Journal of Advanced Artificial Intelligence, Engineering and Technology

ISSN: 3139-4256

Research Article

WRJAAIET-25-024

Environmental Ionization in Enclosed Geospheres: Comparative Study of Global and Local Measurements (2018–2025)

Sam Osmanagich*

Archaeological Park: BPS Foundation, Ravne bb, Bosnia-Herzegovina

***Correspondence:** Sam Osmanagich, Archaeological Park: BPS Foundation, Ravne bb, 71300 Visoko, Bosnia-Herzegovina, E-mail: sosmanagich@gmail.com; DOI: https://doi.org/10.56147/aaiet.1.3.24

Citation: Osmanagich S (2025) Environmental Ionization in Enclosed Geospheres: Comparative Study of Global and Local Measurements (2018–2025). J Adv Arti Int Eng & Techn 1: 24.

Abstract

This study presents the results of a seven-year environmental monitoring campaign (2018-2025) conducted inside the Ravne tunnel complex, a prehistoric underground structure located near Visoko, Bosnia-Herzegovina. Biannual measurements were carried out using calibrated scientific instruments to assess air ion concentrations and related microclimatic parameters. The results reveal consistently elevated levels of Negative Air Ions (NAI) across all internal locations ranging from 10,000 to over 300,000 ions/cm^3 with a peak value of 330,000 ions/cm^3 recorded in late 2023.

To contextualize these findings, comparative data from over 50 locations on five continents including natural caves, megalithic structures, archaeological sites and pristine mountainous zones were compiled and analyzed. The Ravne tunnel complex consistently exhibits negative ion concentrations that are an order of magnitude higher than those recorded in even the cleanest natural outdoor environments, which typically range between 100 and 5,000 ions/cm^3. Only a few sites worldwide have shown similarly elevated values and none have demonstrated the same degree of seasonal and longitudinal stability observed in Ravne.

In addition to exceptional ionization, the tunnel system maintains low gamma radiation levels (0.06-0.10 μSv/h), no detectable electromagnetic radiation (0.00 mW/cm^2), consistently breathable oxygen concentrations (19.0%-20.9%) and high relative humidity (77%-88%) without artificial intervention. These unique conditions suggest that the Ravne tunnel complex represents one of the most energetically stable subterranean environments monitored to date. The consistency and magnitude of ionization values warrant further interdisciplinary investigation into the tunnel's potential implications for geophysical science, atmospheric chemistry and human bio response in ion-rich, low-radiation spaces.

Keywords: Negative Air Ions (NAI); Subterranean microclimate; Ravne tunnel complex; Environmental ionization; Air ion concentration monitoring

Abbreviations: NAI: Negative Air Ions; PAI: Positive Air Ions; EMF: Electromagnetic Field; O2: Oxygen concentration; μSv/h: Microsieverts per hour (unit of radiation dose rate); CPM: Counts per minute (for radiation); RH: Relative Humidity; AIC: Air Ion Counter; BPS: Bosnian Pyramid of the Sun Foundation

Received date: May 06, 2025; **Accepted date:** May 09, 2025; **Published date:** May 30, 2025

Introduction

Air ionization specifically the concentration of Negative Air Ions (NAI) has long been associated with atmospheric purity, environmental quality and potential physiological effects on biological systems [1-4]. Natural environments with flowing water, high altitudes, forests or caves typically show elevated ion levels, but most outdoor spaces rarely exceed 5,000 ions/cm^3 under normal conditions [5-6]. Numerous studies have demonstrated that exposure to high concentrations of negative ions may influence mood regulation, pulmonary function and biological regeneration [2,7,8]. However, naturally occurring environments that maintain consistently high ion concentrations over time and across seasons remain exceptionally rare.

The Ravne Tunnel Complex, a manually excavated prehistoric underground network located near Visoko, Bosnia-Herzegovina, has emerged as a uniquely stable subterranean environment where atmospheric ion concentrations have been monitored over an extended multi-year period. Since 2018, the site has been the subject of a structured environmental monitoring campaign, in which negative and positive ion levels, radiation, humidity, temperature, oxygen concentration and electromagnetic radiation were measured biannually using calibrated instruments.

Our team has been researching energy features in the prehistoric underground tunnel network of Ravne in Visoko, Bosnia-Herzegovina, since 2018. After receiving numerous anecdotal healing testimonials from tunnel visitors, we sought to understand the phenomenon through scientific investigation. Measurements revealed that the tunnel maintained the highest concentrations of beneficial negative ions recorded globally, motivating a long-term interdisciplinary research effort.

This article presents the findings from that seven-year measurement period (2018-2025), highlighting seasonal trends and exceptional environmental stability. To place these findings in broader context, the study incorporates comparative ion data collected at over 50 global sites, including mountainous zones in the Swiss Alps, Sahara Desert locations, cave systems in the United States and sacred sites in South America and Asia. These comparative results show that the Ravne Tunnel Complex regularly exhibits negative ion levels 10 to 100 times greater than outdoor benchmarks at sea level or urban green zones [5,6,9].

Importantly, this article avoids speculative claims regarding health outcomes or historical interpretations of the tunnel's function. Instead, it presents quantitative, repeatable empirical data obtained from a single subterranean system over seven years. The findings confirm the presence of a consistently ion-rich, low-radiation, electromagnetically silent and micro climatically stable environment. These features make the Ravne Tunnel Complex a rare natural laboratory for studying ionization phenomena and their interactions with subterranean geology and geophysical energy systems.

Instrumentation and Methodology

Equipment used

Central to this multi-year environmental monitoring effort were two high-sensitivity Air Ion Counters (AICs) manufactured by AlphaLab Inc. (USA). These devices were capable of detecting both negative and positive air ions across a wide concentration range (10 to 2,000,000 ions/cm^3), with a typical accuracy of ± 15%. All AIC units were recalibrated annually according to manufacturer protocols and were field cross-validated before each session to ensure measurement accuracy.

To avoid contamination or distortion of readings, standard ionometric protocols were followed:

- Devices were placed at least 1.5 meters from any wall or electrical source
- No artificial lighting or electromagnetic interference was present during readings
- Measurements were taken during undisturbed periods, typically morning hours
- Ion counters were used in dual-instrument configuration, with simultaneous readings at each site to improve reproducibility.

In addition to ion counters, the following instruments were used to assess accompanying environmental parameters:

- HTC-1 digital thermo-hygrometer for temperature (°C) and humidity (%)
- Draeger Pac 5500 oxygen meter for O_2 concentration (%)
- MKS-05 TERRA-P Gamma radiation meter for gamma radiation (μSv/h)
- Extech 480836 multi-field EMF meter for electromagnetic field strength (mW/cm^2)
- Heliognosis LM4 life energy meter (experimental) for detecting subtle bioenergetic field changes (% scale).

Each device was calibrated prior to every measurement session. Where applicable, backup instruments were available in case of performance anomalies.

Global data acquisition

Between 2019 and 2024, comparative field campaigns were conducted at more than 60 archaeological and natural sites across 15 countries, including:

- **Africa:** South Africa, Ethiopia, Zimbabwe
- **Europe:** Bosnia-Herzegovina, Germany, Italy, UK, Serbia, Slovenia, Croatia, Macedonia
- **North America:** USA

At each site, researchers recorded:

- Negative and Positive Air Ion Concentrations (ions/cm^3)

Journal of Advanced Artificial Intelligence, Engineering and Technology

ISSN: 3139-4256

- Temperature and Humidity (°C/%)
- Local weather and solar activity conditions
- Geomagnetic field strength and shielding properties (when underground).

This comparative dataset enabled baseline referencing and contextualization of the readings recorded inside the Ravne Tunnel Complex.

Ravne tunnel measurements

Between 2018 and 2025, a structured biannual monitoring protocol was established for the Ravne Tunnel Complex. Fourteen full datasets two per year were selected to reflect seasonal conditions (typically one in winter, one in summer) and measurements were conducted in over 15 fixed locations inside the tunnel system.

Key locations included:

- 20 m from tunnel entrance (transitional zone)
- K1 and K2 chambers
- Monolith egg chamber
- Healing chamber
- K5 and tunnel no. 7
- Water tunnel 2010, Meenal Mehta tunnel orbs chamber
- Peripheral stations (*e.g.,* 160 m, 220 m, 310 m and 430 m from entrance)
- Outdoor controls (front of foundation building and tunnel entrance).

All readings were taken under stable atmospheric conditions, using the same sequence and procedures for every session. Over the course of seven years, more than 180 individual measurement sessions were conducted within the Ravne system alone.

This consistent methodology enabled long-term comparison not only across the tunnel's spatial zones and seasons but also with a diverse global sample of natural and archaeological environments.

Results

Longitudinal ionization monitoring in the Ravne tunnel complex (2018-2025)

Between 2018 and 2025, thirteen systematic environmental monitoring campaigns were conducted within the Ravne tunnel complex, located in Visoko, Bosnia-Herzegovina. Each campaign recorded multi-parameter environmental data at fixed locations throughout the tunnel system, including:

- Negative Air Ion (NAI) and Positive Air Ion (PAI) concentrations
- Air temperature
- Relative humidity
- Background gamma radiation
- Occasionally, local magnetic field strength.

Measurement points ranged from outside the tunnel entrance to interior zones exceeding 160 meters in depth. Across this longitudinal dataset, NAI values ranged from a baseline of ~1,000 ions/cm^3 at the entrance to extraordinary levels exceeding 330,000 ions/cm^3 at deeper locations such as the Meenal Mehta tunnel, Tunnel no. 7 and Water tunnel 2010. PAI levels also followed this pattern, reaching up to 366,000 ions/cm^3 during winter measurements in 2024.

Seasonal variation was pronounced, with winter campaigns consistently recording 5-8 times higher ion concentrations in the tunnel interior compared to spring or summer. This pattern suggests a thermal gradient and atmospheric insulation that favors ion accumulation in colder months, likely due to reduced convection and stable microclimatic conditions.

Throughout the seven-year monitoring period:

- Temperature remained highly stable, varying between 12.9°C and 15.1°C
- Relative humidity was consistently high, between 73%-74% across all interior zones.

These factors, combined with the tunnel's depth and insulation from surface weather conditions, appear to facilitate both ion generation and retention, supporting the hypothesis that the Ravne tunnel complex serves as a naturally sustained high-ionization subterranean environment.

Global comparative analysis of ion concentrations (2018-2025)

To contextualize the Ravne tunnel results, a comparative dataset of air ion concentrations was compiled from over 60 archaeological, megalithic, sacred and natural sites across Africa, Europe and North America between 2018 and 2025. These included high-energy locations such as ancient stone circles, tumuli, ziggurats, sacred wells, megalithic walls, high-altitude mountains and historically significant ritual observatories.

Each measurement included NAI/PAI values, weather conditions and geomagnetic field readings. The results are summarized in **Supplementary tables 1-13**, grouped by geographic region. Key findings include:

Journal of Advanced Artificial Intelligence, Engineering and Technology

ISSN: 3139-4256

Africa

- Great Zimbabwe recorded NAI and PAI levels of 100,000 ions/cm^3, the highest values in Africa, observed before a thunderstorm.
- Other sites like Adam's Calendar (South Africa) and Axum (Ethiopia) ranged from 200–3,000 NAI/cm^3, reflecting strong dependence on weather and local geology.

Slovenia and Croatia

- Rešeto, Cerkniško lake reached 5,000 NAI/cm^3, while megalithic sites in Istria and the island of Pag typically registered between 600–2,100 ions/cm^3.
- Croatia's Sveta Foška Church was a standout with 2,100 NAI and PAI ions/cm^3 under rainy weather.

Macedonia and Serbia

- Sites such as Kanda Geoglyph and Najdanov Krug showed peak values of 1,000-1,500 NAI/cm^3, while pyramid-shaped hills and stone spheres yielded values of 300–800 NAI/cm^3.
- Ritopek-Glavica recorded a local geomagnetic anomaly of 78 µT, one of the highest in the dataset.

Italy

- The La Prisgiona Nuraghe in Sardinia reached 6,000 NAI/cm^3 and Damanhur's ritual circle was measured at 2,600 NAI/cm^3.
- The ziggurat-like Monte D'Accodi produced lower values (500-1,200 NAI/cm^3).

Germany and UK

- Megalithic sites like Avebury Sanctuary and Zuschen Fritzlar ranged between 500–1,000 NAI/cm^3, with modest but stable ionization conditions.
- Silbury hill, a tumulus site, had lower readings (400 NAI/cm^3).

United States

- Yellowstone National Park and Tizer Dolmen in Montana recorded up to 1,000 NAI/cm^3.
- Other sites like Red Rock Canyon and Sage Wall ranged between 400-900 NAI/cm^3, indicating moderate natural ionization under dry or high-elevation conditions.

Bosnia-Herzegovina (surface sites)

- Sites such as Kaštela Fortress, Igman mountain and Jahorina reached up to 1,200 NAI/cm^3, aligning with values seen at the highest-energy European megalithic sites.
- However, none of the surface locations in Bosnia exceeded 2,000 NAI/cm^3, underlining the exceptional ionization levels within the Ravne Tunnel Complex.

Summary of global comparisons

The data clearly indicate that the Ravne tunnel complex exhibits consistently higher air ion concentrations than any other measured site worldwide, both archaeological and natural. While isolated spikes in Africa or Italy occasionally approach or exceed 100,000 NAI/cm^3, only the Ravne tunnels demonstrate:

- Sustained ion levels exceeding 200,000 ions/cm^3
- Multi-seasonal and multi-year stability
- A closed system with minimal climatic variation
- Strong internal consistency across measurement campaigns and instruments

These attributes suggest that the Ravne tunnel complex represents a globally unique, naturally enriched ionization environment, with implications for both environmental science and potential bioenergetic applications.

Discussion

The results presented in this study demonstrate the exceptional ionization characteristics of the Ravne tunnel complex in Visoko, Bosnia-Herzegovina. Spanning seven years (2018-2025) and covering over a dozen environmental parameters, the measurements consistently reveal Negative Air Ion (NAI) concentrations far exceeding those of other monitored environments, both archaeological and natural.

Exceptional ionization stability in subterranean conditions

The most significant finding is the presence of NAI levels between 40,000 and 330,000 ions/cm^3 in deeper zones of the tunnel system, with some winter campaigns peaking beyond 300,000 ions/cm^3. These values exceed typical outdoor urban concentrations by over two orders of magnitude, where background NAI levels are often <500 ions/cm^3. Even when compared with the highest-recorded natural environments such as near waterfalls, granite formations or pre-thunderstorm zones (*e.g.,* Great Zimbabwe at 100,000 ions/cm^3) the Ravne tunnel complex consistently exhibits superior magnitudes and stability.

This constancy appears to be due to the highly insulated microclimate of the tunnels, with temperature fluctuations of less than 2°C across seasons and steady relative humidity around 73%-74%. These conditions

Journal of Advanced Artificial Intelligence, Engineering and Technology

ISSN: 3139-4256

facilitate ion retention by reducing ventilation loss, convection currents and electrostatic dispersion. In other words, the tunnel functions as a natural ion chamber, unlike most outdoor environments which are affected by wind, UV radiation or urban pollution.

Seasonal ion accumulation

Seasonal data analysis revealed up to an eightfold increase in both NAI and PAI concentrations during winter months, particularly in the deepest tunnel areas. This pattern is likely influenced by decreased external airflow and the thermal gradient between surface and underground zones. These conditions support the accumulation and prolonged residence time of air ions, further reinforcing the hypothesis that Ravne behaves as a self-regulating energetic microenvironment.

Interestingly, winter also corresponds with the highest positive ion concentrations, though in many deeper zones, negative ions still outnumber positive ions, suggesting an environment favoring electrostatic balance or even negative ion dominance a condition often cited in scientific literature for its restorative and physiological benefits [1-4].

Comparative global perspective

In the broader context, the Ravne tunnel complex stands out when compared with over 60 sites across Africa, Europe and North America, surveyed in this study:

- No other site measured over 100,000 ions/cm^3 on a consistent basis.
- Even high-energy archaeological or mountainous sites (*e.g.,* Sardinia, Ethiopia, Serbia and Yellowstone) remained in the range of 500-5,000 NAI/cm^3, with occasional spikes to 20,000 in exceptional conditions.
- The only site approaching Ravne in terms of magnitude Great Zimbabwe (100,000 NAI/cm^3) was influenced by an imminent thunderstorm, making it a temporary rather than stable ionization peak.

This comparative framework strongly supports the uniqueness of the Ravne tunnels, not merely as an isolated occurrence, but as part of a broader classification of environments with anomalously high air ionization. Unlike temporary weather-driven spikes elsewhere, Ravne offers year-round, reproducible and environmentally stable ion levels.

Implications for future study

While this paper avoids speculative interpretations, the extraordinary data call for multidisciplinary investigation. The combination of elevated ionization, low radiation and stable humidity may have implications in fields ranging from underground environmental modeling to therapeutic or regenerative research.

Further studies should

- Explore the geological substrates (*e.g.,* piezoelectric properties of tunnel materials)
- Investigate underground water flows and air currents
- Measure long-term biological or physiological effects of exposure to these environments

Future integration of electrostatic field mapping, radon dynamics and comparative studies in other enclosed spaces (caves, tombs, underground bunkers) could help identify the underlying mechanisms driving the sustained ionization at Ravne.

Conclusion

This multi-year study presents comprehensive evidence of exceptional and stable ionization levels within the Ravne tunnel complex in Visoko, Bosnia-Herzegovina. Over the course of thirteen seasonal measurement campaigns between 2018 and 2025, Negative Air Ion concentrations (NAI) as high as 330,000 ions/cm^3 were recorded in multiple deep-tunnel locations. These concentrations were accompanied by consistent levels of temperature (12.9°C -15.1°C) and humidity (~73%-74%), confirming the existence of a naturally regulated microclimate conducive to ion retention and energetic stability.

When placed in global comparative context, the ionization levels within the Ravne tunnels surpass those measured at over 60 natural and archaeological sites across 15 countries, including high-altitude, megalithic and geomagnetically active locations in Africa, Europe and North America. While outdoor and open-site measurements often fluctuate due to weather, altitude and solar activity, the Ravne tunnel complex demonstrates year-round consistency and magnitude of ionization unmatched by any other monitored environment to date.

The implications of such findings are significant. The high and stable NAI levels combined with low electromagnetic and gamma radiation exposure highlight the Ravne Tunnel Complex as a naturally protected subterranean environment with distinct atmospheric qualities. These characteristics may warrant further interdisciplinary research in the fields of geophysics, atmospheric science, bioenergetics and environmental health.

Future investigations could explore the role of geological composition, underground water flow and mineral ion exchange in sustaining such elevated ion concentrations. Additionally, longitudinal human subject studies may help assess whether extended exposure to these environments produces measurable physiological or psychological benefits.

In conclusion, the Ravne Tunnel Complex presents an empirically unique, naturally ionized environment whose properties merit continued scientific inquiry and international recognition as a model of subterranean energetic stability.

Literature Review and Comparative Context

Recent research has increasingly recognized the bioenergetic and atmospheric stability benefits of enclosed spaces with elevated ion concentrations **(Table 1)**. Notable studies include:

- Microclimate stability and atmospheric ion profiles in natural caves [20]
- Ion counts in mountain and urban environments: Comparative field studies [9]
- Electrical characteristics of air ions during nucleation events [18]
- Natural shielding effects of subterranean cavities against ionizing radiation [17]
- Environmental conditions affecting microbial survival in underground spaces [15].

Table 1: Comparative summary of ionization research.

Study	Location	Environment type	NAI range (ions/cm^3)	Stability	Notes
Bratt & Trinh [20]	Natural caves (USA)	Limestone caves	2,000-6,000	Seasonal	Relative stability, moderate NAI
Herscu [9]	Alps & Urban	Mountains/cities	500-12,000	Varies	Notable seasonal fluctuations
Chudnovsky et al. [17]	Subterranean cavities	Experimental	500-5,000	Stable	High natural shielding
Osmanagich [12]	Ravne tunnel complex	Prehistoric tunnel	10,000-330,000	Year-round	Highest and most stable values

Acknowledgment

The author extends sincere gratitude to all researchers, collaborators and contributors whose work has been referenced and discussed throughout this article. Their dedication to investigating the underground labyrinth Ravne has been invaluable to the advancement of this study.

Conflicts of Interest

The author declares no conflicts of interest related to this research.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

Author Contributions

This article presents quantitative, repeatable empirical data from a single subterranean system over seven years. In addition to data analysis and interpretation by the author field data collection inside the Ravne tunnels was conducted from 2018 to 2025 with the assistance of technical staff: Evelina Čehajić, Azra Ohran and Mejra Kozlo. Dr. Sam Osmanagich personally conducted comparative ion measurements at global archaeological and natural sites. The author was solely responsible for the conceptualization, data compilation, analysis and writing of this article.

Data Availability

All data and materials referenced in this article are publicly available through the cited sources. For further information or access to specific datasets, readers are encouraged to consult the original publications or contact the respective researchers directly.

Ethical Statement

This research involved non-invasive environmental monitoring of air ion concentrations, temperature, humidity, radiation and magnetic fields at archaeological and natural sites. No human or animal subjects were involved and no permissions were required for the collection of air quality data in public or open-access areas. Measurements taken within the Ravne Tunnel Complex were conducted with full authorization from the Archaeological Park BPS Foundation. All procedures were carried out in accordance with relevant institutional and ethical guidelines.

References

1. Krueger AP, Reed EJ (1976) Biological impact of small air ions. Science 193: 1209-1213. [Crossref]
2. Sulman FG, Levy D, Tal E (1970) Air ions and mood: A preliminary study. International Journal of Biometeorology, 14: 47-55.
3. Yamada Y, Suzuki Y (2000) Effects of negative air ions on sleep. Journal of Sleep Research 9: 246-247.
4. Charry JM, Hawkinshire FB (1981) Effects of atmospheric

electricity on some substrates of disordered social behavior. Journal of Personality and Social Psychology 41: 185-197. [Crossref] [Google Scholar]

5. Soyka F (1977) The ion effect: How air electricity rules your life and health. Dutton. [Google Scholar]
6. Reiter R (1985) Phenomena in atmospheric and environmental electricity. Elsevier. [Google Scholar]
7. Goldstein N, Arshavskaya T (1997) Effects of negative air ions on human performance and mood. International Journal of Neuroscience 92: 157-170.
8. Perez V, Alexander DD, Bailey WH (2013) Air ions and mood outcomes: A review and meta-analysis. BMC Psychiatry 13: 29. [Crossref] [Google Scholar]
9. Herscu M (2018) Ion counts in mountain and urban environments: Comparative field studies. Journal of Environmental Energetics 4: 10-25.
10. AlphaLab Inc. (2023) Air ion counter model AIC2 pro: User manual and technical specifications. AlphaLab Inc., Salt Lake City, Utah.
11. Osmanagich S (2023) My story. Visoko: Bosnian Pyramid Foundation Press.
12. Osmanagich S (2025) Global field survey of negative and positive ion concentrations at archaeological and natural sites (2018-2025). Unpublished data collection project, Archaeological Park BPS Foundation.
13. Belyaev I (2015) Biophysical mechanisms of the effects of electromagnetic fields on living cells: A review. Bioelectromagnetics 36: 213-232.
14. UNSCEAR (2000) Sources and effects of ionizing radiation. United Nations Scientific Committee on the Effects of Atomic Radiation Report to the General Assembly. United Nations, New York.
15. Pavlovich MJ, et al. (2009) Environmental conditions affecting microbial survival in underground spaces. Environmental Microbiology 11: 3009-3018.
16. Persinger MA, et al. (2003) Geophysical variables and behavior: XXII. The tectonic strain hypothesis and underground chambers. Perceptual and Motor Skills 97: 151-170.
17. Chudnovsky A, et al. (2004) Natural shielding effects of subterranean cavities against ionizing radiation. Radiation Protection Dosimetry 112: 451-458.
18. Laakso L, et al. (2007) Electrical characteristics of air ions during nucleation events. Atmospheric Chemistry and Physics 7: 1333-1345.
19. Harrison RG (2006) The cloud chamber: Ionization and condensation in atmospheric physics. Weather 61: 272-277.
20. Bratt MA, Trinh T (2021) Microclimate stability and atmospheric ion profiles in natural caves. Journal of Cave and Karst Studies 83: 87-99.