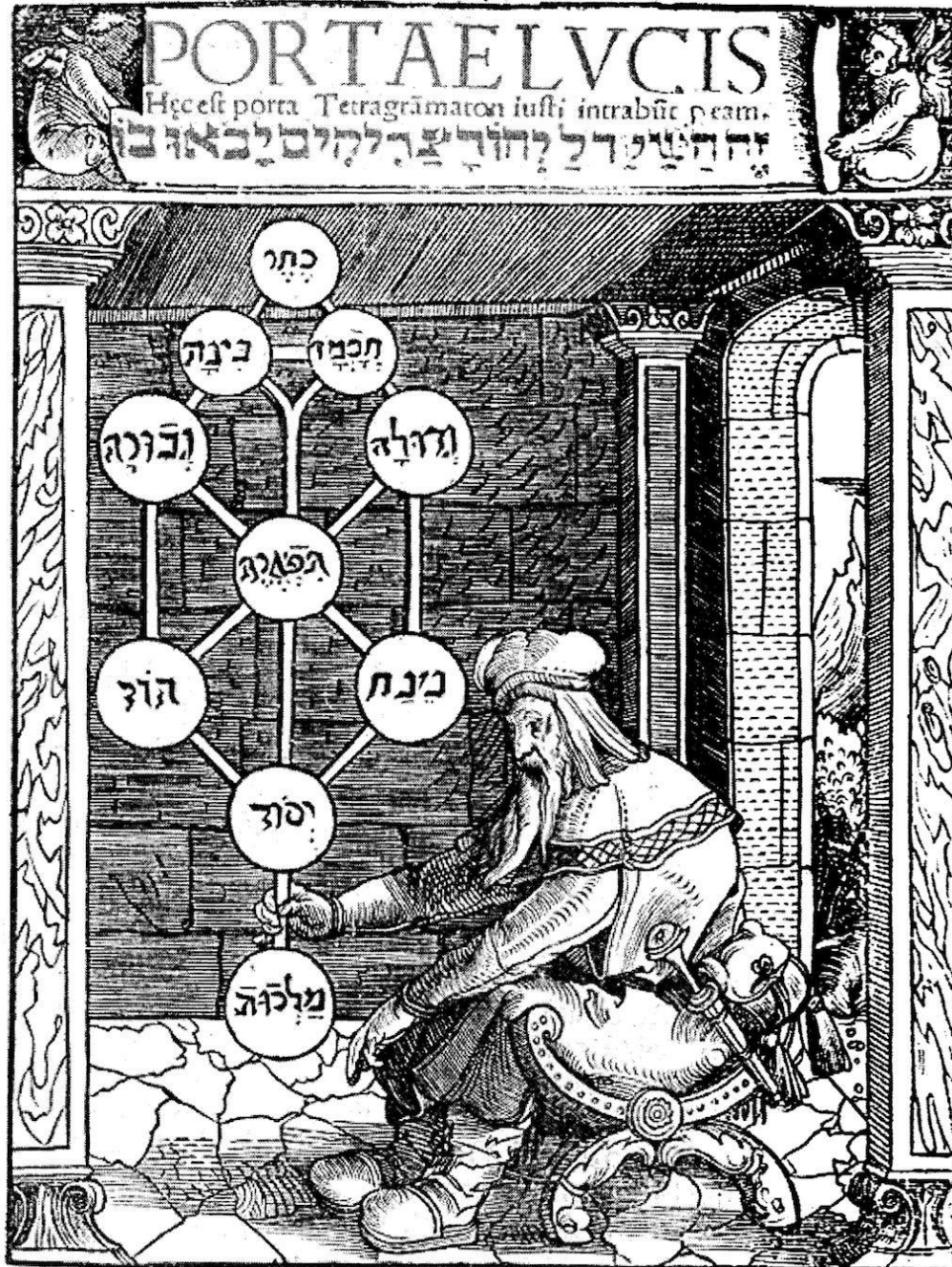
From my upcoming book: The Quantum Blueprint, in the chapter “Introduction to Kabbalah”

There are four worlds known in the Hermetic Kabbalah. Yahweh reveals the human design, in God’s and Goddess’ image, incorporating the four Worlds of the Tree of Life חביה (Kabbalah): Atziluth אצילות, Briaה ברלאה, Yetzirah לצורה, and Assiah עשלה, each respectively representing an element and an attribute:

1. Fire, the World of Emanation, the Spiritual World.
2. Air, the World of Creation, the Mental World.
3. Water, the World of Formation, the Emotional World.

#### 4. Earth, the World of Action, the Physical World.

The first emanation of light descends into the four worlds to manifest out of the non-existence and the unknowable, like a lightning flash, to create, form, and act upon. The fifth world is the simultaneous presence of the four worlds, working and connecting in the form of man/woman, though not yet manifest. Adam Kadmon אדם קדמון means “the primordial man.” The primordial man is identified with the entire Universe and the soul or essence of all things. Kadmon, קדמון, means “primary of all primaries,” the first pristine emanation, emerging from the Ein-Sof, אין סוף, (infiniteness or limitlessness), the transcendental par excellence. Analogous to the simultaneous presence and works of the four elements (Fire, Air, Water, and Earth), the Primordial Man can refer to the fifth element, the Ether, the perfect Man, the completion of the Great Alchemical Work, the capstone of the Pyramid, which is God’s manifestation in the form of a Man/Woman. The pure, lucid state of God and Goddess’ consciousness is concealed and hidden in all of us. The ‘lucid and luminous light’ is yet to access and manifest to reveal the Primordial Man/Woman as a Mirror/Image of God/Goddess.



Portae Lucis by Joseph Gikatilla (1248 -1325) Augsburg, 1516 The book is a Latin translation by Paulus Ricius of Gikatilla's most influential kabbalistic work. [Source Image](#).

“The Tree of Life, that simple yet all-comprehending diagram, is devised with so profound a philosophy that it represents the subjective as well as the objective worlds and serves to indicate the relationship between them. The Ten Holy Sephiroth sum up

the objective world on all its levels and in all its aspects, together with its different phases of evolution; and when we remember that the different aspects, according to the Doctrine of Emanations, correspond to the successive phases of evolution, just as do the various stages of animal organization from the single-celled organism for the vertebrate, we shall see how comprehensive is this glyph which can be applied horizontally to time and vertically to type, epitomizing, in fact, the whole of the evolutionary theory of life and form

The Ten Holy Sephiroth themselves are conceived of as linked one to another by the zigzag course of the Lightning-Flash, which represents the line of the course of evolution, descending from Kether to Malkuth; the Twenty-two Paths, however, are united by the coils of the Serpent Nechushtan, the Serpent of Wisdom, which loops one to another, laboriously upward, till its crowned head rests upon Kether, thus indicating the evolution and initiation of the soul of man.” Dion Fortune

In alchemy, the Cosmic Egg is often linked to the *Philosopher’s Egg*, a stage of transmutation, while the Tree of Life is linked to Kabbalah’s ten Sephirot, representing stages of divine manifestation.

Both symbols are associated with the concept of divine emanation and the unfolding of reality from a singular source.

The Tree of Life follows a branching pattern, similar to fractals and the Golden Ratio, symbolizing growth and expansion.

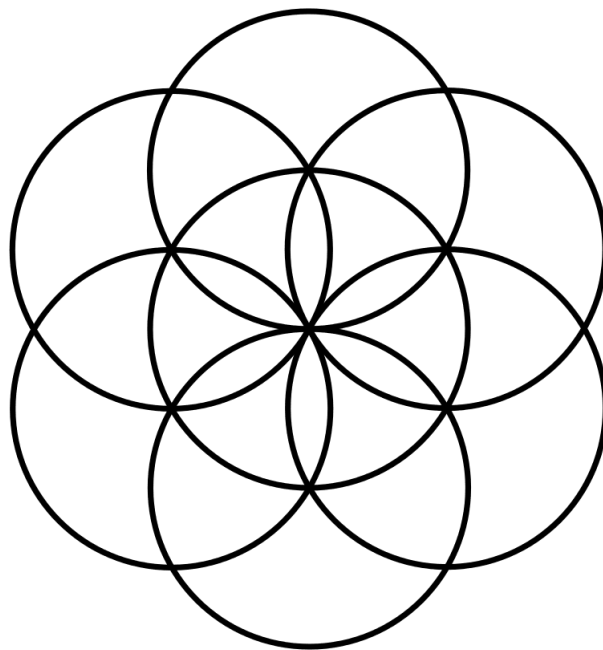
The Cosmic Egg follows the sacred oval or sphere, often linked to the Vesica Piscis, a shape found in the Flower of Life pattern.

In [Part III—The Geometric Construction of the Cosmic Egg](#), we discussed how the Cosmic Egg is geometrically constructed, which

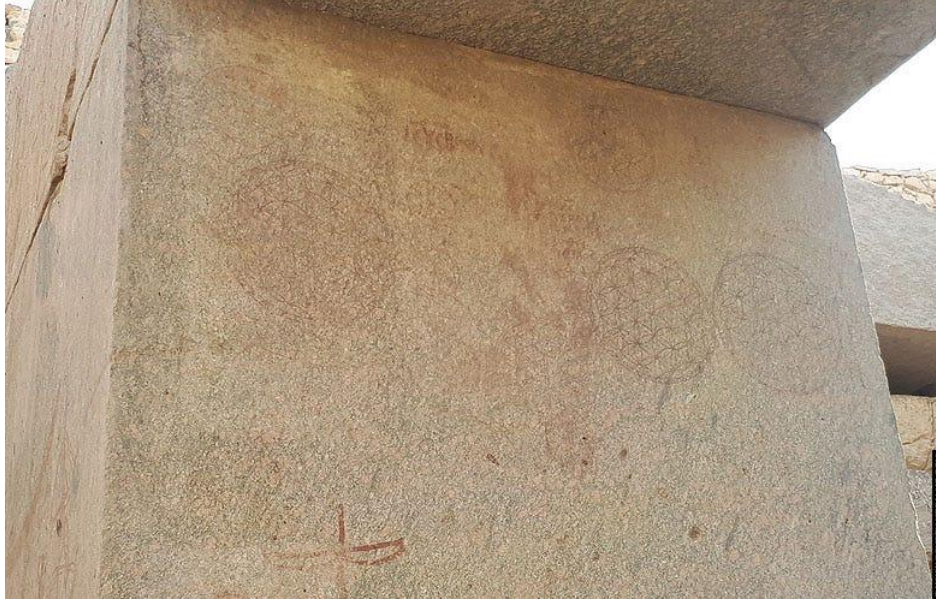
allowed us to locate the seven chakras (and beyond) as they were defined on the Vitruvian Man's body along the Axis Mundi. We will see now that the Tree of Life can also be constructed within the Cosmic Egg using Sacred Geometry.

### **The Tree of Life within the Seed of Life**

First, what is the seed of life? The Seed of Life is a sacred geometric symbol that consists of seven overlapping circles. Its earliest origins trace back to ancient Egypt, where it adorned the walls of the Osirian Temple in Abydos. Throughout history and across cultures, this symbol has represented the cyclical nature of life and the interconnectedness of all living beings. Like a seed in nature, it holds the blueprints for life and the potential for creation and growth—it is the cosmic womb from which all life emerges.



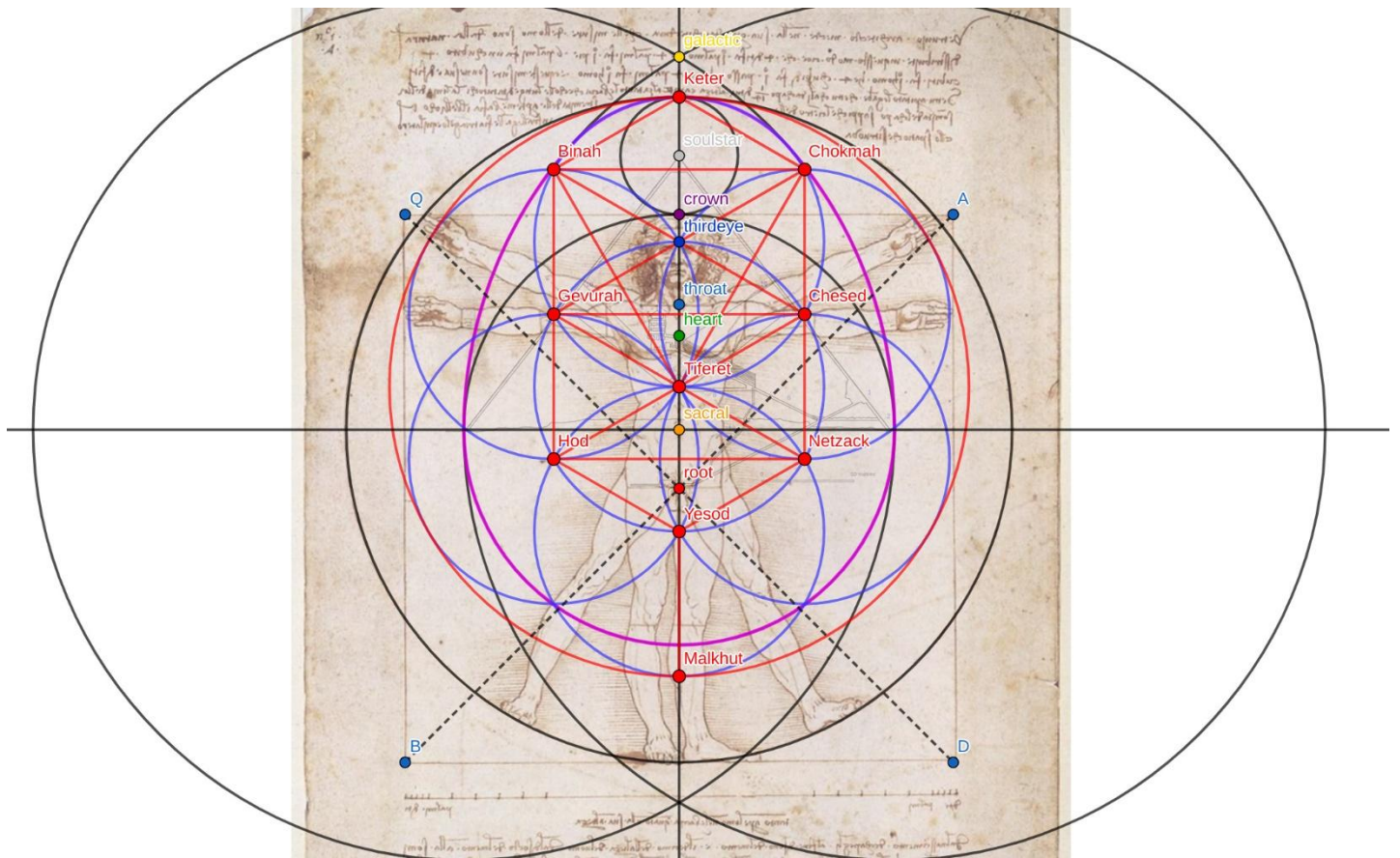
Seed of Life in Sacred Geometry



Flower of Life, intricately laser-etched onto the granite walls of the Osirion, in Abydos' Temple, Egypt

### **The construction of the Tree of Life**

The geometric construction is simple. We build the seed of life, consisting of seven circles, starting from the pivotal circle that links the Egyptian Triangle 3-4-5 and the Cosmic Egg. It is natural to construct the seed of life from that particular circle. The center of that circle is the location of the Third Eye, and a section of that circle is merging with the top section of the Cosmic Egg. Let's recall that that circle has a diameter of 7.4 if the length and width of the Cosmic Egg are respectively 14 and 11. That particular circle can be called Jesus' circle because the gematria of Jesus in English is 74. On this scale, the branches of the Tree of Life measure 3.7, 6.4, or 7.4.



The Blueprint of Creation: Seed and Structure: How the Cosmic Egg Hatches into the Tree of Life

In this particular geometric map, there are 10 *Sephiroth* (spheres of consciousness), which can be seen as the spheres of existence or energy centers that connect all things, including us as human beings. This blueprint of creation can be mapped out in every being. There are many traditions to describe the *Sephiroth* and their many associations. Below is one way of describing the different layers of the diagram we constructed:

1. *Keter*: Universal Chakra—an entry point to the higher spiritual realms, located at the tipping point of the Cosmic Egg.

2. *Chokmah*: Wisdom, Spark of Insight—located on the top left side of our body, higher up than our head, at the level of our soul star chakra or the apex of the Great Pyramid.
3. *Binah*: Understanding, Deep Contemplation—located on the top right side of our body, higher up than our head, at the level of our soul star chakra or the apex of the Great Pyramid.
4. *Chesed*: Kindness, Giving—located near the left shoulder of our body, at the level of our higher heart (between the heart and throat).
5. *Gevurah*: Power, Restraint—located near the right shoulder of our body, at the level of our higher heart (between the heart and throat).
6. *Tiferet*: Harmony, Beauty—located at the center of our body, at the level of our solar plexus.
7. *Netzach*: Triumph, Endurance—located near the left hip of our body, at the level of our lower belly (between the root and sacral).
8. *Hod*: Glory, Dignity—located near the right hip of our body, at the level of our lower belly (between the root and sacral).
9. *Yesod*: Foundation, Righteousness, Connection—located near below the root, at the level of our thighs (higher than the knees).
10. *Malkhut*: Kingdom (also known as Shechinah, Divine Presence)—located near the feet of our body, at the level of our tibias (below the knees).

The blueprint of creation is encoded in the Cosmic Egg, the primordial seed containing the essence of all existence. Like a seed holding the pattern of a towering tree, the Cosmic Egg carries the foundational structure of reality, waiting to unfold. As it hatches, its energy spirals into form, giving rise to the Tree of Life—the sacred architecture through which creation manifests across

dimensions. This process mirrors the unfolding of consciousness, where the unseen potential within the seed expands into structured reality. Just as a tree grows from its blueprint encoded within, so too does the universe evolve, following the sacred geometry of life itself. The journey from seed to structure is not just cosmic but deeply personal—an invitation to awaken, expand, and embody the hidden patterns of creation within ourselves.

## The Vision of the Cosmic Egg - part I

The fiery Cosmic Egg is starting to break

[SALAH-EDDIN GHERBI](#)

JAN 23, 2025

### What is the Cosmic Egg?

The Cosmic Egg, as a symbol of the primordial origin of the world, was considered the archetype capable of bringing every element back to its original purity, restoring the corruption of matter. For this reason, the Philosopher's Stone, sought by the alchemists for its ability to transmute base metals into gold, was assimilated to an egg, often of a vitreous consistency, whose components Shell, Albumen, and Tuorlo corresponded to the three alchemical ingredients Salt, Mercury, and Sulphur, which, properly combined, led to the culmination of the Great Work.

Illuminated copy of an image in Hildegard von Bingen's *Scivias* (ca. 1151), depicting a "cosmic egg" from one of her spiritual visions.

*Scivias* — a contraction of *Sci vias Domini* (Know the Ways of the Lord)—was the German Benedictine abbess, mystic, and polymath first's major visionary work, and one of the biggest milestones in her life. Describing 26 religious visions she experienced, the work survives in ten medieval manuscripts, two lost in modern times. The most esteemed of these was the well-preserved Rupertsberg manuscript, prepared under Hildegard's immediate supervision or that of her immediate tradition, made around her death. It resided in the Wiesbaden Hessische Landesbibliothek until World War II, when it was taken to Dresden for safekeeping, and subsequently lost. Some hoped that the German reunification in 1990 would cause it to

reappear, but to date it has not. A faithful illuminated copy was made at the Hildegard Abbey in Eibingen in 1927-1933 and it is this copy shown above. **The Public Domain Review**

## **The Vision of the Cosmic Egg**

Below is an excerpt of Hildegard's visions:

After this I saw a vast instrument, round and shadowed, in the shape of an egg, small at the top, large in the middle and narrowed at the bottom; outside it, surrounding its circumference, there was bright fire with, as it were, a shadowy zone under it... But from the fire that surrounded the instrument issued a blast with whirlwinds, and from the zone beneath it rushed forth another blast with its own whirlwinds, which diffused themselves hither and thither throughout the instrument. In that zone too there was a dark fire of such great horror that I could not look at it, whose force shook the whole zone, full of thunder, tempest, and exceedingly sharp stones both large and small. And while it made its thunders heard, the bright fire and the winds and the air were in commotion, so that lightning preceded those thunders; for the fire felt within itself the turbulence of those thunders. **The Ovum Mysterium or The Fiery Cosmic Egg by Hildegard von Bingen**

Exegesis:

The firmament in the likeness of an egg and what it signifies: For this vast instrument, round and shadowed, in the shape of an egg, small at the top, large in the middle, and narrowed at the bottom, faithfully shows Omnipotent God, incomprehensible in His majesty and inestimable in His mysteries and the hope of all the faithful; for humanity at first was rude and rough and simple in its actions but was enlarged through the Old and New Testaments and finally at the end of the world is destined to be beset with many tribulations.

## **Further Interpretations of the Cosmic Egg**

The author Dianna Elizabeth Conner comments:

Hildegard the theologian compared God to a Cosmic Egg that surges flames into the universe, emptying and filling itself like a womb—creative, beneficial, and nurturing to all life within. She spoke of this sacred feminine as Divine Love, the essence of the universe—the highest

fiery power that shines in water, burns in the sun, moon, and stars, stirring everything into existence, and causing all life to glisten with this light.

Across history, various cultures have embraced the cosmic egg symbol as a fundamental way to explain how our universe started and evolved. Many different societies have employed the cosmic egg archetype, which holds sacred spiritual meanings in their original cultures:

- The golden egg of the Hindu *Rigveda* texts.
- The ancient Egyptian sun egg was laid by a primaeval goose.
- The benben stone of meteoric iron, where the phoenix perched, is in the temple at Heliopolis near the Nile.
- The Dogon egg of the creator-god Amma.
- The cosmic, serpent-encircled egg of the Greek Orphic religion.
- The *Omphalos* stone at the oracle of Delphi.
- The Hopi Mystery Egg at the end of the Fourth World contains the sun yolk, a whirling swastika (pre-Nazi), and a spot of menstrual blood.

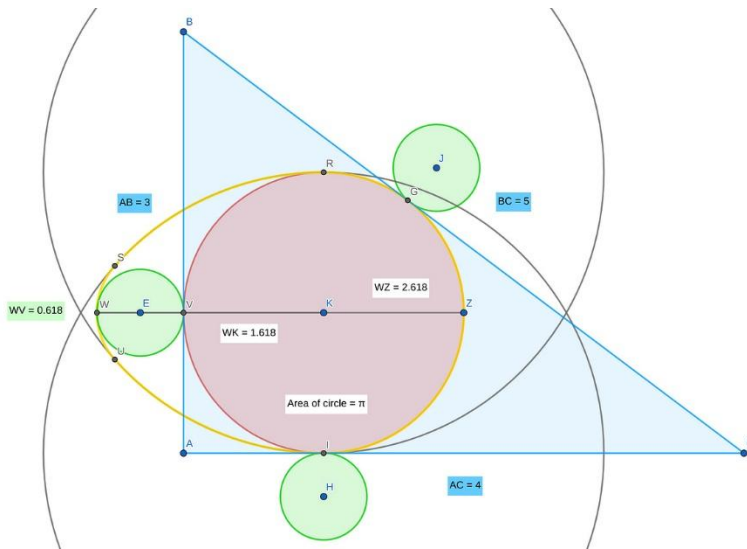
**Our planet is moving toward a major transition. The fiery cosmic egg is starting to break, and the spirit bird appears to announce a new beginning.**

## **The Design of the Golden Egg**



The Golden Egg is defined by the Golden Ratio  $\Phi$  1.618

From the [Egyptian Triangle 3-4-5](#) discussed in my previous article, a great mathematical relationship can be defined between the height of the Golden Egg as the square of the golden proportion Phi  $\Phi$  1.618, that is, 2.618, and the number Pi  $\pi$  3.141, as shown in the illustration below. The egg is a perfect example of an object with curvature. Without curvature, there would be no motion governed by the spin effect.



The Golden Egg, geometrically constructed from the Triangle 3-4-5

As previously seen in [Egyptian Triangle 3-4-5](#), the circle inscribed inside the triangle is of diameter 2. The golden egg circumscribes the small green circle of diameter  $\phi$  (0.618) tangent to the sides of the triangle 3-4-5 and the red circle of diameter 2.

Interestingly, the quotient ratio of Pi  $\pi$  3.141 with the square of the golden proportion Phi  $\Phi$  1.618, that is, 2.618, is a good approximation of the quotient ratio of 6 with 5.

As above, so below

$$\pi\Phi^2 = \pi\phi^2 \approx 65$$

## The Cosmic Egg on a planetary scale

On another note, the Cosmic Egg can also be built on the relationship between the Moon and Earth, which is a representation of the Cosmic Egg on a planetary scale that involves only these two celestial bodies, with the assumption that Earth is a perfect circle and has no bulges.

In the third part of the Cosmic Egg, I will be speaking on the important correlations between the Great Pyramid, the transcended line of length 7.4 determined from [the Egyptian Triangle 3-4-5](#) (see previous article to grasp the context) and the Cosmic Egg of Earth, not to mention its

chakras and how this mirrors an individual and the collective consciousness. Although this part will bring some interesting metaphysical and philosophical concepts, part III will be also quite mathematical.

The second part of the Cosmic Egg will be focused on the Inner Alchemical Process of an individual, the development of his/her psyche through the different layers of consciousness. For this, we will compare Hildegard's vision of the Cosmic Egg and Assagioli's Egg Diagram of the human psyche.

Once the third part is published, I will sum up the previous articles in a video for animated and illustrated content of this particular discovery using GeoGebra. The Great Pyramid is not only a technological device but also a time machine that accompanies humanity in its evolutionary process into higher consciousness.

## Cracking The Cosmic Egg - Part II

An inner Alchemical Process toward the Golden Frequency (Christic Energy)

[SALAH-EDDIN GHERBI](#)

JAN 27, 2025

### The Cosmic Egg, a Universal Symbol

Across numerous creation myths, a powerful motif emerges: the **birth of the Universe** from an egg that contains the essence of creation, awaiting only the gentle warmth of incubation.

- **In Greek mythology**, the Orphic Egg is the cosmic egg from which the primordial hermaphroditic deity Phanes emerges, bringing forth the creation of the gods and the universe.
- **Norse tradition** speaks of the Ginnungagap, the great void from which all life sprang. While not an egg per se, this void is similar to the concept of the cosmic egg as a source of life and creation.

- **Hindu scriptures** describe the universe as a cosmic egg, Brahmanda, with Brahma, the creator god, emerging from it, illustrating the idea of cyclical creation and destruction.
- **In Finnish mythology**, the world is created from the fragments of a duck's egg, laid on the knee of Ilmatar, the goddess of the air, further emphasising the theme of creation from an egg.

In almost all cases, this embryonic motif emerges out of darkness, floating upon the waters of chaos. Within this egg typically resides a divine being who creates himself from nothing (AKA The ex nihilo). This creator then goes on to form the material universe.

This 'ex nihilo' creator either uses the material within the cosmic egg shell or the substance of chaos, to bring shape and order to the world. The tricky question is, however, what came first, the god or the egg? In some myths, this egg has a maker, often a woman, who brings the creator god into existence.

## **The Cosmic Egg, in Alchemy**

In Alchemy, the symbolism of the egg relates to the vessel, the container in which transmutation takes place. The **athanor**, the alchemists' furnace, was customarily compared to the cosmic egg due to its shape and, above all, to its role as matrix and vessel of all transmutation. C. G. Jung (Jung, 1968, p. 202) provides an excellent summary of the symbolic links between the Egg and the Alchemical Opus:

“In alchemy the egg stands for the chaos apprehended by the artifex, the prima materia containing the captive world-soul. Out of the egg – symbolised by the round cooking vessel – will rise the eagle or phoenix, the liberated soul (...).” Jung, 1968 (p. 202)

In all cosmogonies, the **egg** is an image and model of wholeness. In eastern philosophies (Hinduism, Buddhism and Taoism), the theme

of the primordial egg is closely linked to the idea of the Great One, the principle of non-duality in which life's intrinsic opposition between becoming and non-becoming is simultaneously synthesised.

If, on the one hand, the egg symbolises the One beyond the dichotomy of being/non-being, on the other hand, it also represents genesis and revelation (Amariu, 1988, p. 8). In symbolic language, it is linked to the idea of fertile chaos. The cosmic egg is One, and at the same time, it contains Heaven and Earth, the lower and higher waters, yin and yang: the whole range of existential possibilities and multiplicity of beings.

## **An Inner Alchemical Process**

An adapted version written by Cherry's Cache from **'Cracking the Egg', Chapter One, Everyday Alchemy - Author Cherry Gilchrist**, inspires a profound sense of transformation, courage, and the challenge of committing to change. It serves as a metaphor for moments in life where decisive action is necessary to break free from the comfort of the familiar and venture into the unknown, even if it means facing fear or uncertainty.

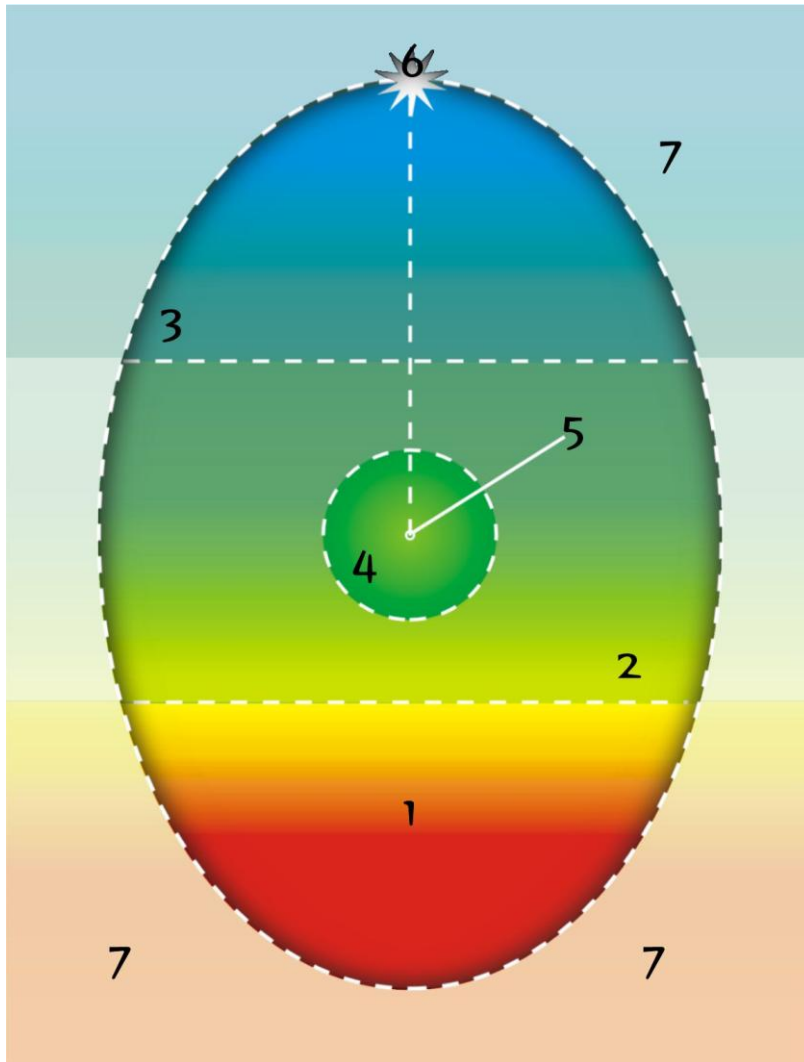
This is the moment. You hold the sword in your hand, ready to pierce the egg that stands before you. It is the perfect egg, and the perfect moment to do the deed. Now is your chance to strike.

But it is terrifying to commit yourself to this moment. It is much easier to linger in the past or dream of the future. And the egg is beautiful as it is. If the sword doesn't strike cleanly, you might shatter the shell and damage the precious embryo of life inside it. Wouldn't it be better to leave it be?

It is your choice, of course. The sword carries your intention, and you must decide whether you will use it to break open the alchemical egg and initiate the process of transformation. The egg may look perfect, but it is as yet undeveloped. From the moment of opening the egg, you must begin the work of developing the raw material it contains through every stage of change until it becomes alchemical gold. The egg will certainly perish if its potential is not released, so the choice cannot be postponed indefinitely. The gold you aspire to, on the other hand, is incorruptible. It is a symbol for enlightenment, the Elixir of Life, the realisation of Life beyond life, the Sun behind the sun. It is a place of safety for the human spirit, and an entry point into the divine world.

The moment of impending change is frightening. The act of splitting the egg open will catapult the alchemist into an unknown world; from this moment on, he will be changed. He will have to leave his old life behind. On his face we can read apprehension, and even a hint of terror. But he knows that even though he trembles on the brink, he has to go forward. This chance may only come once in a lifetime.

In Psychosynthesis, symbols are considered as superior vessels for knowledge, bridging imagination, thought and intuition. Roberto Assagioli created the egg diagram to illustrate the multidimensional nature of the human psyche and how the various parts of one's consciousness relate to each other. Like all diagrams it has its limitations – mainly because it's a static representation of something that is a dynamic and ever-changing process.



Psychosynthesis Egg Diagram, formulated by Roberto Assagioli. It depicts various aspects of consciousness as described in

Psychosynthesis. [Source: Wikimedia.](#)

From the Illuminated copy of an image in Hildegard von Bingen's Scivias (ca. 1151), depicting a "cosmic egg" from one of her spiritual visions, presented in [the vision of the Cosmic Egg - part 1](#), you will also intuitively recognise some similarities.

Illuminated copy of an image in Hildegard von Bingen's Scivias (ca. 1151), depicting a "cosmic egg" from one of her spiritual visions.

Both diagrams emphasise concentric development, moving from the dense physical/instinctual layers (outer) to the divine/spiritual realms (inner or upper).

The Egg Diagram comprises seven parts each with its respective number from 1 to 7:

1. **Lower Unconscious:** Basic instincts and drives (experiences of fear, shame, pain, despair and even rage).
2. **Middle Unconscious:** Memories and experiences (ability to form patterns of “skills, behaviours, feelings and attitudes).
3. **Higher Unconscious:** Spiritual and higher aspirations (aesthetic experience, creative inspiration, and higher states of consciousness).
4. **Field of Consciousness:** Current awareness. Directly aware of ‘stream of thoughts’, ‘images’, ‘sensations and feelings’, ‘desires’ and ‘impulses’.
5. **Conscious I:** Personal self-awareness. “I” is the direct “reflection” of self and “the essential being of a person”, distinct, but not separate from all other components of experiences. The “I” consists of two functions: the consciousness (awareness) and will (personal will).
6. **Transpersonal Self:** Connection to higher self. “Peak experiences” and characterised by such qualities as ecstasy, union, compassion, wholeness, joy, and beauty.
7. **Collective Unconscious:** Shared human experiences and knowledge over a period.

While the self is said to endure the challenges of the lower unconscious and the everyday awareness of the middle unconscious, it is encouraged to rise above the "flat lands" of life and strive to ascend toward higher realms.

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mirrors an individual and the collective consciousness. Although this part will bring some interesting metaphysical and philosophical concepts, part III will also be quite mathematical.

## **The Geometric Construction of the Cosmic Egg - part III**

Sacred Geometry and Chakra System of Earth/Humanity

[SALAH-EDDIN GHERBI](#)

FEB 04, 2025

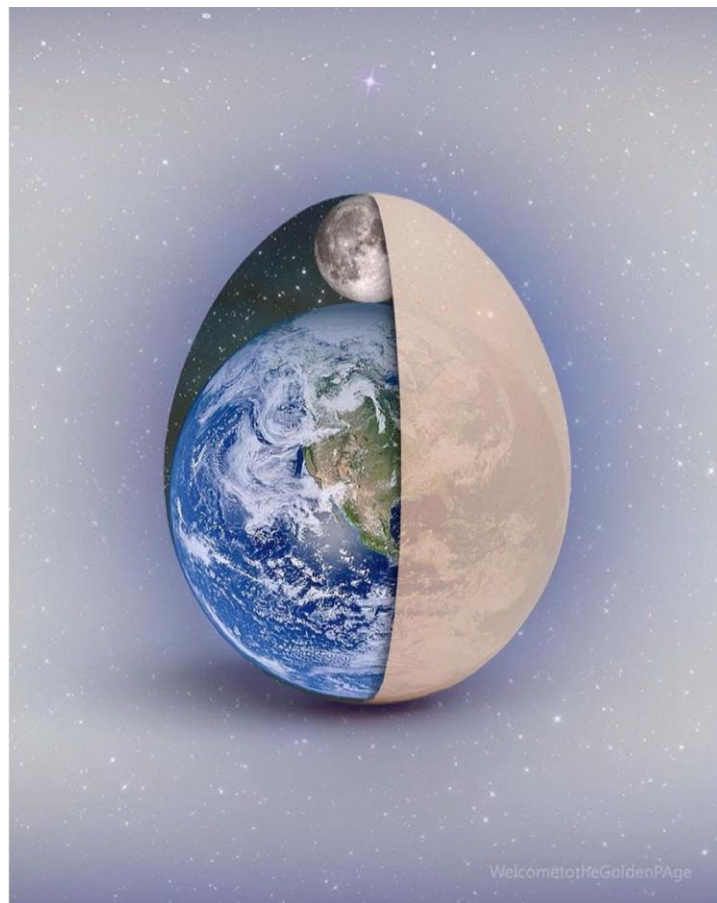
### **The Great Work is Within**

Alchemical Harmony: The Union of Strength, Innocence, and Enlightenment. Adapted version of “Una and the Lion, from Spenser's Faerie Queene” by Briton Rivière (1840-1920).

This image symbolizes, in a truly beautiful way, the alchemy of the inner path towards enlightenment and spiritual renewal. In the center, the woman is in white, representing purity and wisdom, walking beside contrasting creatures– the lion and the lamb– representing raw power and gentle innocence. The lion, characterized by strength and will, represents the ego's transformative energy once tempered by courage, while the lamb symbolizes meekness, purity, and divinely imbued surrender. Their coexistence represents the work of the alchemist in balancing opposites within oneself: integrating power with gentleness and achieving inner harmony. Behind them stands a blazing sun with a human face, expressing the alchemical gold, the final aim of the Great Work, revealing itself as a manifestation of the Higher Self, lighting the way with cosmological energy and spiritual truth. The lion, lamb, woman, and sun beauty form a pictorial allegory–the unification of dualities–to direct the seekers more mystically

towards the transmutation of that common ideal of wholeness and transcendence.

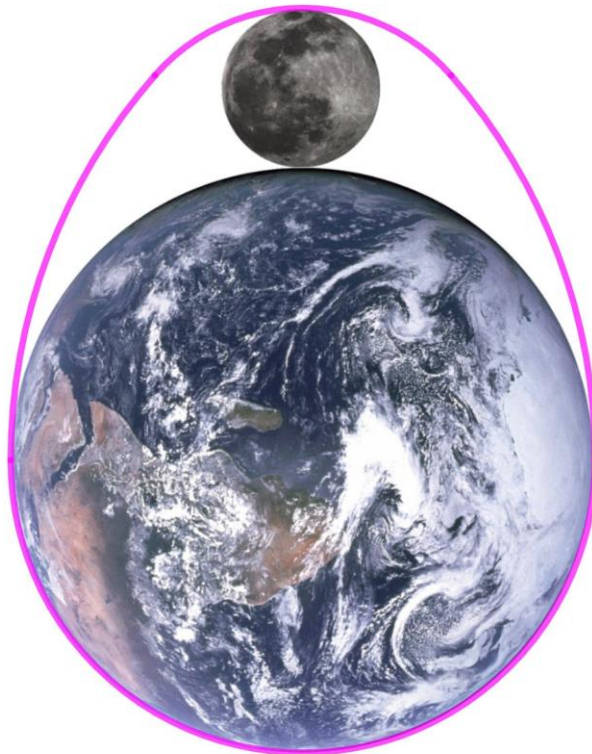
The Cosmic Egg, as a symbol of the primordial origin of the world, was considered the archetype capable of bringing every element back to its original purity, restoring the corruption of matter. For this reason, the Philosopher's Stone, sought by the alchemists for its ability to transmute base metals into gold, was assimilated to an egg, often of a vitreous consistency, whose components Shell, Albumen, and Tuorlo corresponded to the three alchemical ingredients Salt, Mercury, and Sulphur, which, properly combined, led to the culmination of the Great Work.



## The Construction of the Cosmic Egg on a Planetary Scale

The Cosmic Egg can be built on the relationship between the Moon and Earth, which is a representation of the Cosmic Egg on a planetary scale that involves only these two celestial bodies, with the assumption that Earth is a perfect circle and has no bulges.

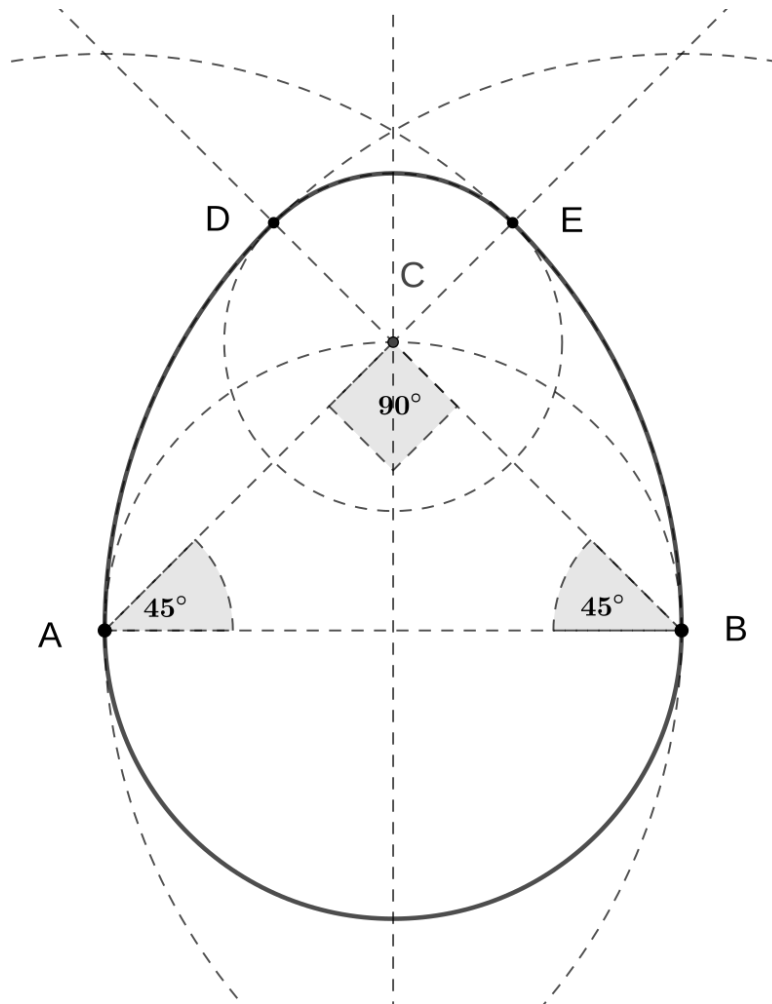
**How can we mathematically construct an egg-shaped curve that outlines the Earth and the Moon when they are tangent to each other?**



Cosmic Egg constructed with the Earth and Moon

In Euclidean geometry, Moss's egg is an oval made by smoothly connecting four circular arcs. It can be constructed from a right

isosceles triangle ABC with apex C. Source [Wikipedia](#)



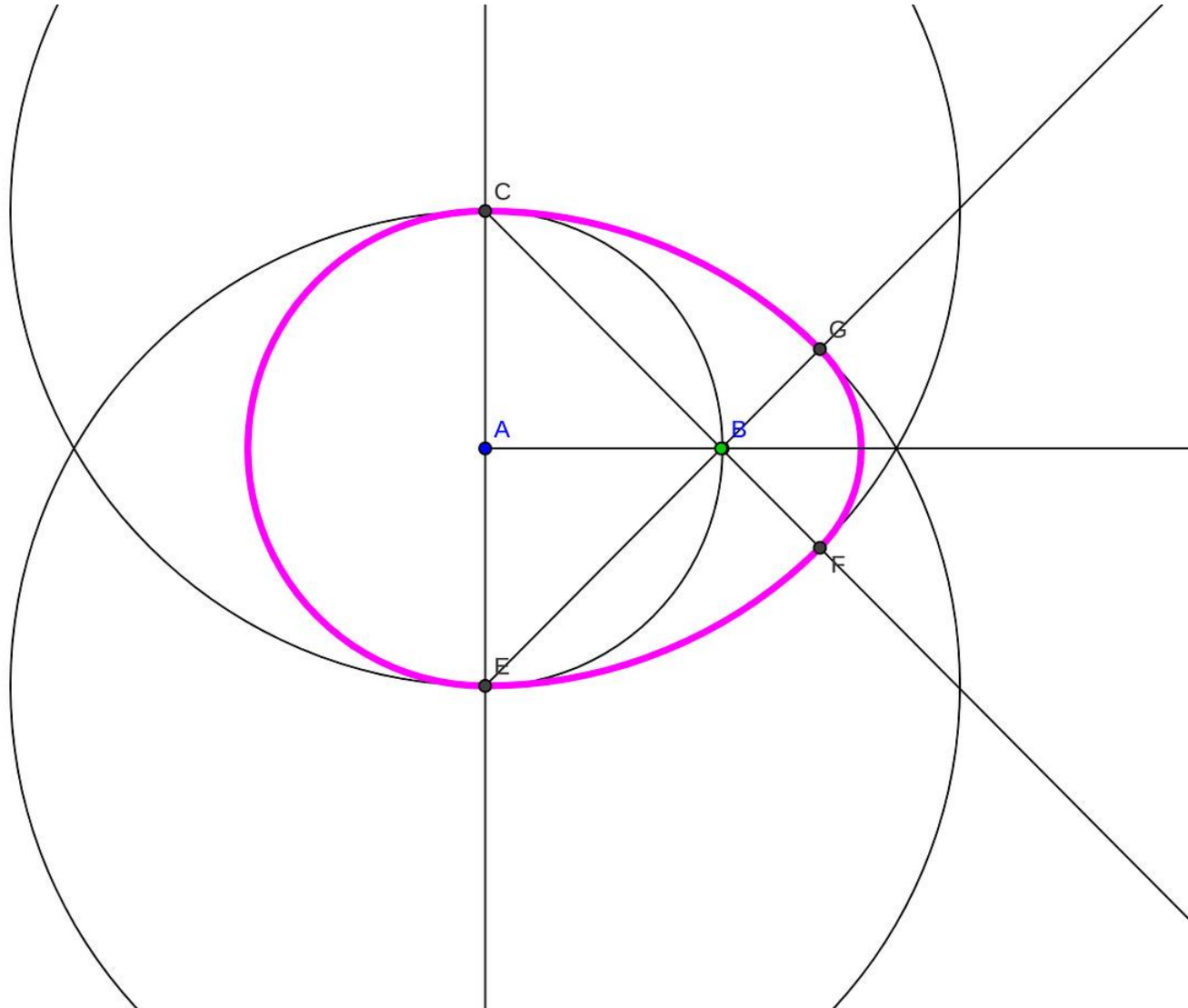
### Moss's egg outline

Using arcs and circles, we can construct these egg-shaped curves that resemble cross-sections of real eggs. The complexity of these constructions varies greatly. They are relatively easy once the principle has been figured out, but the constructions are done in many steps and are quite time-consuming.

We can use GeoGebra to create a worksheet that allows us to experiment with different shapes of eggs. Click on the image below to explore the interactive GeoGebra environment. You can vary the location of the center point (green dot located on point B as you land on the page) to create different egg shapes. You can drag this green dot along the horizontal line to see what kind of egg shapes are formed. The author of this interactive activity aimed to

show you the passage of an egg to a fish shape as you drag the green dot further away from B. Notice that the Vesica Piscis is involved in the construction, so the Great Pyramid is also involved behind the scenes.

- ✓ points
- ✓ lines

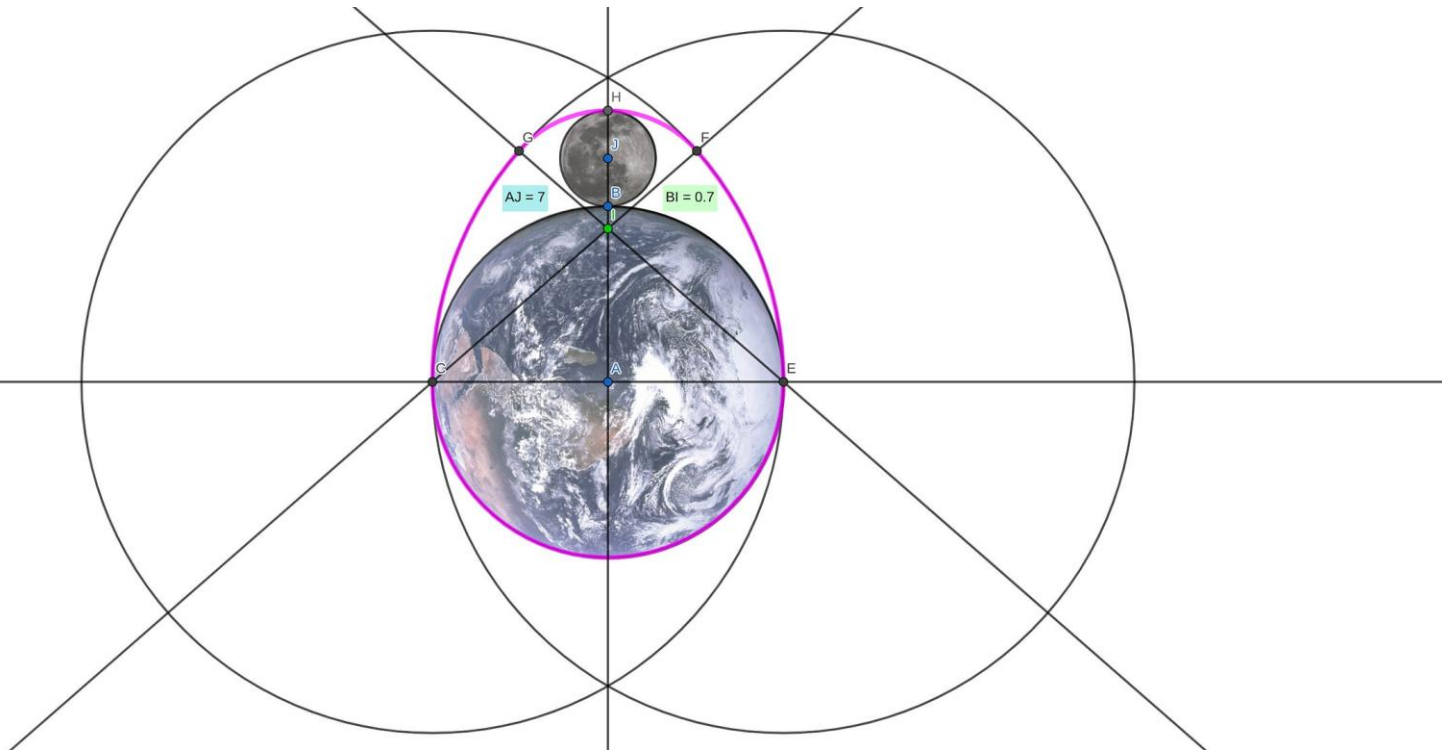


### Moss Egg or Euclidean Egg

So, the important mathematical question we can ask is, **what would be the location of the center point (green dot) when we apply this construction with the diameters of the Earth (7920**

**miles) and the Moon (2160 miles), respectively scaled down to 11 and 3?**

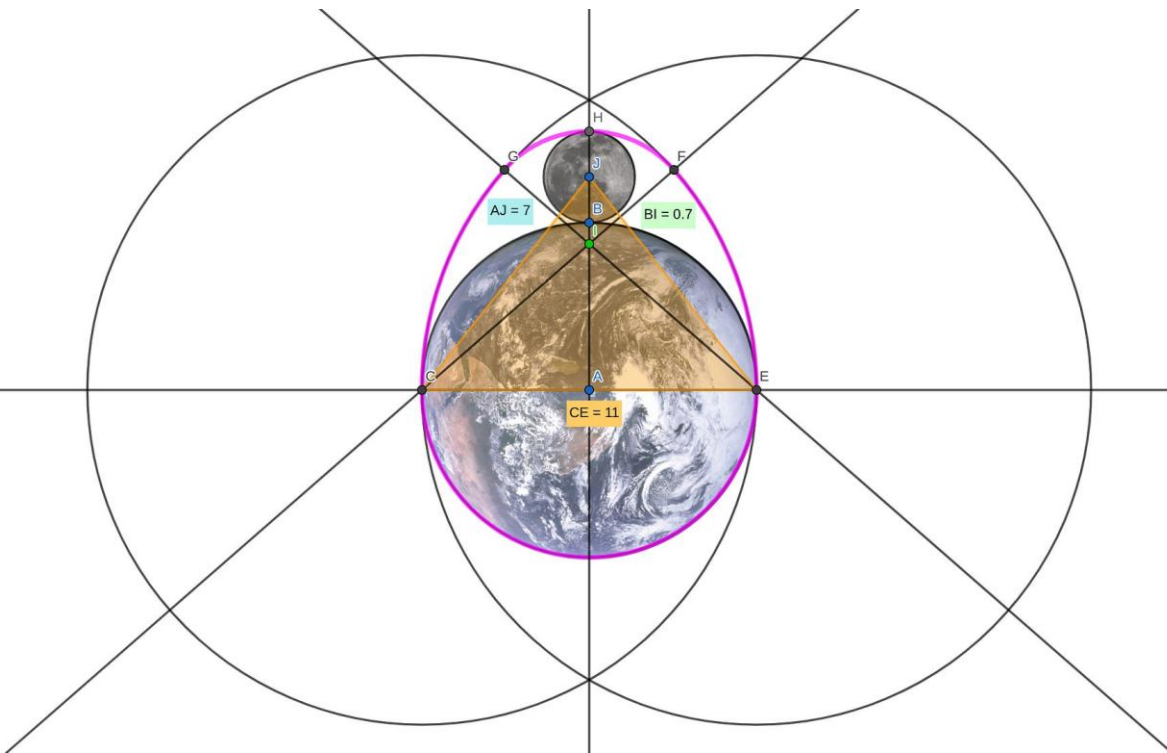
After working a little while on GeoGebra, the exact location of the green dot was found to be just under point B as the anchoring point I (see figure below). The distance between points I and B is 0.7 (segment [IB]), which is particularly interesting because the distance between the center points of the Earth and the Moon is 7 (segment [AJ]). There is only a factor of 10 between the two segments. This highlights the fractal nature of the Cosmic Egg to the proportional ratio between the Earth and the Moon, which is  $11/3 = 3.666+ \sim 3.7$ .



Anchoring Point I match the Cosmic Egg constructed with the Earth and the Moon in Sacred Geometry.

## **The Cosmic Egg and the Great Pyramid Connection**

In this part, we will be discussing the connection between the Great Pyramid and the Cosmic Egg. Hold your breath, as the dimensions of the Great Pyramid can be incorporated within the design above. If we had to scale down its dimensions within the design, its height would be 7 (segment [AJ]) and its base would be 11 (segment [CE]).



The Construction of the Great Pyramid within the Cosmic Egg Design.

Incorporating the Great Pyramid brings a new dimension to the Cosmic Egg, as it was found that our physical body can be superimposed on this design while mirroring the different levels of energy that play out in our chakra system and the Great Pyramid itself. Chakras are spiritual energy centers in the body, and there are seven basic chakras. Each chakra corresponds to specific internal organs and nerve bundles and contains “prana,” or healing energy. These geometric correlations were highlighted by Robert



The position of the Chakras (energy centers) within the geometric construction of the Cosmic Egg.

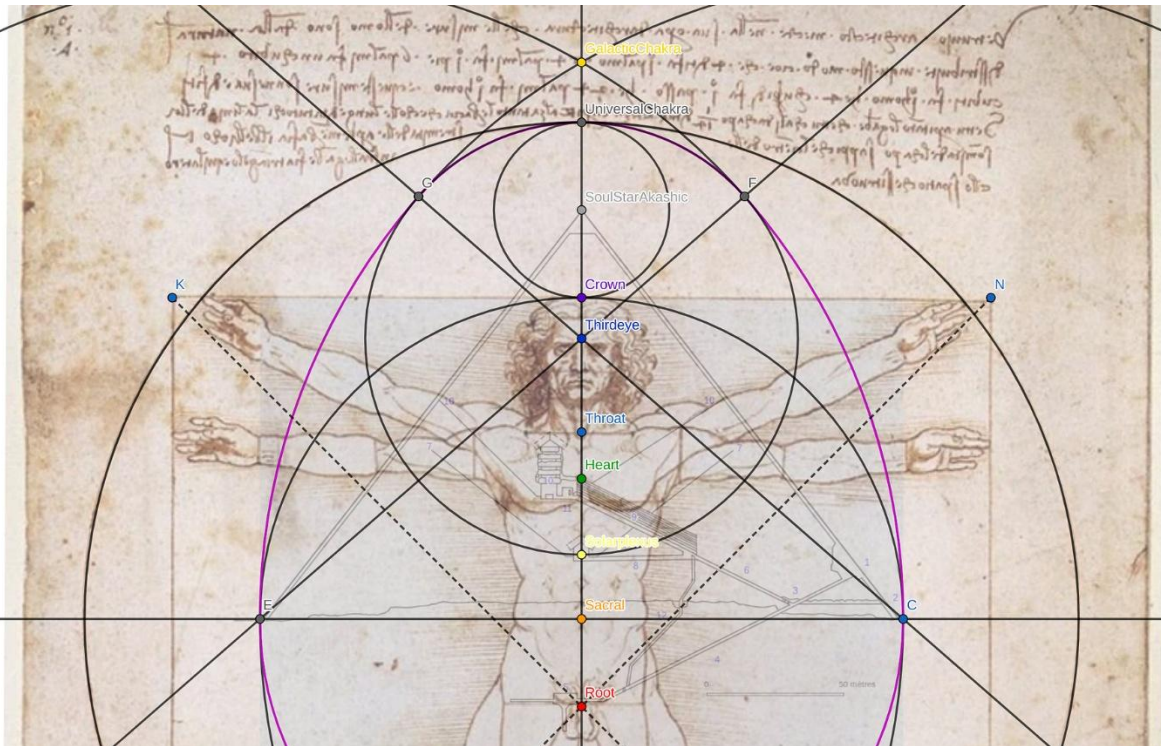
From the geometric construction of the Cosmic Egg, I had to consciously locate the seven chakras with the present geometric shapes.

1. The **Root Chakra** was located at the intersection between the diagonals of the rectangle in the Vitruvian Man.
2. The **Sacral Chakra** was located at the mid-point of the side-length base of the Great Pyramid or the center of the Earth's circle.
3. The **Solar Plexus Chakra** was located at the bottom point of Jesus' Circle of diameter 7.4, which corresponds to the location of the Queen's Chamber.
4. The **Heart Chakra** was located at the mid-point between the sacral and third-eye chakras, just at the top end of the Grand Gallery, before the entrance to the King's Chamber.
5. The **Throat Chakra** was located at the topmost chamber of the King's Chamber, precisely at the top point of the gabled roof.
6. The **Third Eye Chakra** was located at the anchoring point of the Cosmic Egg derived from the Moss-Egg or Euclidean Egg, with the dimensions of Earth and Moon. This is a perfect match, as the Cosmic Egg was described as the Third Eye in ancient civilisations, often associated with intuition and spiritual awareness.
7. The **Crown Chakra** was located at the top of the head, the tangent point between the Earth and the Moon.

Finally, we could interpret further the higher chakras as we go beyond the rectangle KNTQ representing the physical realm whose Vitruvian Man is inscribed:

- The **Soul Star Chakra** was located at the center of the Moon, at the apex of the Great Pyramid, which is the missing capstone.
- The **Universal Chakra** was located at the top point of the Moon.
- The **Galactic Chakra** was located at the top intersection point between the greater Vesica Piscis, and it made sense considering those two circles represent a different scale in higher dimensions.

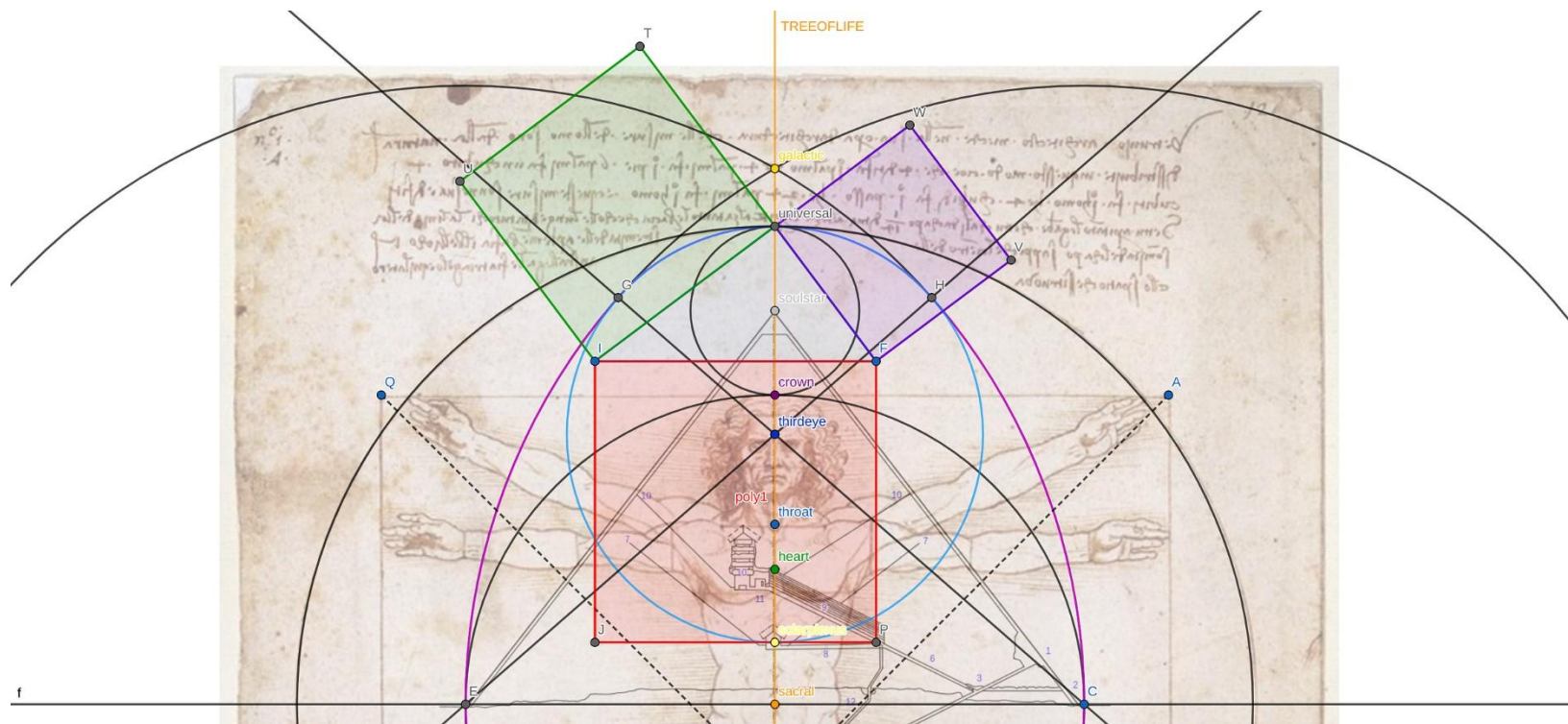
Below is a zoom-in of the diagram above, where we can see the superimposition of the Great Pyramid with a view of the inside.



Zoom in on the diagram above, showing a better view of the inside Great Pyramid superimposed with the geometric construction of the Cosmic Egg.

# The Transcended line/descent of light/Axis Mundi

There is a geometric correlation between the transcended line or the descent of light (7.4 aka Jesus in English gematria) from the Egyptian Triangle 3-4-5 (Euclid's 47th problem) and the Cosmic Egg in their construction. As far as I know, it is an **important and new discovery**. The concept of the transcended line or the descent of light makes full sense once we explore and contemplate the diagram below.



Tree of Life passes through the energy centers (chakras), which correspond to the transcended line or descent of light from the Egyptian Triangle 3-4-5 (Euclid's 47th Problem).

The blue circle is the bridge between the Egyptian Triangle 3-4-5 and the Cosmic Egg and can be called Jesus' circle (as the diameter

is 7.4 and the English gematria of Jesus is 74). As we can see, the **transcended line**, or the **descent of light**, corresponds to the line passing through our energy centers (chakras), often referred to as the central channel. This concept appears across many cultures and traditions: In Hinduism and Yoga, the Sushumna Nadi runs along the spine, allowing Kundalini energy to rise through the chakras. In Taoist practices, the Microcosmic Orbit describes the flow of Qi through central meridians. Kabbalah's Tree of Life aligns with this idea, mapping the ascent of consciousness through the Sephirot. Norse mythology's Yggdrasil, the World Tree, connects different realms, much like the energy axis within us. Indigenous traditions speak of the Sacred Tree or World Pillar, linking Earth and the sky. Even in Western esotericism, the Caduceus (with its intertwined serpents) symbolises this central energetic pathway.

The concept perfectly fits with the geometric construction of the Cosmic Egg. We can also compare the diagram above with the different levels of consciousness as described in psychosynthesis in Part II - Cracking the Cosmic Egg. The connection to the Higher Self corresponds to the universal chakra located at the sharp end of the egg, the top point of the Moon.

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FEBRUARY 10, 2025

# Wildland fires are unpredictable— spaceborne lidar is helping reduce that uncertainty

by [Northern Arizona University](#)



The aftereffects of the Slater Fire, which burned in northern California in 2020. Credit: Chris Hakkenberg, Northern Arizona University

Recent wildfires are larger and more intense than they've ever been in the historical record. If you've been watching the news at any point in the last decade, that's no surprise.

The reasons for that are complex, though not surprising—hotter, drier weather; more [fuel](#) built up from decades of fire suppression; and increasing human ignitions from campfires to powerline malfunctions.

What is surprising is the role that spaceborne lidar is playing in [fire management](#) and what having a unique view of the Earth can tell us about reducing [fire risk](#) and hazard. Recent research from Northern Arizona University [published](#) in *Communications Earth & Environment* found that when conditions are intense—particularly with hot, dry winds—fires can roar through landscapes burning at high severity in dense and sparse forests alike.

The one exception to this trend is with ladder fuels, which are shrubs, [small trees](#) and lower branches that can carry a fire from the forest floor to the canopy, where it can then grow exponentially and spread more quickly.

Unlike the total amount of fuel in a forest, it turns out the vertical location of those fuels, especially when they act as ladder fuels, may be the most important factor in predicting wildfire severity even in extreme conditions. Further, management efforts that focus on ladder fuels can help reduce the size and severity of wildfires in the American Southwest no matter what the weather is doing.

"This research uses large-scale satellite data to show that if fire weather is extreme and there's ignition, let's say from burning embers blown by the wind, a fire is more likely to result in a high-severity burn due to factors like low humidity and wind speed versus the sheer fuel volumes," said Chris Hakkenberg, an assistant research professor in the School of Informatics, Computing, and Cyber Systems (SICCS) at NAU and lead author of the study.

"That said, we were surprised to find a critical exception to this trend—specifically with ladder fuels. Put simply, even in extreme weather conditions, forests with fewer ladder fuels tended to experience less severe fires."

That's good news for land and fire managers, though nothing new for those practicing cultural burns for millennia.

## **The important role of fire—and NASA—in fire management**

Land managers have long known fire is useful in land management. Controlled or prescribed fires can burn dried grass and other undergrowth, so when a wildfire tears through a forest, it doesn't move as quickly up into the tree crowns and is more likely to die out on its own.

NASA's spaceborne lidar Global Ecosystem Dynamics Investigation (GEDI), which was used in the study to characterize pre-fire fuel for 42 large California fires from 2019 to 2021, is uniquely able to peer into forests, providing consistent data of fuel structure for large areas and over multiple years.

The team was able to determine that, among all measures of forest fuel, such as canopy height or volume, the presence of ladder fuels was the single most consistent determinant of high severity fire. Likewise, fewer ladder fuels were associated with reduced burn severity.

That means in the future, land and fire managers can use [satellite data](#) on weather and fuels to find out well before a fire which areas are at greatest risk and how to reduce that risk by working with managers on the ground to implement pre-fire ladder fuel treatments and guide suppression efforts.

## What extreme weather means for fire severity

Forest fuels are not a great predictor of severity, especially when extreme weather is part of the equation, Hakkenberg said.

"While wildfires are a natural component of western U.S. fire-adapted ecosystems, this trend from mixed-severity toward large, high-severity fires has resulted in wildfire regimes that are more destructive to forest ecosystems and more dangerous to human communities," he said.

"These high-severity fires also run the risk of altering our forestlands to a new normal: converting them to shrub or grasslands where trees are unable to establish due to high-intensity fire's impact on microclimate, soil conditions and the seed bank."

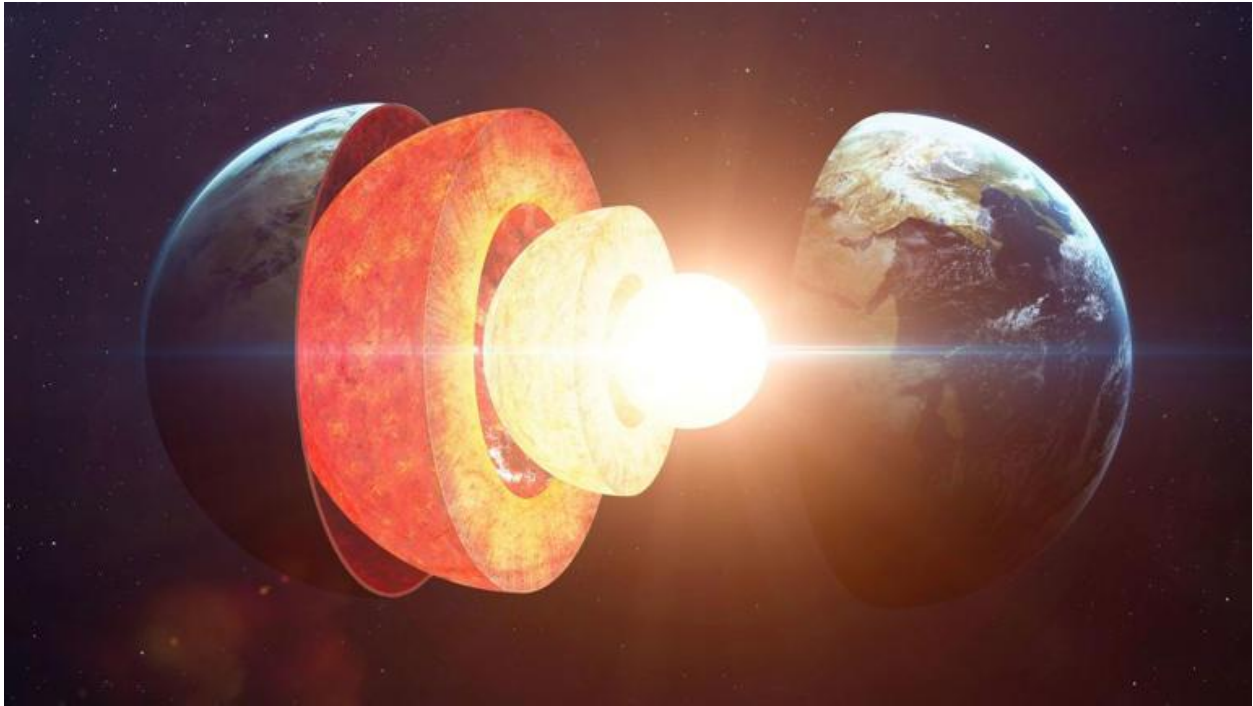
The need to develop ways to adapt to a new climate normal across landscapes with historically dense forest fuels is great, but focusing management on [ladder](#) fuels is one promising approach.

**More information:** Christopher R. Hakkenberg et al, Ladder fuels rather than canopy volumes consistently predict wildfire severity even in extreme topographic-weather conditions, *Communications Earth & Environment* (2024). DOI: [10.1038/s43247-024-01893-8](https://doi.org/10.1038/s43247-024-01893-8)

**Journal information:** [Communications Earth & Environment](#)

# 'It's almost science fiction': Scientists say the shape of Earth's inner core is changing

Provided by [Northern Arizona University](#)



A wealth of new information about Earth's inner core has surfaced in recent months. Scientists now have evidence that the planet's innermost layer is changing shape. © forplayday/iStockphoto/Getty Images

Scientists who just months ago confirmed that [Earth's inner core](#) recently reversed its spin have a new revelation about our planet's deepest secrets — they identified changes to the inner core's shape.

Earth's innermost layer is a hot, solid ball of metal surrounded by a liquid metal outer core. For decades, planetary scientists suspected that the solid inner core deformed over time as it spun. Now, researchers have found the first evidence of changes taking place over the past 20 years in the shape of the inner core. Signs of the core's deformation appeared in waves from earthquakes that were strong enough to reach Earth's center.

The research team used that same earthquake data for a 2024 study to resolve a longstanding debate over the inner core's rotation. They found that the inner core once spun faster than Earth itself. But beginning around 2010, the solid

inner core's spin slowed. It's now [revolving backward](#), relative to the rest of the planet.

Their new study, published Monday in the journal [Nature Geoscience](#), builds on that discovery, using earthquake data gathered from 1991 to 2023. The scientists' prior work on core rotation helped them interpret variations in the height of seismic waves, defining them as indicators of changes to the surface of the inner core, said Dr. John Vidale, a coauthor of the previous study and lead author of the new study.

"We can compare the signals that we see when the inner core is returned to the same position as it was in some other time and see if there's differences that can't be explained by the rotation," Vidale, Dean's Professor of Earth Sciences at the University of Southern California's Dornsife College of Letters, Arts and Sciences, told CNN. Shape changes in the core could hold clues about the forces deep inside Earth that power our magnetosphere, the invisible lines of magnetic energy that protect our planet from solar weather and deadly radiation, the researchers reported.

"Earth evolves on a geological timescale, so observing changes on an annual timescale is always intriguing, as it enhances our understanding of inner core dynamics," said [Dr. Yoshi Miyazaki](#), an associate professor in the department of Earth and planetary sciences at Rutgers University in New Jersey.

"Previous studies have already discussed how inner core rotation has changed over the past decade, and this study introduces a new perspective — non-rotational changes — adding another dimension to the discussion. I believe this will further fuel these debates," Miyazaki, who was not involved with the new research, told CNN in an email.

## **'Almost science fiction'**

Of all Earth's layers, the inner core is the most remote and mysterious. This solid sphere of iron and nickel is about 70% the size of the moon, with a radius of approximately 759 miles (1,221 kilometers).

Temperatures in the inner core are as high as 9,800 degrees Fahrenheit (5,400 degrees Celsius), and pressures can reach up to 365 gigapascals (GPa) — more

than 3 million times greater than [Earth's average atmospheric pressure](#) on land. While direct observation of the core is impossible, scientists study it by analyzing changes in the size and shape of seismic waves as they pass through the core.

Earthquakes generate two types of waves. Primary waves, or P waves, are the first waves produced by a quake, and move the ground in the same direction that the wave is moving. Shear waves, or S waves, are slower than P waves and move the ground perpendicular to the wave's direction.

Amplitude changes in a type of core-penetrating P wave — PKIKP waves — hinted at deformations in the inner core's shallowest level, according to the new study. At the boundary where the solid inner core meets the liquid of the outer core, the sphere's surface might be more malleable than it is at deeper levels.

"It's almost science fiction to visualize what's happening on the surface of the inner core," Vidale said. "It's a place that's so different from our day-to-day lives, with different timescales, different materials and incredible forces. And yet, we can get down there and learn more about it by just sifting through some of the latest observations."

## **Movement 'like landslides'**

The scientists analyzed 168 paired waves from quakes in 42 locations near the South Sandwich Islands, a chain of volcanic islands in the South Atlantic Ocean. Tracking the speed and direction of the core's rotation gave the researchers a way to detect changes in the shape of the core. Once they knew the core's rotation speed, they could model its position and then compare different PKIKP waves that reached the core as it revolved into the same spot.

Amplitude changes in those paired waves could then be assigned to shape changes in the core, rather than rotation changes, according to the study. However, what that deformation of the inner core might look like is harder to pin down.

"Maybe the topography is going up and down. Maybe it's sloughing around like landslides," Vidale said. "The most likely thing is the outer core is just pushing on the inner core and moving it around a little bit."

While just one inner core location showed signs of deformation between 2004 and 2008, there may be more that are yet to be detected, the researchers reported.

"It's hard to know if we are looking at an anomalous or a normal location," Vidale said. "But one guess would be that some amount of deformation is happening fairly often in many places." As Earth's solid inner core spins, the molten outer core churns and sloshes. Their interactions generate magnetic energy, which unspools to enfold our planet in the magnetosphere. But the liquid outer core is shrinking. Millimeter by millimeter, the inner core has siphoned molten metal from the liquid core surrounding it, Vidale said. It likely took billions of years for the inner core to cool and solidify, and over the next few billion years, the inner core will continue to cool, sipping drops of liquid metal from the outer core, until Earth's entire core is a solid metal sphere, he added.

"That'll kill the magnetic field," Vidale said. "There won't be the moving iron down there anymore." However, such an event is billions of years in our future. And before that could happen, Earth will likely be obliterated as our sun expands into a red giant and swallows the inner planets of the solar system, Vidale said. Until then, scientists should have ample time to investigate the unseen workings at the heart of our planet and discover what Earth's internal spinning, churning and shape-shifting might hold in store for the planet.

"Regarding the impact on life, as mentioned in the paper's introduction, inner core growth plays a crucial role in generating Earth's magnetic field, which protects us from harmful solar radiation," Miyazaki said. "While a direct connection between life on Earth's surface and the ICB (inner-outer core boundary) remains distant, what happens at the ICB still has some implications for Earth's long-term evolution."

# World's biggest underground thermal lake discovered in Albania at bottom of 330-foot abyss

Scientists have discovered the world's largest underground thermal lake in a cave in southern Albania, the results of a new expedition confirm.

Researchers from the Czech Republic first found the lake four years ago, but they did not have the right instruments to measure it at the time, according to a translated [statement](#) from the Neuron Foundation — an organization that promotes research by Czech scientists.

Now, the team has announced it returned to the lake in 2024 with state-of-the-art 3D scanners, confirming that the hidden water body is the biggest of its kind known to science.

The scientists named the lake "Neuron" after the foundation, which funded the recent expedition. The lake measures 454 feet (138 meters) long and 138 feet (42 m) wide.

"In order for Czech science to present this phenomenal discovery, it was necessary to conduct scientific research and precise measurements," [Marek Audy](#), a cave explorer who led both expeditions, said in the statement.

Audy and his colleagues first discovered the hidden chamber while exploring the border region between Albania and Greece, which has been [subject to political tensions](#) for over a century and therefore been off limits for some research.



The lake is thermal, meaning it is heated by geothermal processes inside Earth's crust. (Image credit: Neuron Foundation)

While exploring the region around the town of Leskovik in Albania, the team spotted a huge column of steam wafting from a mountain range and, upon closer inspection, saw it was rising from an abyss more than 330 feet (100 m) deep, Audy said.

The researchers descended into the pit and found an extensive system of caves, including some with thermal springs and one containing a vast lake, Audy said.

"During our initial exploration, we created a basic map using our equipment and immediately realized that we had discovered something extraordinary," photographer and expedition member Richard Bouda told [Euronews](#).

Last year, with funding from the Neuron Foundation, the researchers returned to the site with a lidar scanner — a remote-sensing instrument that uses a laser to measure distances and create 3D models — to map the lake in detail. The results indicate that the lake holds 294,350 cubic feet (8,335 cubic meters) of water, equivalent to about 3.5 Olympic swimming pools.

Audy told [National Geographic CZ](#) they hope to return to Lake Neuron to study it further. "It's something that could have a huge impact on understanding

underground ecosystems and geological processes," he said. "We want to look at other parts of the cave, learn more about the geology and biology of this area."

Researchers previously found a similar, albeit smaller underground thermal lake in Hungary, [Reuters reported](#) in 2008. That lake and its chamber, discovered beneath Turkish baths in the capital city of Bucharest, were "the biggest active, water-filled thermal water cave and hall in the world" at the time they were found, cave explorer Sandor Kalinovits, one of the lake's discoverers, reportedly said.

## **Scientists discover enormous reservoir hidden in Cascades — more than twice the amount of water in Lake Mead**

published January 15, 2025

An enormous water reservoir — likely the largest aquifer of its kind in on Earth — sits inside the volcanic rocks of the Oregon Cascades,



scientists have revealed.

The Oregon Cascades hold at least 81 cubic kilometers of water beneath their volcanic rocks, scientists find. (Image credit: tomwachs/Getty Images)

A hidden reservoir of groundwater more than twice the size of Lake Mead is buried inside the Oregon Cascades, a new study reports.

Scientists found that the underground aquifer holds at least 19.4 cubic miles (81 cubic kilometers) of water below the surface of the mountain range. The finding could impact both water use and scientists' understanding of volcanic processes in the region.

"It is a continental-size lake stored in the rocks at the top of the mountains, like a big water tower," study co-author [Leif Karlstrom](#), an Earth scientist at the University of Oregon, [said in a statement](#). "That there are similar large volcanic aquifers north of the Columbia Gorge and near Mount Shasta likely make the Cascade Range the largest aquifer of its kind in the world." The Cascade mountain range extends for about 700 miles (1,100 kilometers) from Northern California to British Columbia, Canada, and has been built up by volcanic activity over millions of years. Within Oregon, the High Cascades, whose volcanic rocks date back 8 million years, is home to smooth slopes and ongoing volcanic activity, while the older Western Cascades that dates to 45 million years ago is filled with canyons and valleys carved by flowing streams. The researchers used the gradual shift between these two zones to study how volcanic processes have affected the region over time.

In the study, published Jan. 13 in the journal [PNAS](#), the researchers measured how the temperature of rocks in the mountain range changes with depth. Deeper rock tends to be hotter because it's under more pressure and closer to Earth's hot interior, but the team found several areas where the temperature remained constant, even as the depth increased. That implied the rock was being cooled, which they attributed to water permeating the rock.

"We initially set out to better understand how the Cascade landscape has evolved over time, and how water moves through it," study co-author [Gordon Grant](#), a hydrologist with the U.S. Forest Service, [said in the statement](#). "But in conducting this basic research, we discovered important things that people care about: the incredible volume of water in active storage in the Cascades and also how the movement of water and the hazards posed by volcanoes are linked together."

# Wyoming's Two Ocean Creek Is Only Body Of Water That Flows Into Atlantic And Pacific

Parting of the Waters deep in the Teton Wilderness is a uniquely Wyoming wonder where Two Ocean Creek splits, flowing into both the Atlantic and Pacific oceans. It's the only body of water on the planet to do that.



Two Ocean Creek in Wyoming's Teton Wilderness is the only body of water on the planet that splits and flows into both the Pacific and Atlantic oceans. (Getty Images)

In the deep wilderness of Bridger-Teton National Forest, not far from the southern border of Yellowstone National Park, hikers can find a small stream with two forks, each flowing downhill in different directions.

A sign is posted on one of the trees standing on an island between the two forks of the creek. A simple inscription attests to the remarkable natural wonder of the waters.

“Continental Divide – Elev. 8200 – Two Ocean Pass – Parting of the Waters – Two Ocean Creek.”

“One branch heads to the Atlantic Ocean and the Gulf of Mexico, and one branch goes to the Pacific Ocean,” said Mark Fisher, Wyoming geologist and contributor to [the website Geology of Wyoming](#). “It’s a unique feature on the Continental Divide.”

## Two Oceans, One Creek

Two Ocean Creek, located high in the mountains along Two Ocean Pass, is one of Wyoming’s lesser-known geological wonders. The 3-mile-long creek is positioned so that its water will eventually flow into either the Atlantic or Pacific oceans.

H.H. “Rip” Van Winkle, the Teton National Forest Supervisor from 1957-1963, described it as “the Y” and surmised that its water had flowed toward both oceans for hundreds of years.

“In lowest water stages, the creek is four or five feet wide and about six inches deep,” he wrote. “It divides into approximately equal streams. Atlantic and Pacific Creeks. The division takes place in the timber, rather than in the open park ... (and) fish can cross the Continental Divide in the two creeks.”

Two Ocean Pass was listed as a National Natural Landmark Site in 1965, but that hasn’t increased its visibility to the wider world. That doesn’t detract from its importance to the Greater Yellowstone Region and its status as one of the most significant waterways in North America.

## Sea To Shining Sea

At the Parting of the Waters, it’s 3,488 miles to the Atlantic Ocean and 1,353 miles to the Pacific Ocean. Whichever way the water flows, it’s got quite a trek ahead.

Eastward water in Atlantic Creek flows into the Yellowstone River, continuing into the Missouri River, then the Mississippi River, and finally to the Gulf of Mexico. Westward water in Pacific Creek flows into the Snake River and then to the Columbia River, which empties into the Pacific Ocean.

Two Ocean Pass will often flood during a wet spring. This creates a temporary expanse of marshland where water can more easily reach Two Ocean Creek at “the Y.”

That flooding makes Two Ocean Creek an important migratory route for Yellowstone’s native cutthroat trout. The fish use the high-elevation waterway to migrate between the Snake and Yellowstone rivers.

However, the creek is also a corridor for invasive species. [A 2020 study by the National Park Service and U.S. Geological Survey](#) revealed that nonnative lake trout may have used Two Ocean Creek to reach the Greater Yellowstone Ecosystem, and if other fish species do the same in the future, it could become an ecological liability.

“We conclude that invasive movements by lake trout from the Snake River over Two Ocean Pass may have resulted in their colonization of Yellowstone Lake,” the paper reads. “Moreover, Yellowstone Lake may be vulnerable to additional invasions because several other nonnative fish inhabit the upper Snake River.”

But how did such a unique waterway come to be? The answer lies in Wyoming’s volcanic history, long before the nearby supervolcano forced its way into the neighborhood.

Parting of the Waters is a spot in Wyoming where water from North Two Ocean Creek can flow to either the Pacific Ocean to the west or Atlantic to the east. This wooden sign indicates it's 3,488 miles to the Atlantic and 1,353 miles to the Pacific.



Two Ocean Lake in the Teton Wilderness of Wyoming. (J. Bonney, National Park Service)

Arrow leftArrow right

## From Gardiner To Dubois

The Continental Divide lies along the entire 3,000-mile expanse of the Rocky Mountains. A visitor driving through Yellowstone could cross the divide three times during their visit. Adjacent to the relatively young Yellowstone volcano, there's the much older volcanic rock of the Absaroka Volcanic Province. The expanse of 50-million-year-old rock stretches 160 miles long and nearly 50 miles across.

Wyoming is known for being incredibly diverse geologically, sitting on some of [the oldest, most stable bedrock in North America](#). Fisher said the Absaroka Volcanic Province exemplifies the Cowboy State's pre-Yellowstone volcanism.

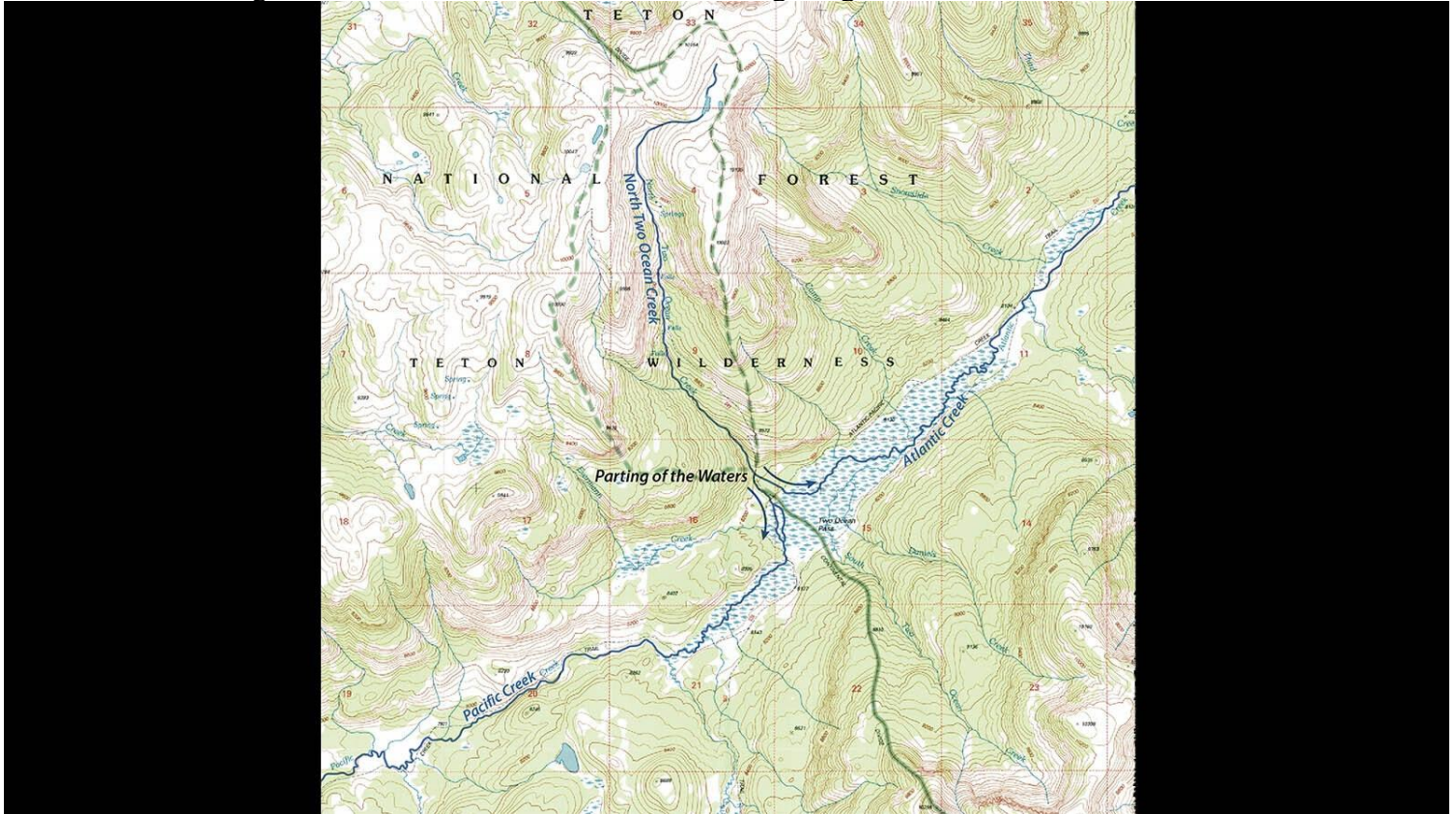
"This is not Yellowstone," he said. "The Yellowstone stuff is within the last two million years. The Absaroka Volcanic Province runs from North Yellowstone in Montana, from Gardiner and Cooke City, south of Cody, and almost To Dubois."

Two Ocean Pass is contained entirely within the Absaroka Volcanic Province, a vast volcanic field created by the uplift of the Rocky Mountains over 50 million years ago. The rugged terrain

created from that uplift created the quirk of geology that allows Two Ocean Creek to split and flow downhill to the Atlantic and Pacific Oceans.

While it is located within the Greater Yellowstone Region, Fisher said, Yellowstone itself had nothing to do with creating Two Ocean Creek, even if it directly benefits from it.

“Those rocks erupted so long ago that it was cold, extinct volcanic field by the time Yellowstone did its thing,” he said. “That’s what created this rare geologic feature.”



This map illustrates how the creek splits in Two Ocean Pass to flow into both the Atlantic and Pacific oceans. (U.S. Geological Survey)

## Lewis And Clark Missed Out

There is a “path” to Two Ocean Pass, but a round-trip hike requires a 40-mile trek along the Atlantic-Pacific Trail and an extra quarter-mile to reach the Parting of the Waters. None but the most intrepid hikers and riders will get to say they’ve seen the stream that feeds two oceans. Meriwether Lewis and William Clark were two people who would have wanted to make the trek to the Parting of the Waters. In 1803, they were tasked with finding a waterway connecting the two oceans on either side of the burgeoning United States.

“The object of your mission is to explore the Missouri River,” President Thomas Jefferson wrote to Lewis in 1803, “and such principal streams of it, as, by its course and communication with the waters of the Pacific Ocean, whether the Columbia, Oregon, Colorado, or any other river, may offer the most direct and practicable water-communication across the continent, for the purposes of commerce.”

Lewis and Clark followed the Mississippi River upriver into North Dakota and Montana, where they reached the headwaters of the Missouri River. They eventually went overland to the

Columbia River and reached the Pacific Ocean in November 1805, but never found a communicable waterway connecting east to west.

Two Ocean Creek isn't the commercial water route Jefferson hoped Lewis and Clark would discover. Nevertheless, it's precisely what he wanted to find – an uninterrupted passage across the continent.

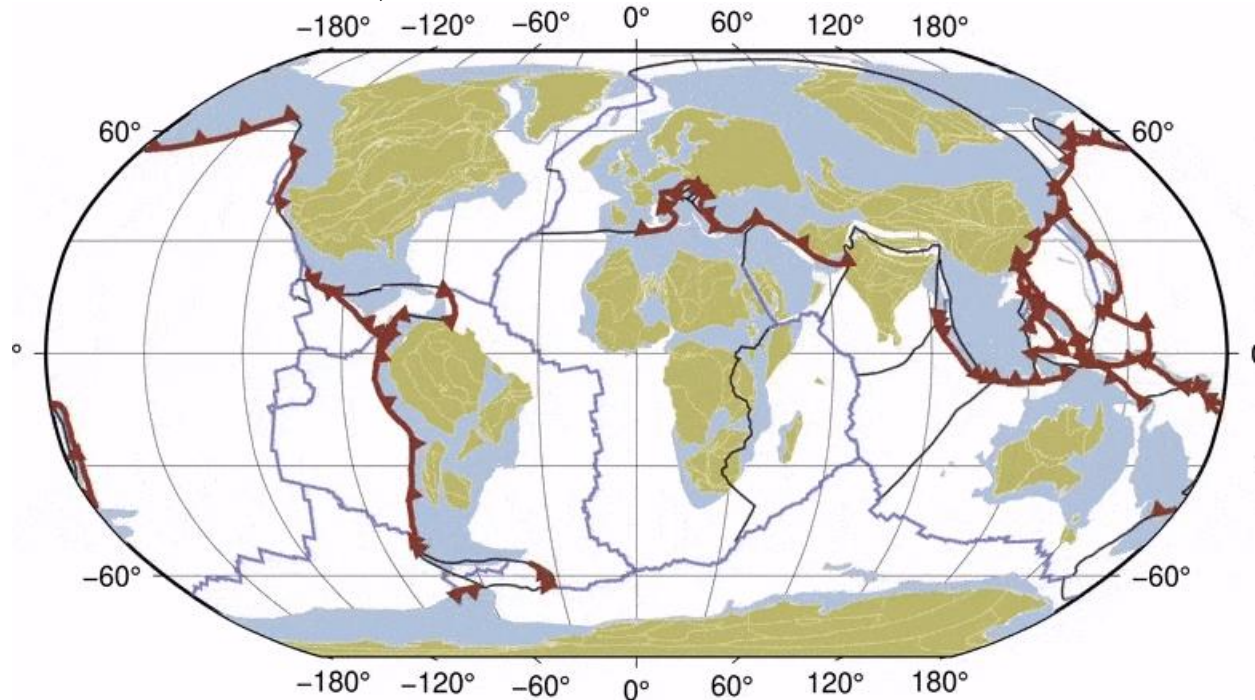
Two decades later, Jim Bridger discovered what had eluded Lewis and Clark deep in the Wyoming wilderness. It's only fitting that Two Ocean Pass and Two Ocean Creek reside in the national forest that bears Bridger's name.

Given the effort it takes to get there, Fisher's never been to Two Ocean Pass to see the Parting of the Waters. But he doesn't need to see it to recognize its provenance for Wyoming and North America.

"The landscape is positioned in such a way that the creek just so happens to divide to reach both oceans," he said. "I wouldn't say I'm an expert on the Continental Divide, but I don't know of anywhere else like Two Ocean Creek."

# A Billion Years in 40 Seconds: Mesmerizing Video Reveals the Evolution Our Dynamic Planet

BY UNIVERSITY OF SYDNEY FEBRUARY 8, 2021



Scientists released a video showing a billion years of Earth's tectonic plate movement. This helps us understand habitability and find critical metals for a low-carbon future. The video reveals continents shifting, including Antarctica's past equatorial position.

## New research helps understand how plate tectonics powers life on Earth.

- Plate tectonics are responsible for the deep-carbon and deep-water cycles.
- Arrangement of continents has changed sea level in the past.
- The evolution of life is modified by tectonics — continents are rafts with evolving species that mix when continents combine.
- A growing focus on renewable and low-carbon technologies will mean we need to find more copper and other resources. To find these deposits our new models of plate tectonics will help reduce the environmental footprint of mineral exploration and extraction.

Geoscientists have released a video that for the first time shows the uninterrupted movement of the Earth's tectonic plates over the past billion years.

The international effort provides a scientific framework for understanding planetary habitability and for finding critical metal resources needed for a low-carbon future.

It reveals a planet in constant movement as land masses move around the Earth's surface, for instance showing that Antarctica was once at the equator.

The video is based on new research published in the March 2021 edition of *Earth-Science Reviews*.

*Video showing the movement of Earth's tectonic plates over the past billion years. Credit: Dr. Andrew Merdith/University of Lyon*

Co-author and academic leader of the University of Sydney EarthByte geosciences group, Professor Dietmar Müller, said: "Our team has created an entirely new model of Earth evolution over the last billion years.

Professor Dietmar Müller from the EarthByte group in the School of Geosciences at the University of Sydney. Credit: Britta Campion

"Our planet is unique in the way that it hosts life. But this is only possible because geological processes, like plate tectonics, provide a planetary life-support system."

Lead author and creator of the video Dr. Andrew Merdith began work on the project while a PhD student with Professor Müller in the School of Geosciences at the University of Sydney. He is now based at the University of Lyon in France.

Co-author, Dr. Michael Tetley, who also completed his PhD at the University of Sydney, told Euronews: "For the first time a complete model of tectonics has been built, including all the boundaries"

"On a human timescale, things move in centimeters per year, but as we can see from the animation, the continents have been everywhere in time. A place like Antarctica that we see as a cold, icy inhospitable place today, actually was once quite a nice holiday destination at the equator."

Co-author Dr. Sabin Zahirovic from the University of Sydney, said: "Planet Earth is incredibly dynamic, with the surface composed of 'plates' that constantly jostle each other in a way unique among the known rocky planets. These plates move at the speed fingernails grow, but when a billion years is condensed into 40 seconds a mesmerizing dance is revealed.

“Oceans open and close, continents disperse and periodically recombine to form immense supercontinents.”

Earth scientists from every continent have collected and published data, often from inaccessible and remote regions, that Dr. Andrew Merdith and his collaborators have assimilated over the past four years to produce this billion-year model.

It will allow scientists to better understand how the interior of the Earth convects, chemically mixes and loses heat via seafloor spreading and volcanism. The model will help scientists understand how climate has changed, how ocean currents altered and how nutrients fluxed from the deep Earth to stimulate biological evolution.

Professor Müller said: “Simply put, this complete model will help explain how our home, Planet Earth, became habitable for complex creatures. Life on Earth would not exist without plate tectonics. With this new model, we are closer to understanding how this beautiful blue planet became our cradle.”

Reference: “Extending full-plate tectonic models into deep time: Linking the Neoproterozoic and the Phanerozoic” by Andrew S. Merdith, Simon E. Williams, Alan S. Collins, Michael G. Tetley, Jacob A. Mulder, Morgan L. Blades, Alexander Young, Sheree E. Armistead, John Cannon, Sabin Zahirovic and R. Dietmar Müller, 24 December 2020, *Earth-Science Reviews*.

DOI: [10.1016/j.earscirev.2020.103477](https://doi.org/10.1016/j.earscirev.2020.103477)

# A Complete Interpretation of Earth Timeline

Oct 17, 2024

The story of Earth is a fascinating journey through time, spanning billions of years and filled with dramatic transformations. From the fiery beginnings of our planet to the lush, diverse world we know today, **Earth's timeline** is a testament to the power of natural forces and the resilience of life. Imagine witnessing the formation of continents, the rise and fall of massive creatures, and the dramatic shifts in climate that have shaped our world.

Understanding Earth's timeline provides insight into our planet's past and offers valuable lessons for our future. How did life begin, and what events led to the incredible diversity we see today? What can the past tell us about our current challenges, such as global warming and biodiversity loss? As we explore these questions, we'll uncover the key milestones that have defined Earth's history and gain a deeper appreciation for the intricate web of life that continues to evolve. Join us on this captivating journey through time and discover the wonders of our planet's history.

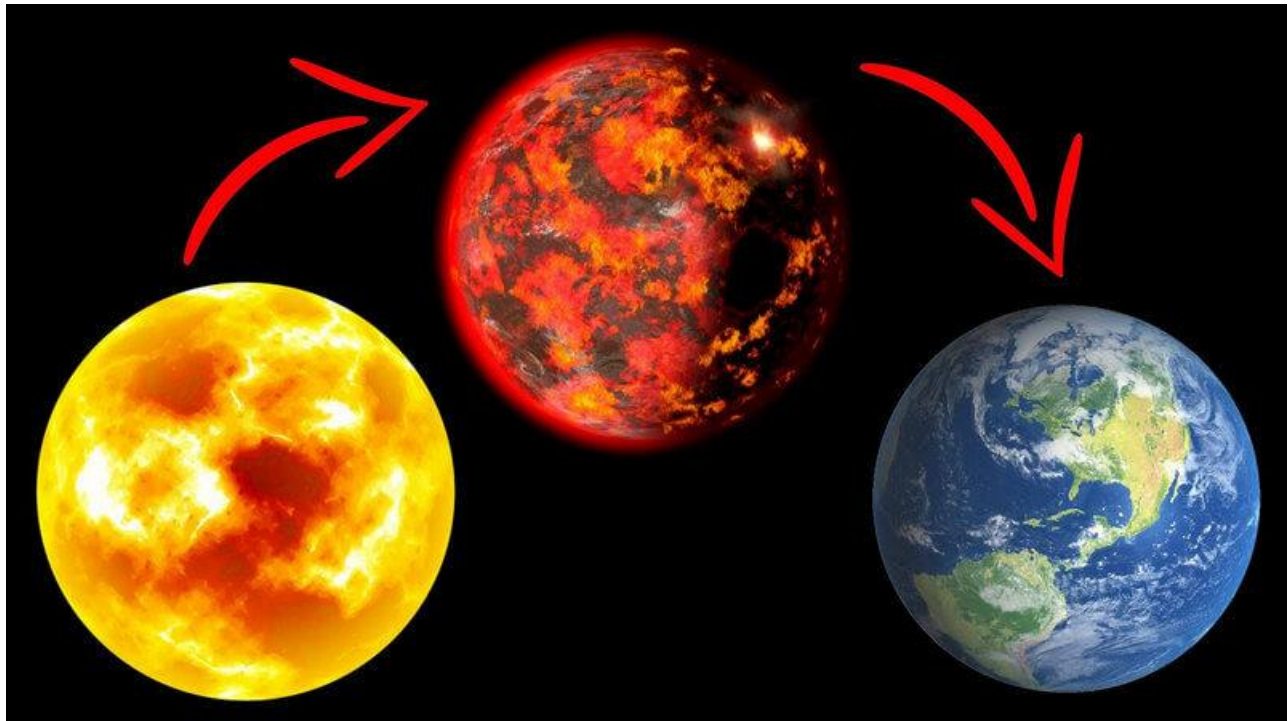


- [Part 1. What Created Earth](#)
- [Part 2. A Timeline of Earth](#)
- [Part 3. How to Draw an Earth Timeline](#)

- [Part 4. Why the Earth is the Most Suitable Planet for Creatures](#)

## Part 1. What Created Earth

Earth formed about 4.5 billion years ago from the solar nebula. The origin of the Earth is a giant rotating cloud of gas and dust left over from the Sun's formation. As gravity pulled the particles together, they collided and merged, gradually building into larger bodies known as planetesimals. These planetesimals further combined to form the early Earth. During this time, the young planet underwent intense volcanic activity and frequent collisions with other celestial bodies, including a massive impact that is believed to have led to the formation of the Moon.

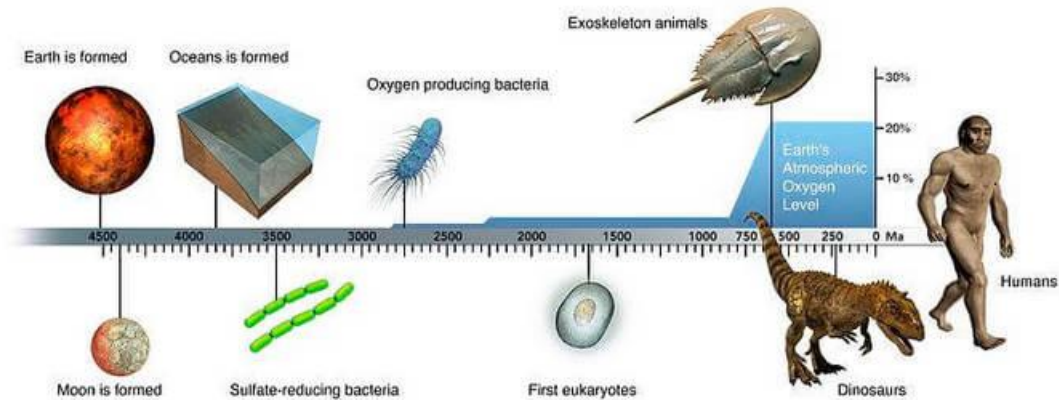


A solid crust formed as the Earth cooled, and volcanic gases created an early atmosphere. Water vapor condenses to form oceans, setting the stage for the development of life. Over millions of years, Earth's environment evolved, leading to the diverse and dynamic planet we know today. This process highlights the intricate

interplay of cosmic forces and natural phenomena that contributed to creating our home in the universe.

## Part 2. A Timeline of Earth

- 4.5 Billion Years Ago: Earth forms from the solar nebula.
- 4.4 Billion Years Ago: Formation of the Moon after a massive impact.
- 4 Billion Years Ago: Earth's crust solidifies; early atmosphere forms.
- 3.8 Billion Years Ago: First signs of life appear.
- 2.5 Billion Years Ago: Oxygen begins accumulating in the atmosphere.
- 1.5 Billion Years Ago: First eukaryotic cells develop.
- 600 Million Years Ago: Multicellular life emerges.
- 540 Million Years Ago: Cambrian Explosion; rapid diversification of life.
- 250 Million Years Ago: Permian-Triassic extinction event.
- 65 Million Years Ago: Dinosaurs go extinct; the rise of mammals.
- 2.5 Million Years Ago: Ice ages begin; early humans evolve.
- 10,000 Years Ago: End of the last Ice Age; dawn of agriculture.



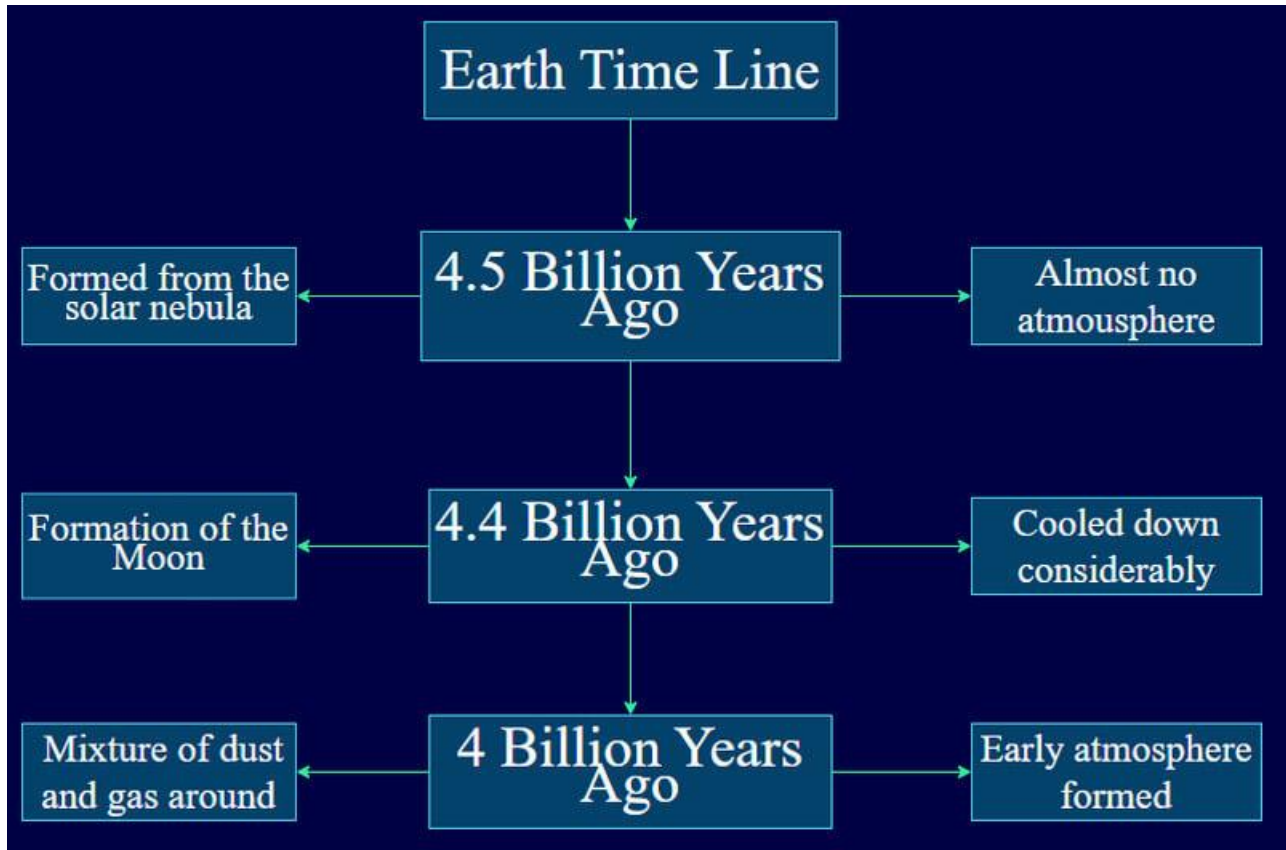
## Part 3. How to Draw an Earth Timeline

After learning the timeline of the earth and its formation, let's look at the methods used to draw it. Here, [MindOnMap](#) is a proper tool to help us.

Visualizing the history of our planet has never been easier than with the help of mind mapping tools like MindOnMap. By creating an Earth timeline using this powerful diagramming technique, you can bring the vast expanse of geological time into a clear, organized format.

The beauty of using a mind map for an Earth timeline lies in its ability to capture the interconnected nature of Earth's development. From the formation of the planet billions of years ago to the emergence of modern [human evolution](#), a mind map allows you to trace the intricate web of events, processes and milestones that have shaped our world. By structuring this information visually, you can gain a deeper, more holistic understanding of our planet's remarkable history and civilization.

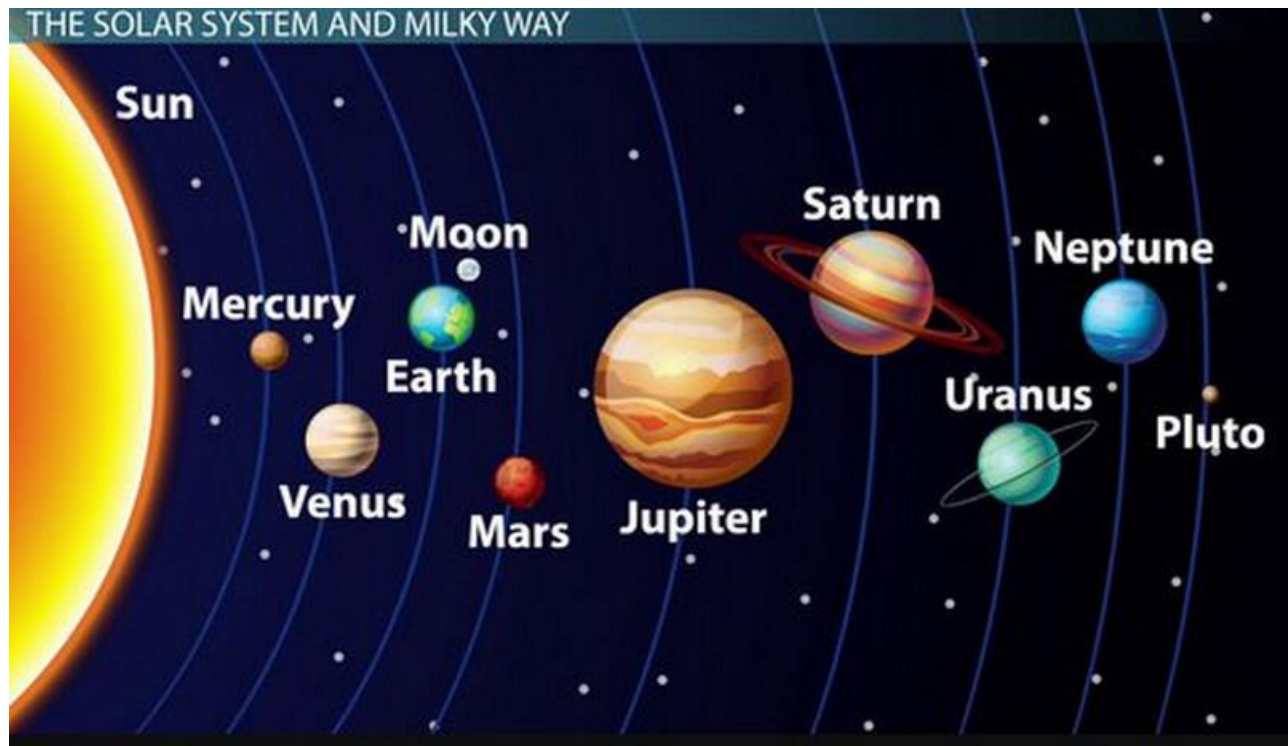
On the top, you can choose multiple tools there. First, click "Topic" to create a central topic. You can fill out the " Earth Timeline " there. Next, select a central topic to add subtopics and click "Subtopic". You may fill the time in it. After that, you should add the events under the time by repeating the former method. What's more, the functions on the right allow you to refine your works further by adding styles, icons, and so on.



## Part 4. Why the Earth is the Most Suitable Planet for Creatures

Earth is uniquely suited for life due to a combination of factors absent or insufficient on other planets in our solar system. One of the most critical factors is the presence of

liquid water. Earth exists in the Sun's "habitable zone," where temperatures allow water to remain fluid, essential for all known life forms. In contrast, planets like Mars and Venus are either too cold or too hot, resulting in water being trapped as ice or vapor.



Meanwhile, Earth's magnetic field protects the planet from solar winds, which might strip away the atmosphere, as has likely happened to Mars. A stable climate, diverse ecosystems, and a balanced chemical composition further contribute to Earth's ability to support life. In contrast, gas giants like Jupiter and Saturn have hostile environments with crushing pressures and toxic gases, making them inhospitable for life as we know it.

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FEBRUARY 14, 2025

# Does planetary evolution favor human-like life? Study ups odds we're not alone

by [Pennsylvania State University](#)



A new model upends the decades-old "hard steps" theory that intelligent life was an incredibly improbable event and suggests that maybe it wasn't all that hard or improbable. The team of researchers said the new interpretation of humanity's origin increases the probability of intelligent life elsewhere in the universe. Credit: NASA

Humanity may not be extraordinary but rather the natural evolutionary outcome for our planet and likely others, according to a new model for how intelligent life developed on Earth.

The model, which upends the decades-old "hard steps" theory that [intelligent life](#) was an incredibly improbable event, suggests that maybe it wasn't all that hard or improbable. A team of researchers at Penn State, who led the work, said the new interpretation of humanity's origin increases the probability of intelligent life elsewhere in the universe.

"This is a significant shift in how we think about the history of life," said Jennifer Macalady, professor of geosciences at Penn State and co-author on the paper, which was [published](#) Feb. 14 in the journal *Science Advances*.

"It suggests that the evolution of complex life may be less about luck and more about the interplay between life and its environment, opening up exciting new avenues of research in our quest to understand our origins and our place in the universe."

Initially developed by theoretical physicist Brandon Carter in 1983, the "hard steps" model argues that our evolutionary origin was highly unlikely due to the time it took for humans to evolve on Earth relative to the total lifespan of the sun—and therefore the likelihood of human-like beings beyond Earth is extremely low.

In the new study, a team of researchers that included astrophysicists and geobiologists argued that Earth's environment was initially inhospitable to many forms of life, and that key evolutionary steps only became possible when the global environment reached a "permissive" state.

For example, complex animal life requires a certain level of oxygen in the atmosphere, so the oxygenation of Earth's atmosphere through photosynthesizing microbes and bacteria was a natural evolutionary step for the planet, which created a window of opportunity for more recent life forms to develop, explained Dan Mills, postdoctoral researcher at The University of Munich and lead author on the paper.

"We're arguing that intelligent life may not require a series of lucky breaks to exist," said Mills, who worked in Macalady's astrobiology lab at Penn State as an undergraduate researcher.

"Humans didn't evolve 'early' or 'late' in Earth's history, but 'on time,' when the conditions were in place. Perhaps it's only a matter of time, and maybe other planets are able to achieve these conditions more rapidly than Earth did, while other planets might take even longer."

The central prediction of the "hard steps" theory states that very few, if any, other civilizations exist throughout the universe, because steps such as the origin of life, the development of complex cells and the emergence of human intelligence are improbable based on Carter's interpretation of the sun's total lifespan being 10 billion years, and the Earth's age of around 5 billion years.

In the new study, the researchers proposed that the timing of human origins can be explained by the sequential opening of "windows of habitability" over Earth's history, driven by changes in nutrient availability, sea surface temperature, ocean salinity levels and the amount of oxygen in the atmosphere.

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Given all the interplaying factors, they said, the Earth has only recently become hospitable to humanity—it's simply the natural result of those conditions at work.

"We're taking the view that rather than base our predictions on the lifespan of the sun, we should use a geological time scale, because that's how long it takes for the atmosphere and landscape to change," said Jason Wright, professor of astronomy and astrophysics at Penn State and co-author on the paper.

"These are normal timescales on the Earth. If life evolves with the planet, then it will evolve on a planetary time scale at a planetary pace."

Wright explained that part of the reason that the "hard steps" model has prevailed for so long is that it originated from his own discipline of astrophysics, which is the default field used to understand the formation of planets and celestial systems.

The team's paper is a collaboration between physicists and geobiologists, each learning from each other's fields to develop a nuanced picture of how life evolves on a planet like Earth.

"This paper is the most generous act of interdisciplinary work," said Macalady, who also directs Penn State's Astrobiology Research Center. "Our fields were far apart, and we put them on the same page to get at this question of how we got here and are we alone? There was a gulf, and we built a bridge."

The researchers said they plan to test their alternative model, including questioning the unique status of the proposed evolutionary "hard steps." The recommended research projects are outlined in the current paper and include such work as searching the atmospheres of planets outside our solar system for biosignatures, like the presence of oxygen.

The team also proposed testing the requirements for proposed "hard steps" to determine how hard they actually are by studying uni- and multicellular forms of life under specific environmental conditions such as lower oxygen and temperature levels.

Beyond the proposed projects, the team suggested the [research community](#) should investigate whether innovations —such as the origin of life, oxygenic photosynthesis, eukaryotic cells, animal multicellularity and Homo sapiens—are truly singular events in Earth's history. Could similar innovations have evolved independently in the past, but evidence that they happened was lost due to extinction or other factors?

"This new perspective suggests that the emergence of intelligent life might not be such a long shot after all," Wright said.

"Instead of a series of improbable events, evolution may be more of a predictable process, unfolding as global conditions allow. Our framework applies not only to Earth, but also other planets, increasing the possibility that life similar to ours could exist elsewhere."

The other co-author on the paper is Adam Frank of the University of Rochester.

**More information:** Daniel Mills, A reassessment of the "hard-steps" model for the evolution of intelligent life, *Science Advances* (2025). DOI: [10.1126/sciadv.ads5698](https://doi.org/10.1126/sciadv.ads5698). [www.science.org/doi/10.1126/sciadv.ads5698](https://www.science.org/doi/10.1126/sciadv.ads5698)

**Journal information:** [Science Advances](#)  
Provided by [Pennsylvania State University](#)

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FEBRUARY 14, 2025

# Research reveals how Earth got its ice caps

by [University of Leeds](#)



Credit: Pixabay/CC0 Public Domain

The cool conditions which have allowed ice caps to form on Earth are rare events in the planet's history and require many complex processes working at once, according to new research.

A team of scientists led by the University of Leeds investigated why Earth has existed in what is known as a "greenhouse" state without ice caps for much of its history, and why the conditions we are living in now are so rare.

They found that Earth's current ice-covered state is not typical for the planet's history and was only achieved through a lucky coincidence.

Many ideas have previously been proposed to explain the known cold intervals in Earth's history. These include decreased CO<sub>2</sub> emissions from volcanoes, or increased carbon storage by forests, or the reaction of CO<sub>2</sub> with certain types of rocks.

The researchers undertook the first ever combined test of all of these cooling processes in a new type of long-term 3D model of the Earth which was first developed at the University of Leeds. This type of "Earth Evolution Model" has only recently been made possible through advances in computing.

They concluded that no single process could drive these cold climates, and that the cooling in fact required the combined effects of several processes at once. The results of their study were [published](#) 14 February 2025 in *Science Advances*.

The findings will help to reconcile a debate in the Earth Science community about which processes were responsible for driving these cold periods.

Lead author, Dr. Andrew Meredith, who carried out the research while working in the School of Earth and Environment at the University of Leeds, said the study helped to explain why icehouse states are so rare.

"We now know that the reason we live on an Earth with ice caps—rather than an ice-free planet—is due to a coincidental combination of very low rates of global volcanism, and highly dispersed continents with big mountains, which allow for lots of global rainfall and therefore amplify reactions that remove carbon from the atmosphere," he explained.

"The important implication here is that the Earth's natural climate regulation mechanism appears to favor a warm and high-CO<sub>2</sub> world with no [ice caps](#), not the partially glaciated and low-CO<sub>2</sub> world we have today.

"We think this general tendency towards a warm climate has helped prevent devastating 'snowball Earth' global glaciations, which have only occurred very rarely and have therefore helped life to continue to prosper."

Benjamin Mills, Professor of Earth System Evolution in Leeds' School of Earth and Environment, supervised the project. He added that the results of the research had important implications for [global warming](#) and the immediate future.

"There is an important message, which is that we should not expect the Earth to always return to a cold state as it was in the pre-industrial age," he said.

"Earth's current ice-covered state is not typical for the planet's history, but our current global society relies on it.

"We should do everything we can to preserve it, and we should be careful with assumptions that [cold climates](#) will return if we drive excessive warming before stopping emissions. Over its long history, the Earth likes it hot, but our human society does not."

**More information:** Andrew Merdith, Phanerozoic icehouse climates as the result of multiple solid-Earth cooling mechanisms, *Science Advances* (2025). DOI: [10.1126/sciadv.adm9798](https://doi.org/10.1126/sciadv.adm9798). [www.science.org/doi/10.1126/sciadv.adm9798](https://www.science.org/doi/10.1126/sciadv.adm9798)

**Journal information:** [Science Advances](#)  
Provided by [University of Leeds](#)

## Breakthrough discovery explains how all life on Earth began

Researchers have taken a significant step in uncovering how [life began on Earth](#), introducing a fresh perspective on the complex journey from chemistry to biology.

The work centers on artificial coacervate droplets—tiny molecular assemblies that may bridge the gap between non-living molecules and living cells. Their findings offer profound insights into the origins of life, sparking interest and debates across the scientific community.

### The Origins of Life and Protocells

The quest to unravel how life arose from simple molecules has intrigued scientists for nearly a century. Early theories proposed in the 1920s by Oparin and Haldane described [primitive cells](#), or "protocells," as key players in life's emergence. These protocells were thought to form spontaneously from organic molecules through a process called liquid-liquid phase separation (LLPS).

# Earth's magnetic North Pole is heading to Russia, what it will do to your GPS?

The magnetic north pole is moving towards Siberia because of changes in Earth's core.

**Updated:** Dec 21, 2024



Navigation systems need to be updated because Earth's magnetic field is changing. (Representational image)

In about every five years, the U.S. National Oceanic and Atmospheric Administration (NOAA) and the British Geological Survey update the World Magnetic Model (WMM).

However, the latest update is quite special because it's going to significantly change how compass needles and navigation systems work.

For those of us who don't know, WMM is actually a map of Earth's magnetic field. It "provides precise navigational data for all military and civilian planes, ships, submarines, and GPS units," NOAA.

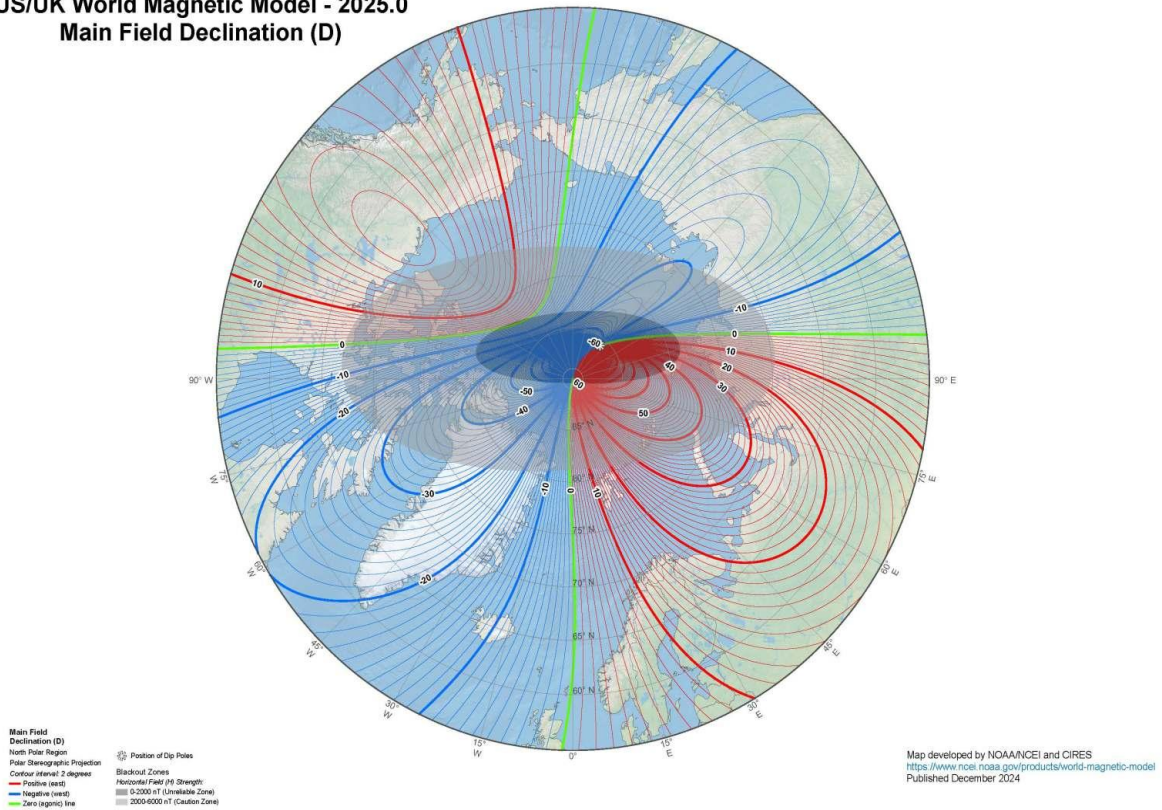
Since Earth's magnetic field changes over time, the WMM is updated every five years to keep it accurate.

# Important highlights of WMM 2025

The recent WMM update reveals that [Earth's magnetic North Pole](#) is moving from Canada to Siberia in Russia.

This shift is driven by the flow of molten iron and nickel between our planet's two large magnetic lobes: the North American lobe beneath Canada and the Siberian lobe under Siberia.

US/UK World Magnetic Model - 2025.0  
Main Field Declination (D)



An image of the WMM 2025 model. Source: [NOAA NCEI](#)

In the last two decades, the movement of iron and nickel within Earth's outer core has made the Siberian lobe region more active, strengthening its influence and causing the [magnetic North Pole to move faster](#) towards Siberia.

“The current behavior of magnetic north is something that we have never observed before. Magnetic north has been moving slowly around Canada since the 1500s,” William Brown, global geomagnetic field modeler at the British Geological Survey, [said](#).

However, “In the past 20 years, it accelerated towards Siberia, increasing in speed every year until about five years ago, when it suddenly decelerated from 50 to 35 km (31 to 22 miles) per year, which is the biggest deceleration in speed we’ve ever seen,” Brown added.

Our navigation systems, especially those [relying on Earth's magnetic data](#), must be adjusted to the change WMM 2025 highlights. Otherwise, our airplanes and vessels may never reach their destination.

For instance, "Imagine someone planning to travel by sleigh from a chimney top in South Africa to a snow-covered roof in the UK, a journey of around 8,500 km. Using the previous WMM and setting off just one-degree off-course, he would end up approximately 150 km away from where he should," the BGS team notes.

## The new model is more accurate

In case you're worried about whether [the GPS](#) on your smartphone will remain accurate after the WMM 2025 update, don't worry. The map and other GPS-driven apps in your smartphone will receive the required update from the respective service providers.

Plus, they are likely to work better after the update. This is because WMM 2025 comes with much higher resolution and accuracy.

"WMM 2025 includes improved spatial resolution of approximately 300 kilometers at the equator compared to the standard spatial resolution of 3300 kilometers at the equator. Higher resolution provides greater directional accuracy," the NOAA team said.

The latest WMM map is 10 times more detailed than previous versions and is set to guide our journeys for the next five years — unless [Earth's magnetic behavior](#) suddenly decides to go bonkers.

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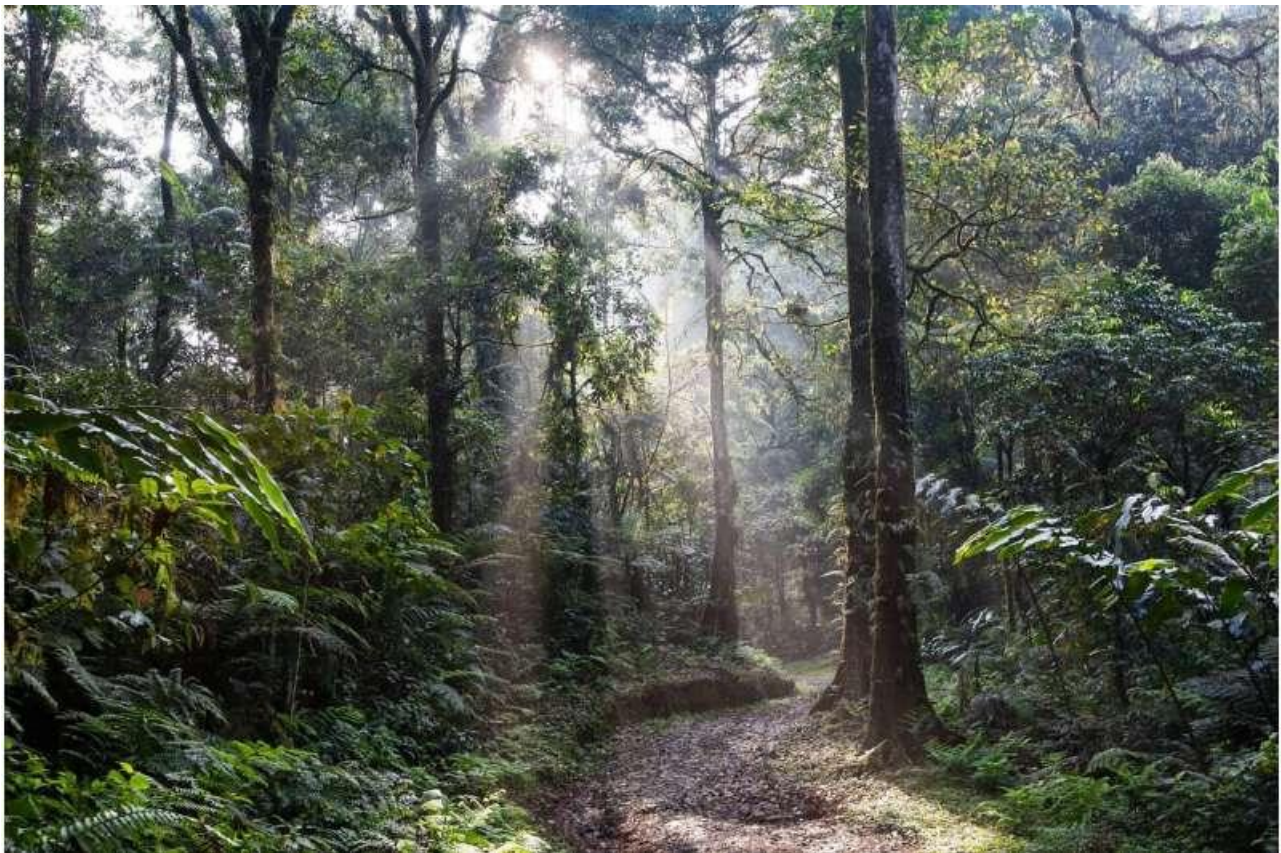
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MARCH 4, 202

# Tree planting is still the best way to remove carbon, despite climate and economic risks, say researchers

by Russell Parton, [University of Exeter](#)



Credit: Pixabay/CC0 Public Domain

Tree planting can be the most cost-effective way of removing carbon as long as careful choices are made about which type of trees to plant and where.

Governments worldwide have committed to expanding [tree cover](#) to remove [greenhouse gases](#), with the U.K. committing to plant 30,000 hectares of trees each year until 2050.

However, [environmental economists](#) point out that there are significant risks of converting farmland to forests in a future of climate change and economic uncertainty.

These include the risk of large-scale tree planting displacing agriculture and impacting food security, depending on where it takes place.

In a study [published](#) in the *Proceedings of the National Academy of Sciences*, the researchers use the U.K. as an example to demonstrate that uncertainties about climate change and the economy make the difficult trade-off between carbon removal and agriculture even trickier.

Frankie Cho, a Ph.D. graduate from the University of Exeter and lead author of the study, explains, "One problem is that, because it is unclear what countries around the world will do to tackle climate change, we don't know how challenging the climate will be in the future. If climate change is extreme, broadleaf trees in the southern U.K. offer the best carbon removal—but that's prime farmland and could be really costly under certain economic futures.

"If climate change is milder, planting conifers on less productive land makes more sense, but those trees will not grow well if conditions are more extreme. The problem is that we don't know what the future holds and can't be certain which type of trees we need to plant and where."

However, using recent advances in decision-making theory under uncertainty, the researchers show that despite these risks, tree planting can still be the most cost-effective way to remove carbon.

Their study shows that a "portfolio" approach to tree planting—diversifying species and planting locations—helps balance risks and moves beyond planting strategies that simply hope that everything will be okay.

This strategy minimizes the danger of betting on the wrong future, ensuring tree-planting decisions remain resilient in the face of uncertain future climatic and economic conditions.

Importantly, they show that if policymakers adopt these portfolio approaches to tree-planting, it becomes a far more cost-effective strategy for carbon removal than alternatives like biomass energy with [carbon capture](#) and storage or direct air capture technologies.

Co-author of the study, Professor Brett Day, from the University of Exeter, added, "We don't have any other option that can remove carbon from the atmosphere at the scale and cost that we need to meet our Net Zero targets. While [tree-planting](#) carries risks, our study shows that, if done strategically, it remains the best solution we have."

**More information:** Frankie H. T. Cho et al, Resilient tree-planting strategies for carbon dioxide removal under compounding climate and economic uncertainties, *Proceedings of the National Academy of Sciences* (2025). DOI: [10.1073/pnas.2320961122](https://doi.org/10.1073/pnas.2320961122)

**Journal information:** [Proceedings of the National Academy of Sciences](#)

Provided by [University of Exeter](#)

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MARCH 4, 2025

# Environmental scientists highlight role of paint in microplastic pollution

by Cynthia Macdonald, [University of Toronto](#)



Example sources of paint microplastics to the environment. Microplastics are generated from (A and B) murals and architectural/building paints, (C) household and craft paints, (D) automobile and road paints, (E) boats and marine coatings/paints, and (F) sewage, gas, and other infrastructure paints. The ship pictured in panel (E) is the MV Ithaka in Hudson Bay (Churchill, Manitoba). Credit: *Environmental Toxicology and Chemistry* (2025). DOI: 10.1093/etjnl/vgae034

Plastic waste is recognized as a major cause of environmental harm, with products like water bottles, plastic bags and clothing fibers acknowledged as major contributors to plastic pollution—but research by University of Toronto environmental scientists shows another source deserves more attention: paint.

In a study [published](#) in the journal *Environmental Toxicology & Chemistry*, researchers in the Faculty of Arts & Science's department of ecology and evolutionary biology show how paint has been severely understudied when it comes to research on microplastics.

Defined as plastic particles less than five millimeters in size, microplastics are known to accumulate in air, water, food and even our bodies over time—and have been shown to have toxic effects on both marine life and human health.

The researchers say paint has been severely underestimated as a [microplastic](#) pollutant because it can be difficult to identify.

"Often, paint will show up as 'anthropogenic unknowns' when characterizing microplastics," says Zoie Diana, post-doctoral researcher who co-authored the study with Assistant Professor Chelsea Rochman and master's student Yuying Chen. "Researchers have been wondering what such particles are and hypothesizing, based on computer modeling, that paint might be responsible for a large portion of them."

To investigate this further, the researchers surveyed existing literature to determine where paint pollution comes from. They found there were around 800 studies published on microplastics in 2019, but only 53 focused on paint, making for a significant research gap.

Although paint has traditionally been considered a form of plastic, on average, 37% of it is composed of synthetic resins that bind pigments together.

To help fill the gap in the research, Diana is creating a spectral library—a technique to identify the molecular structure of unknown fragments.

She notes that there are many measures being employed to reduce microplastic pollution—for example, rain gardens, landscape sites which absorb polluted stormwater.

"Rain gardens installed by major highways in San Francisco have been shown to reduce downstream microplastic emissions by 91 percent, which is a really high success rate," she says. "You can also install a filter in your washing machine that will capture microfibers before they're passed along to the wastewater treatment plant."

Where paint is concerned, some existing measures include special vacuums that can prevent paint emissions from leeching into the environment during building construction.

Diana says it's vital to devise and deploy more measures to reduce paint pollution, given the ubiquitous nature of paint.

"There's paint from boats. There's also paint on buildings, on our roads. Once you walk around the city, you start to see it everywhere you look," she says.

She's also optimistic that a global plastics treaty will be signed in the near future. "That's something that's in the works, and I'm excited to see where it lands—particularly to reduce microplastics, which—as we've seen—are found everywhere."

**More information:** Zoie T Diana et al, Paint: a ubiquitous yet disregarded piece of the microplastics puzzle, *Environmental Toxicology & Chemistry* (2025). DOI: [10.1093/etjnl/vgae034](https://doi.org/10.1093/etjnl/vgae034)

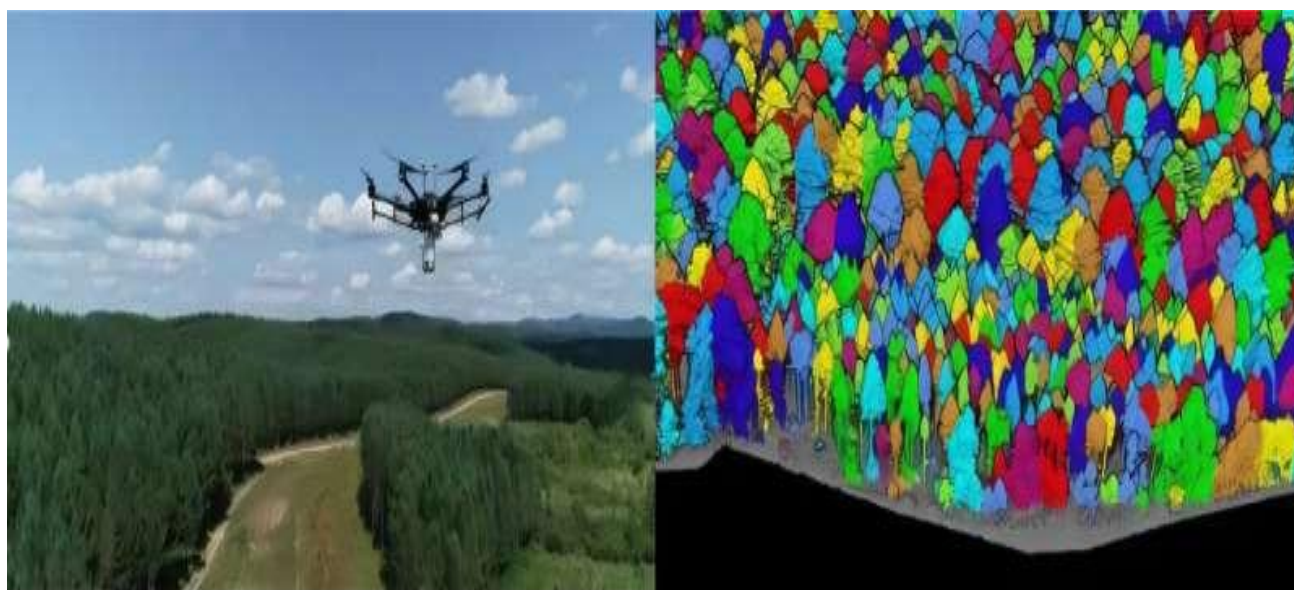
**Journal information:** [Environmental Toxicology and Chemistry](#)  
Provided by [University of Toronto](#)

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MARCH 4, 2025

# How many trees are there in China? LIDAR and big data leaf through the forests to find out

by [Peking University](#)



(a)

(b)

UAV-mounted LiDAR data collection and individual tree segmentation. Credit: Peking University

A paper provides significant insights into China's tree population: by 2020, the average tree density in China was approximately 689 trees per hectare, bringing the total number of trees in the country to around 14.26 billion—roughly 100 trees per capita. The research team was led by Professor Guo Qinghua from the School of Earth and Space Sciences at Peking University. The study, titled "How many trees are there in China?," was [published](#) in *Science Bulletin*.

China has emerged as a pivot of the global push for environmental conservation due to its large-scale reforestation and ecological restoration projects. Yet, fundamental questions

remain: How many [trees](#) are there in China? How are they distributed? The answers to them are central to forest resource management, ecological protection, and the response to global climate change.

Traditional manual plot sampling for forest surveys may not be applicable to estimating on a national scale, and thus it is necessary to put in place advanced techniques for tree population estimates.

## What's new?

LiDAR technology and big data: Since 2015, Professor Guo's team has been systematically collecting near-surface LiDAR data covering over 1,400 square kilometers and exceeding 400TB in volume. By means of individual tree segmentation and multi-source data integration, they developed a multi-model ensemble learning algorithm to map out the tree [density](#) across China for the year 2020 at a resolution of 100 meters.

Multi-scale and multi-dimensional analysis: Apart from providing statistics, the research also offers a multi-scale, multi-dimensional analysis of the intricate distribution of forest trees across the country.

Key findings include:

- By vegetation zone: Cold temperate coniferous forests, with a density of 720 trees/ha, contributed over 60% of China's total tree count (8.79 billion trees), whereas warm temperate deciduous broadleaf forests exhibited the highest density at 989 trees/ha.
- By geographic region: The northeast, southeast, and southwest regions represented significantly higher numbers and densities of trees than the north and northwest. Specifically, the southwest region held the highest tree count at 3.6 billion.
- By [river basin](#): The Yangtze River basin topped the list with 496 million trees, while the southeast, southwest, and Pearl River basins each exceeded 1 billion.
- By province: Sichuan, Heilongjiang, Yunnan, and Guangxi provinces were home to more than 1 billion trees each, accounting for 32% of the national total. Sichuan ranked first due to its terrain and climate conditions. Xizang led in per capita tree count with  $1,982 \pm 121$  trees per capita, reflecting the disparity between the distribution of trees and inhabitants, which provides insights for resource management and ecological policies.

In response to the "Trillion Tree Campaign", China is also working to plant, protect, and restore 70 billion trees over the next decade. This research provides solid scientific support by accurately mapping tree density nationwide, enabling more effective reforestation planning, improved planting and waste prevention. The integration of high-precision data and intelligent model ensures that trees are planted in optimal locations, maximizing ecological and economic benefits, presenting a "Chinese solution" for global sustainability and restoration.

**More information:** Kai Cheng et al, How many trees are there in China?, *Science Bulletin* (2025). DOI: [10.1016/j.scib.2025.02.001](https://doi.org/10.1016/j.scib.2025.02.001)  
Provided by [Peking University](#)



# HOW ADAPTIVE LIDAR COULD REVOLUTIONIZE AUTONOMOUS FARMING

TIM MCMILLAN · MARCH 5, 2025

Farming, one of the oldest human endeavors, is on the brink of a technological revolution. As labor shortages and the increasing demand for food push agriculture toward automation, researchers are developing innovative solutions to make [autonomous farming](#) a reality.

A new study from the University of California, Riverside, accepted for publication in the May issue of [Computer and Electronics in Agriculture](#), introduces an adaptive LiDAR odometry and mapping system designed for autonomous agricultural robots. This breakthrough aims to enhance navigation and mapping capabilities in challenging farm environments, making unmanned farms more feasible.

“The key design principle of this framework is to prioritize the incremental consistency of the map by rejecting motion-distorted points and sparse dynamic objects,” researchers wrote. “The

effectiveness of the proposed method is validated via extensive evaluation against state-of-the-art methods on field datasets collected in real-world agricultural environments featuring various planting types, terrain types, and robot motion profiles.”

## **THE CHALLENGE OF AUTONOMOUS FARMING**

Unlike the smooth roads and structured layouts of urban environments, agricultural fields present unique challenges for autonomous robots. Uneven terrain, dynamic obstacles like swaying crops, and the lack of fixed reference points make navigation complex.

Traditional [LiDAR-based](#) navigation systems, which work well in controlled environments, often struggle to maintain accuracy in these unpredictable conditions.

To address this, the research team at UC Riverside developed a new framework that enhances localization and mapping for mobile robots operating in unstructured farmlands. Their system prioritizes map consistency and accuracy by filtering out motion-distorted data and dynamically adapting to changing field conditions.

## **HOW ADAPTIVE LIDAR ENHANCES AGRICULTURAL ROBOTICS**

The new system, called AG-LOAM (Adaptive Generalized LiDAR Odometry and Mapping), employs a robust LiDAR odometry algorithm based on dense Generalized Iterative Closest Point (G-ICP) scan matching.

It also features an adaptive mapping module that selectively updates maps based on motion stability and data consistency. Motion stability filtering determines when to update the map, ensuring that motion-distorted data is not integrated into the navigation system. Mapping consistency filtering rejects unreliable points, allowing the system to maintain high map accuracy over time. The framework processes

incoming data quickly, allowing robots to navigate efficiently without accumulating drift errors.

Through extensive field tests, researchers demonstrated that AG-LOAM consistently outperformed existing LiDAR-based localization systems in agricultural settings. It proved more resilient to environmental disturbances and robot movement irregularities than traditional methods.

## **FIELD TESTING AND PERFORMANCE OF AG-LOAM AUTONOMOUS FARMING**

The research team conducted rigorous tests at the University of California, Riverside's Agricultural Experimental Station. Using a Clearpath Jackal mobile robot equipped with a LiDAR sensor, they collected real-world data across different farm conditions.

Researchers evaluated the system's performance in various planting environments, such as in-row citrus orchards and open crop fields, with different terrain types, including flat land and rugged, uneven surfaces.

One of the most significant findings was AG-LOAM's ability to maintain localization accuracy even in environments with limited GPS availability. Unlike previous systems that rely heavily on satellite signals, this new framework allows robots to navigate using only LiDAR-based mapping, making it highly adaptable to remote and complex agricultural landscapes.

Results showed that AG-LOAM achieved a centimeter-level accuracy in tracking robot movement and generating precise farm maps. In contrast, competing methods suffered from accumulated errors over time, leading to misalignment and unreliable navigation.

## IMPLICATIONS FOR THE FUTURE OF FARMING

The development of AG-LOAM could represent a significant step toward fully autonomous farming. Automated harvesting, pesticide application, and soil monitoring could become more efficient and less labor-intensive with robots capable of accurate self-navigation.

The ability to generate high-resolution, real-time maps of crop conditions also holds promise for precision agriculture, where farmers can make data-driven decisions to optimize yields and resource usage.

Furthermore, the technology could help reduce agriculture's reliance on manual labor, address workforce shortages, and [improve operational efficiency](#).

As farming communities face increasing challenges related to climate change and food security, such advancements could be critical in ensuring sustainable and resilient food production systems.

Despite its success, the AG-LOAM system still faces some limitations. The research team acknowledged that the framework is currently optimized for 360-degree LiDAR sensors, which may not be accessible or cost-effective for all agricultural applications.

Future iterations may explore alternative sensor integration, such as multi-modal systems combining LiDAR with multispectral cameras or inertial measurement units (IMUs) for enhanced navigation accuracy.

Additionally, while the system performs well in structured and semi-structured farm environments, future research will need to adapt it for more diverse agricultural landscapes, including densely vegetated areas and hilly terrains. Integrating AI-based predictive modeling could further enhance its ability to anticipate and adapt to environmental changes in real time.

Nevertheless, AG-LOAM could mark a transformative moment in agricultural automation. By addressing the unique challenges of farm

navigation, the adaptive LiDAR system paves the way for more reliable and efficient autonomous farming solutions.

As research continues to refine and expand its capabilities, the future of [unmanned farms](#) looks increasingly promising, bringing us closer to a new era of intelligent, self-sufficient agriculture.

The research team has made its source code and field data publicly available on [GitHub](#) for those interested in exploring the full study and its dataset.

With continued innovation and collaboration, adaptive robotic farming may soon become an integral part of modern agriculture.

“Results demonstrate that our method can achieve accurate odometry estimation and mapping results consistently and robustly across diverse agricultural settings,” researchers concluded, “whereas other methods are sensitive to abrupt robot motion and accumulated drift in unstructured environments.”

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MARCH 13, 2025

# New map of landscape beneath Antarctica unveiled

by [British Antarctic Survey](#)



Bedmap3 reveals new insights into the topography of Antarctica. Credit: *Scientific Data* (2025). DOI: 10.1038/s41597-025-04672-y

The most detailed map yet of the landscape beneath Antarctica's ice sheet has been assembled by a team of international scientists led from the British Antarctic Survey (BAS).

Known as Bedmap3, it incorporates more than six decades of survey data acquired by planes, satellites, ships and even dog-drawn sleds. The results are [published](#) this week in the journal *Scientific Data*.

The map gives us a clear view of the white continent as if its 27 million cubic km of ice have been removed, revealing the hidden locations of the tallest mountains and the deepest canyons.

One notable revision to the map is the place understood to have the thickest overlying ice. Earlier surveys put this in the Astrolabe Basin, in Adélie Land. However, data reinterpretation reveals it is in an unnamed canyon at 76.052°S, 118.378°E in Wilkes Land.

The ice here is 4,757 m thick, or more than 15 times the height of the Shard, the U.K.'s tallest skyscraper.

Bedmap3 is now set to become an essential tool in the quest to understand how Antarctica might respond to a warming climate, because it enables scientists to study interactions between the ice sheet and the bed.

Dr. Hamish Pritchard, a glaciologist at BAS and lead author on the study detailing the new map, says, "This is the fundamental information that underpins the computer models we use to investigate how the ice will flow across the continent as temperatures rise. Imagine pouring syrup over a rock cake—all the lumps, all the bumps, will determine where the syrup goes and how fast. And so it is with Antarctica: some ridges will hold up the flowing ice; the hollows and smooth bits are where that ice could accelerate."

Bedmap3, as the name suggests, is the third attempt to draw a picture of Antarctica's rock bed that began in 2001, but this new effort represents a dramatic refinement. It includes more than double the number of previous data points (82 million), rendered on a 500 m grid spacing.



Removing the 27 million cubic km of ice that covers Antarctica, the hidden locations of the tallest mountains are revealed. Credit: *Scientific Data* (2025). DOI: 10.1038/s41597-025-04672-y

Big knowledge gaps have been filled by recent surveys in East Antarctica, including around the South Pole, along the Antarctic Peninsula and West Antarctic coastlines, and in the Transantarctic Mountains.

The outline of deep valleys is better represented. So too are those places where rocky mountains stick up through the ice. The latest satellite data have also more accurately recorded the height and shape of the ice sheet and the thickness of the floating ice shelves that push out over the ocean at the continent's margin.

The map also records a comprehensive new, continent-wide view of grounding lines—the places where ice at the edge of the continent meets the ocean and begins to float.

The landscape of the rock bed under Antarctica's ice is sensed by a variety of techniques, including radar, seismic reflection (sound waves) and gravity measurements.

Subtracting this topography from the shape and elevation of the ice above provides some fascinating statistics on the polar south.

- Total volume of Antarctic ice, including ice shelves: 27.17 million cu km
- Total area of Antarctic ice, including ice shelves: 13.63 million sq km
- Mean thickness of Antarctic ice, including ice shelves: 1,948 m. (Excluding ice shelves: 2,148 m)
- Potential global sea-level rise if all ice melted: 58 m

Peter Fretwell, mapping specialist and co-author at BAS, says, "In general, it's become clear the Antarctic Ice Sheet is thicker than we originally realized and has a larger volume of ice that is grounded on a rock bed sitting below sea-level. This puts the ice at greater risk of melting due to the incursion of warm ocean water that's occurring at the fringes of the continent. What Bedmap3 is showing us is that we have got a slightly more vulnerable Antarctica than we previously thought."

**More information:** Hamish D. Pritchard et al, Bedmap3 updated ice bed, surface and thickness gridded datasets for Antarctica, *Scientific Data* (2025). DOI: [10.1038/s41597-025-04672-y](https://doi.org/10.1038/s41597-025-04672-y)

**Journal information:** [Scientific Data](#)  
Provided by [British Antarctic Survey](#)

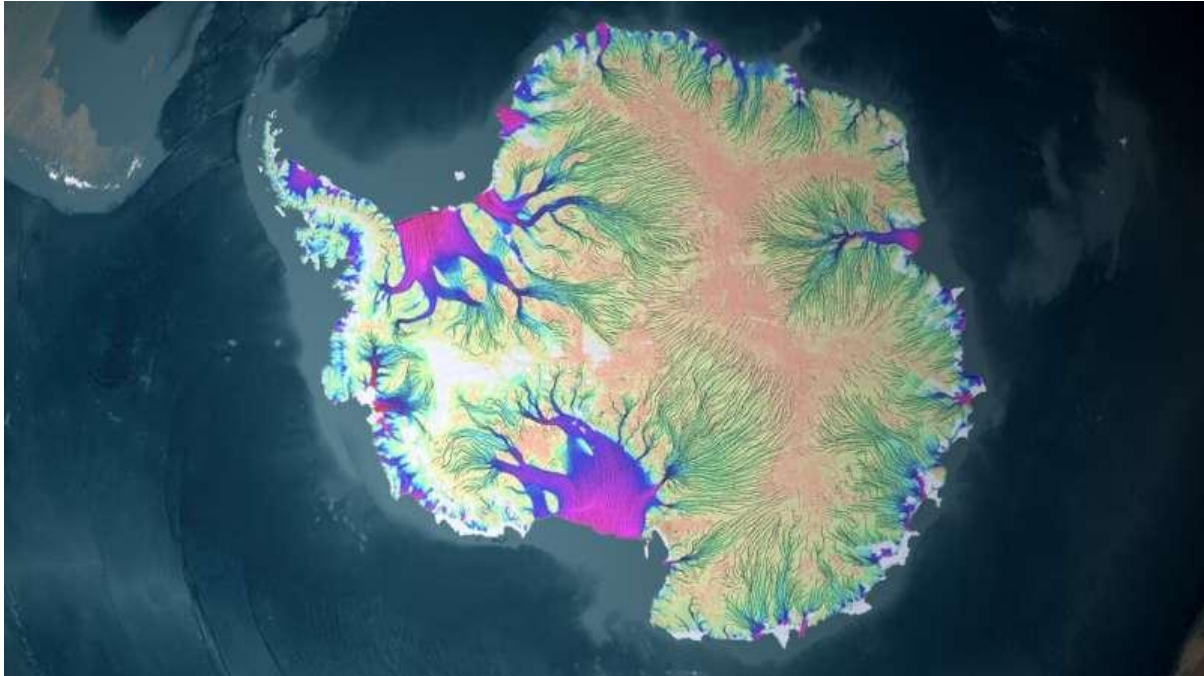
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MARCH 13, 2025

# AI reveals new insights into the flow of Antarctic ice

by [Stanford University](#)



This map, which shows glaciers and tributaries in patterned flows, was created using the same data that Stanford researchers used to train an AI model that revealed some of the fundamental physics governing the large-scale movements of the Antarctic ice sheet. (Image credit: NASA's Goddard Space Flight Center Scientific Visualization Studio). Credit: NASA's Goddard Space Flight Center Scientific Visualization Studio

As the planet warms, Antarctica's ice sheet is melting and contributing to sea-level rise around the globe. Antarctica holds enough frozen water to raise global sea levels by 190 feet, so precisely predicting how it will move and melt now and in the future is vital for protecting coastal areas.

But most [climate models](#) struggle to accurately simulate the movement of Antarctic ice due to sparse data and the complexity of interactions between the ocean, atmosphere, and frozen surface.

In a paper published in [Science](#), researchers at Stanford University used machine learning to analyze high-resolution remote-sensing data of ice movements in Antarctica for the first time.

Their work reveals some of the fundamental physics governing the large-scale movements of the Antarctic ice sheet and could help improve predictions about how the continent will change in the future.

"A vast amount of observational data has become widely available in the satellite age," said Ching-Yao Lai, an assistant professor of geophysics in the Stanford Doerr School of Sustainability and senior author on the paper.

"We combined that extensive observational dataset with physics-informed deep learning to gain new insights about the behavior of ice in its natural environment."

## **Ice sheet dynamics**

The Antarctic ice sheet, Earth's largest ice mass and nearly twice the size of Australia, acts like a sponge for the planet, keeping sea levels stable by storing freshwater as ice.

To understand the movement of the Antarctic ice sheet, which is shrinking more rapidly every year, existing models have typically relied on assumptions about the ice's mechanical behavior derived from laboratory experiments. But Antarctica's ice is much more complicated than what can be simulated in the lab, Lai said.

Ice formed from seawater has different properties than ice formed from compacted snow, and ice sheets may contain large cracks, air pockets, or other inconsistencies that affect movement.

"These differences influence the overall mechanical behavior, the so-called constitutive model, of the ice sheet in ways that are not captured in existing models or in a lab setting," Lai said.

Lai and her colleagues didn't try to capture each of these individual variables. Instead, they built a machine learning model to analyze large-scale movements and thickness of the ice recorded with satellite imagery and airplane radar between 2007 and 2018.

The researchers asked the model to fit the remote-sensing data and abide by several existing laws of physics that govern the movement of ice, using it to derive new constitutive models to describe the ice's viscosity—its resistance to movement or flow.

## **Compression vs. strain**

The researchers focused on five of Antarctica's ice shelves—floating platforms of ice that extend over the ocean from land-based glaciers and hold back the bulk of Antarctica's glacial ice.

They found that the parts of the ice shelves closest to the continent are being compressed, and the constitutive models in these areas are fairly consistent with laboratory experiments.

However, as ice gets farther from the continent, it starts to be pulled out to sea. The strain causes the ice in this area to have different physical properties in different directions—like how a log splits more easily along the grain than across it—a concept called anisotropy.

"Our study uncovers that most of the ice shelf is anisotropic," said first study author Yongji Wang, who conducted the work as a postdoctoral researcher in Lai's lab.

"The compression zone—the part near the grounded ice—only accounts for less than 5% of the [ice shelf](#). The other 95% is the extension zone and doesn't follow the same law."

Accurately understanding the ice sheet movements in Antarctica is only going to become more important as global temperatures increase—rising seas are already increasing flooding in low-lying areas and islands, accelerating coastal erosion, and worsening damage from hurricanes and other severe storms.

Until now, most models have assumed that Antarctic ice has the same physical properties in all directions. Researchers knew this was an oversimplification—models of the real world never perfectly replicate natural conditions—but the work done by Lai, Wang, and their colleagues shows conclusively that current constitutive models are not accurately capturing the ice sheet [movement](#) seen by satellites.

"People thought about this before, but it had never been validated," said Wang, who is now a postdoctoral researcher at New York University.

"Now, based on this new method and the rigorous mathematical thinking behind it, we know that models predicting the future evolution of Antarctica should be anisotropic."

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## AI for Earth science

The study authors don't yet know exactly what is causing the extension zone to be anisotropic, but they intend to continue to refine their analysis with additional data from the Antarctic continent as it becomes available.

Researchers can also use these findings to better understand the stresses that may cause rifts or calving—when massive chunks of ice suddenly break away from the shelf—or as a starting point for incorporating more complexity into ice sheet models.

This work is the first step toward building a model that more accurately simulates the conditions we may face in the future.

Lai and her colleagues also believe that the techniques used here—combining observational data and established physical laws with deep learning—could be used to reveal the physics of other natural processes with extensive observational data.

They hope their methods will assist with additional scientific discoveries and lead to new collaborations with the Earth science community.

"We are trying to show that you can actually use AI to learn something new," Lai said.

"It still needs to be bound by some physical laws, but this combined approach allowed us to uncover ice physics beyond what was previously known and could really drive a new understanding of Earth and planetary processes in a natural setting."

**More information:** Yongji Wang et al, Deep learning the flow law of Antarctic ice shelves, *Science* (2025). DOI:

[10.1126/science.adp3300](https://doi.org/10.1126/science.adp3300). [www.science.org/doi/10.1126/science.adp3300](https://www.science.org/doi/10.1126/science.adp3300)

**Journal information:** *Science*

Provided by [Stanford University](#)

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APRIL 2, 2025

# First ancient genomes from the Green Sahara deciphered

by [Max Planck Society](#)



View from the Takarkori rock shelter in Southern Libya. Credit: Archaeological Mission in the Sahara, Sapienza University of Rome

An international team led by researchers from the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, has sequenced the first ancient genomes from the so-called Green Sahara, a period when the largest desert in the world temporarily turned into a humid savanna-like environment.

The work is published in *Nature*.

By analyzing the DNA of two 7,000-year-old naturally mummified individuals excavated in the Takarkori rock shelter in southwestern Libya by the Archaeological Mission in the Sahara, Sapienza University of Rome, the team showed that they belonged to a long-isolated and now extinct North African human [lineage](#).

This group of cattle pastoralists has only a minor genetic component of non-African ancestry, suggesting that animal husbandry may have spread into the Green Sahara through [cultural exchange](#) rather than large-scale migrations. Moreover, the ancient genomes do not carry sub-Saharan African ancestry, suggesting that, contrary to previous interpretations, the Green Sahara was not a corridor connecting Northern and sub-Saharan Africa.

The study provides critical new insights into the African Humid Period, a time between 14,500 and 5,000 years ago when the Sahara desert was a green savanna, rich in water bodies that facilitated human habitation and the spread of pastoralism.

Later aridification turned this region into the world's largest desert. Due to the extreme aridity of the region today, DNA preservation is poor, making this pioneering ancient DNA study all the more significant.

Genomic analyses reveal that the ancestry of the Takarkori rock shelter individuals primarily derives from a North African lineage that diverged from sub-Saharan African populations at about the same time as the modern human lineages that spread outside of Africa around 50,000 years ago.

The newly described lineage remained isolated, revealing deep genetic continuity in North Africa during the late Ice Age. While this lineage no longer exists in unadmixed form, this ancestry is still a central genetic component of present-day North African people, highlighting their unique heritage.



• View of the Takarkori rock shelter in Southern Libya. Credit: Archaeological Mission in the Sahara, Sapienza University of Rome



- 7,000-year-old natural mummy found at the Takarkori rock shelter (Individual H1) in Southern Libya. Credit: Archaeological Mission in the Sahara, Sapienza University of Rome

## North Africa remained genetically isolated

Furthermore, these individuals share close genetic ties with 15,000-year-old foragers that lived during the Ice Age in Taforalt Cave, Morocco, associated with the Iberomaurusian lithic industry that predates the African Humid Period. Notably, both groups are equally distant from sub-Saharan African lineages, indicating that despite the Sahara's greening, gene flow between sub-Saharan and North African populations remained limited during the African Humid Period, contrary to previous suggestions.

The study also sheds light on Neandertal ancestry, showing that the Takarkori individuals have ten-fold less Neandertal DNA than people outside Africa, but more than contemporary sub-Saharan Africans.

"Our findings suggest that while early North African populations were largely isolated, they received traces of Neandertal DNA due to [gene flow](#) from outside Africa," said senior author Johannes Krause, director at the Max Planck Institute for Evolutionary Anthropology.

## The spread of pastoralism in the Green Sahara

"Our research challenges previous assumptions about North African population history and highlights the existence of a deeply rooted and long-isolated genetic lineage," said first author Nada Salem from the Max Planck Institute for Evolutionary Anthropology.

"This discovery reveals how pastoralism spread across the Green Sahara, likely through cultural exchange rather than large-scale migration."

"The study highlights the importance of ancient DNA for reconstructing human history in regions like Central Northern Africa, providing independent support to archaeological hypotheses," said senior author David Caramelli from the University of Florence.

"By shedding light on the Sahara's deep past, we aim to increase our knowledge of human migrations, adaptations, and cultural evolution in this key region," added senior author Savino di Lernia from Sapienza University in Rome.

**More information:** Ancient DNA from the Green Sahara reveals ancestral North African lineage, *Nature* (2025). DOI: [10.1038/s41586-025-08793-7](https://doi.org/10.1038/s41586-025-08793-7)

Mary Prendergast, Rare ancient DNA from Sahara opens a window on the region's verdant past, *Nature* (2025). DOI: [10.1038/d41586-025-00755-3](https://doi.org/10.1038/d41586-025-00755-3) , [doi.org/10.1038/d41586-025-00755-3](https://doi.org/10.1038/d41586-025-00755-3)

**Journal information:** [Nature](#)  
Provided by [Max Planck Society](#)

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APRIL 5, 2025

# How we used AI to trace the evolution of bacteria on Earth



Credit: CC0 Public Domain

Bacteria are the [most diverse organisms](#) on Earth, with a number of species that's difficult to quantify. They're also incredibly old

Bacteria consist of a single cell. They do not have bones and are not like big animals that leave clear signs in the [geological record](#), which thankful paleontologists can study many millions of years later.

This has made it very hard for scientists to establish a timeline of their early evolution. But with the help of machine learning, we have been able to fill in many of the details. Our new research, [published today in Science](#), also reveals some [bacteria](#) developed the ability to use oxygen long before the Earth became saturated with it roughly 2.4 billion years ago.

## A monumental event in Earth's history

About 4.5 billion years ago, the moon formed. Violently. A Mars-size object collided with Earth, turning its surface into molten rock. If life existed before this cataclysm, it was probably destroyed.

After that, the current ancestors of all living beings appeared: single-celled microbes. For the first 80% of life's history, the Earth was inhabited solely by these microbes.

Nothing in biology makes sense except in the light of evolution, as evolutionary biologist Theodosius Dobzhansky [famously said](#) in 1973. But how did the evolution of life proceed through the early history of the Earth?

Comparing DNA sequences from the wonderful diversity of life we see today can tell us how different groups relate to each other. For instance, we humans are more closely related to mushrooms than we are to apple trees. Likewise, such comparisons can tell us how different groups of bacteria are related to each other.

But comparison of DNA sequences can only take us so far. DNA comparisons do not say when in Earth's history evolutionary events took place. At one point in time, an organism reproduced two offspring. One of them gave rise to mushrooms, the other to humans (and lots of other species too). But when exactly did that organism live? How many years ago?

One thing geology teaches us about is the existence of another monumental event in the history of Earth, 2.4 billion years ago. At that time, the atmosphere of Earth changed dramatically. A group of bacteria called the cyanobacteria invented a trick that would alter the story of life forever: photosynthesis.

Harvesting energy from the sun powered their cells. But it also generated an inconvenient waste product, oxygen gas.

Over the course of millions of years, oxygen in the atmosphere slowly accumulated. Before this "Great Oxidation Event," the Earth contained almost no oxygen, so life was not ready for it. In fact, to uninitiated bacteria, oxygen is a poisonous gas, and so its release into the atmosphere probably caused a mass extinction. The surviving bacteria either evolved to use oxygen, or retreated into the recesses of the planet where it doesn't penetrate.

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## The bacterial tree of life

The Great Oxidation Event is especially interesting for us not only because of its impact on the history of life, but also because it can be given a clear date. We know it happened around 2.4 billion years ago—and we also know most bacteria that adapted to oxygen had to live after this event. We used this information to layer on dates to the bacterial tree of life.

We started by training an [artificial intelligence](#) (AI) model to predict whether a bacteria lives with oxygen or not from the genes it has. Many bacteria we see today use oxygen, such as cyanobacteria and others that live in the ocean. But many do not, such as the bacteria that live in our gut.

As far as machine learning tasks go, this one was quite straightforward. The chemical power of oxygen markedly changes a bacteria's genome because a cell's metabolism becomes organized around oxygen use, and so there are many clues in the data.

We then applied our machine-learning models to predict which bacteria used oxygen in the past. This was possible because modern techniques allow us to estimate not only how the species we see today are related, but also which genes each ancestor carried in its genome.

## A surprising twist

By using the planet-wide geological event of the Great Oxidation Event effectively as a "fossil" calibration point, our approach produced a detailed timeline of bacterial evolution.

Combining results from geology, paleontology, phylogenetics and [machine learning](#), we were able to refine the timing of bacterial evolution significantly.

Our results also revealed a surprising twist: some bacterial lineages capable of using oxygen existed roughly 900 million years before the Great Oxidation Event. This suggests these bacteria evolved the ability to use oxygen even when atmospheric oxygen was scarce.

Remarkably, our findings indicated that cyanobacteria actually evolved the ability to use oxygen before they developed photosynthesis.

This framework not only reshapes our understanding of bacterial evolutionary history but also illustrates how life's capabilities evolved in response to Earth's changing environments.

**Journal information:** [Science](#)  
Provided by [The Conversation](#)

# Scientists Just Proved That All Life on Earth Follows One Simple Rule

A new study provides empirical evidence for a rule explored by biogeographers for centuries. PUBLISHED: JUN 19, 2025



Here's what you'll learn when you read this story:

- The organization of life on Earth follows a simple, hidden rule known as “core-to-transition organization.”
- Hypothesized by biogeographers for centuries, a new study finally finds empirical evidence of this phenomenon using geographic dispersion data across five separate taxa.

- This shows how a majority of species originate from “core regions,” but those species suitable to heat and drought often colonize areas beyond those regions.
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The Earth is home to incredibly remarkable and diverse **biomes** that host millions of species worldwide. (George Lucas managed to create an entire galaxy far, far away for *Star Wars* using just **the natural wonders mostly found in the state of California**.) Although life appears relatively well-distributed across countries and continents—barring Antarctica, of course—a new study suggests that biodiversity isn’t so much an evenly distributed blanket across the planet as it is a “core-to-transition” organization.

This is the insight gleaned from a new article—published earlier this month in the journal **Nature Ecology & Evolution**—analyzing how organisms are divided into biogeographical regions, or bioregions, across the planet’s surface. An international team of scientists from Sweden, Spain, and the U.K. examined the global distribution maps of species across a variety of limbs on the **tree of life**, including amphibians, birds, dragonflies, mammals, marine rays, reptiles, and even trees. Because of this vast swath of differing types of life, the researchers expected that species distribution would vary wildly due to environmental and historical factors.

However, what they discovered is that life all around the world proliferates through a very similar process. First, there is a core area where life appears to flourish, and from there, species tend to radiate outward—hence “core-to-transition” organization.

“In every bioregion, there is always a core area where most species live,” Rubén Bernardo-Madrid, a co-author of the study from Umeå University, **said in a press statement**. “From that core, species expand into surrounding areas, but only a subset manages to persist. It seems these cores provide optimal conditions for **species** survival and diversification, acting as a source from which biodiversity radiates outward.”

These “core” regions are immensely important, as they only cover about 30 percent of the world’s surface but contain more biodiversity than the other 70 percent. These regions likely evolved because they were originally refuges from the devastation brought on by past climatic events, such as the **Last Glacial Maximum**. The study also shows that overall species must be well adapted for heat and drought to colonize new areas beyond these core bioregions.

“The predictability of the pattern and its association with environmental filters can help to better understand how [biodiversity](#) may respond to global change,” Joaquín Calatayud, co-author of the study from Rey Juan Carlos University, said in a press statement.

## Plants have a secret, second set of roots deep underground that scientists didn't know about

News By [Olivia Ferrari](#) published 3 days ago

A global analysis deep in soil found 20% of plants studied have an unexpected deeper set of roots more than 3 feet underground.



Around 20% of plants have a second set of roots deep underground, new research shows. (Image credit: EyeEm Mobile GmbH/Getty Images)

Our understanding of plant and tree roots may have been somewhat shallow. New research reveals many [plants](#) have a hidden second set of roots that extend far deeper into the soil. According to a new study published June 17 in the journal [Nature Communications](#), this second layer of roots extend over 3 feet (1 meter) down and enable the plant to access deeper soil nutrients.

The findings suggest plants might transport and store carbon deeper in the ground than expected, which could help scientists develop longer-term underground carbon storage to mitigate [climate change](#) impacts.

To analyze these deeper rooting systems on a large scale, the researchers used a database of soil samples collected from more than 6 feet (1.8 m) below the surface. From this, they

detected root patterns and soil composition from 44 sites. These sites were from a range of climate zones and ecosystems across the globe, from the Alaskan tundra to rainforests in Puerto Rico.

The findings showed about 20% of the sites around the world had roots that peaked in mass twice along their depth, meaning these plants had a second, deeper system of roots — a phenomenon the researchers call "bimodality."

"We were very surprised by how frequently we find bimodal patterns," study lead author [Mingzhen Lu](#), an ecologist at New York University, told Live Science in an email. For a long time scientists assumed plants had fewer and fewer roots as they went deeper into the ground, Lu said.

The second layer of roots typically reached soils rich in nutrients like nitrogen, enabling plants to tap into these deep-soil resources. Plants get most of their resources from surface soil, for example through rainfall or leaves falling on the ground, Lu said. But a deeper, secondary way to tap into nutrients could boost the resources available to plants if they're not sufficient at the surface.

As only 1 in 5 plants had these roots, this could indicate an opportunistic response given particular conditions, like drier or more unreliable water in surface soil. "It is more of a choice," Lu explained. "Given enough motivation... plants will explore deeper and make use of these deep resources."

Soil scientists need to look deeper to understand what's actually happening underground, the researchers said. "Sampling 10 centimeters [4 inches] deep, or 30 centimeters [12 inches], simply won't cut it," Lu said. "We just miss too much of what's actually going on in the soil."

The idea that plants have deeper roots is not new, [Alain Pierret](#), a soil scientist at the French National Research Institute for Sustainable Development who was not involved with the new study, told Live Science in an email. The traditional theory of diminishing roots deeper into the ground [has previously been questioned](#), and the deep rooting phenomenon [has been studied](#), but not in sufficient detail, Pierret added.

"What is new and remarkable is the dedicated network of field stations used to observe relatively deep root profiles across a range of biomes," Pierret said. He added that more work is needed to fully understand what's going on in these deep rooting systems, and that the deep root systems are probably not only bimodal but likely multi-modal, with even more roots deeper into the ground below the depth the new study focused on.

The findings also mean scientists may have underestimated the potential for carbon storage in soil, according to the researchers. Soil can hold more carbon than the atmosphere, so some climate mitigation measures focus on crops that take in carbon from the air and store it in roots and soil.

"Our current terrestrial carbon budget [is] most likely incorrect, with potentially significant implications for climate change mitigation strategies and policies," Pierret said. The research team is now investigating what these findings mean for carbon storage. "The good

news is plants may already be naturally mitigating climate change more actively than we've realized," Lu said in a [statement](#). "We just need to dig deeper to fully understand their potential."