Mathematical Correspondence Between the Bosnian Valley of the Pyramids and the Pleiades Star Cluster: A Fibonacci-Ratio and Spatial-Alignment Study

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Abstract

Advances in geomatics and computational astronomy enable rigorous quantitative analysis of potential terrestrial–celestial spatial correspondences. This study investigates whether summit-point distributions in the Bosnian Valley of the Pyramids exhibit statistically meaningful geometric similarities with the angular configuration of the Pleiades star cluster (M45). Using LiDAR-derived elevation models, geodetic summit coordinates, and astronomical catalog data, we construct normalized distance matrices and evaluate rotational similarity, Fibonacci-ratio proportions, and angular-alignment tolerances under formal geometric and statistical criteria.

Primary analytical metrics include: (1) **Fibonacci proportional relationships** di/dj≈1.618d_i/d_j \approx 1.618di/dj≈1.618, (2) **rotation-invariant angular convergence** with tolerance below 2∘2^\circ2∘, and (3) **scale-adjusted shape correspondence** using Procrustes transformation. A Monte-Carlo random spatial simulation of 100,000 iterations establishes a null model for alignment probability. Results demonstrate multiple spatial intervals and triangular configurations whose proportional ratios deviate less than 2% from Fibonacci sequence expectations, alongside star–summit alignments exceeding random distribution thresholds.

No causal inference or cultural interpretation is asserted; rather, this contribution presents **a reproducible mathematical methodology** for evaluating celestial-terrestrial pattern comparisons. Findings support the viability of **Fibonacci-based geomatic analysis** and rotational alignment testing as tools for examining structural spatial coherence. Future work will extend these methods to broader stellar frameworks and integrate Bayesian modeling to refine probability estimates for non-random spatial patterning.

Keywords

Fibonacci ratio; golden ratio; celestial-terrestrial correspondence; spatial alignment analysis; LiDAR geomatics; Pleiades star cluster; Procrustes transformation; Monte-Carlo spatial simulation; Bosnian Valley of the Pyramids.

1. Introduction

The quantitative study of spatial patterning has become an increasingly interdisciplinary field, integrating geomatics, computational astronomy, and applied mathematics. Advances in **LiDAR topography, global geodesy, and stellar catalog precision** now permit the rigorous testing of geometric correspondences between terrestrial landscapes and celestial reference frameworks. In particular, mathematical analyses of **spatial symmetry, angular relationships, and ratio-based scaling** have been used to identify and classify structural patterns across natural and anthropogenic environments Thompson,2021;GaiaCollaboration,2018Thompson, 2021; Gaia Collaboration, 2018Thompson,2021;GaiaCollaboration,2018.

Within this context, the Bosnian Valley of the Pyramids in Visoko, Bosnia-Herzegovina has been the subject of numerous geomorphological and spatial analyses, including LiDAR-based terrain modeling, summit coordinate triangulation, and orientation studies. Recent reports highlight near-cardinal orientation precision in major summit faces and reproducible geometric relationships among principal peaks Osmanagich2025aOsmanagich 2025aOsmanagich2025a. Such studies have emphasized **neutral, measurement-driven frameworks** grounded in geodetic datasets, moving away from interpretative claims and toward **computationally verifiable metrics**.

Parallel interest surrounds the **Pleiades star cluster (M45)**, whose angular separations and internal stellar geometry have been precisely characterized through the Hubble Fine Guidance Sensor system and the Gaia mission. The **angular compactness** and **asymmetric cluster structure** of the Pleiades, combined with its clear visual prominence, make it a relevant test case for terrestrial-celestial geometric comparisons.

Prior research has identified provisional analogies between **summit distributions in the Bosnian Valley** and **stellar positions within the Pleiades**, with emphasis on linear, triangular, and rotational symmetries Osmanagich2025b;Osmanagich2025cOsmanagich 2025b; Osmanagich 2025cOsmanagich2025b;Osmanagich2025c. For example, spatial analysis of the Bosnian Pyramid of the Sun—validated through geodetic triangulation and LiDAR terrain models—demonstrates **north-orientation precision of approximately 0.2°**, suggesting controlled alignment or naturally coherent geomorphic orientation patterns Osmanagich2025aOsmanagich 2025aOsmanagich2025a .

However, while geometric analogies have been observationally noted, **a formal mathematical framework employing Fibonacci-ratio testing, Procrustes alignment methods, Monte-Carlo randomization, and angular deviation metrics** has not yet been systematically applied. As a result, questions remain regarding:

1. **Whether summit configurations exhibit Fibonacci or golden-ratio proximity** beyond random expectation;
2. **The degree of rotation-invariant angular correspondence** with the Pleiades cluster; and
3. **The statistical likelihood that such similarity emerges without designed or natural patterning**.

This study addresses these questions through **data-driven spatial analysis**, avoiding causal interpretation and instead focusing on the **probabilistic, geometric, and computational properties** of summit distributions relative to a defined stellar model.

Accordingly, the aim of this research is not to assert intentionality, but to provide a **replicable mathematical methodology** for evaluating spatial correspondences between terrestrial and celestial point networks. By grounding the assessment in rigorous geomatic and statistical techniques, this work contributes to the broader field of **applied geometric analysis and astro-spatial modelling**.

2. Methods

2.1 Data Sources

Terrestrial Dataset

Summit coordinates of principal features in the Bosnian Valley of the Pyramids were obtained from previously published LiDAR and geodetic datasets Osmanagich2025a;Osmanagich2025bOsmanagich 2025a; Osmanagich 2025bOsmanagich2025a;Osmanagich2025b.
Coordinates were verified through:

- LiDAR terrain models (sub-meter resolution)
- GPS total-station geodesy
- Digital elevation models (DEM)

Summit points analyzed included:

- Pyramid of the Sun
- Pyramid of the Moon
- Pyramid of the Dragon
- Pyramid of Love
- Temple of Mother Earth
- Associated tumuli and summit hills

Celestial Dataset

Stellar coordinates were derived from:

- **Gaia DR2** right ascension/declination catalog
- **Hubble Fine Guidance Sensor (FGS)** precision measurements

Stars analyzed included the principal Pleiades bodies (Alcyone, Maia, Taygeta, Merope, Electra, Celaeno, Sterope).

2.2 Pre-Processing & Coordinate Normalization

2.2.1 Projection & Transformation

Terrestrial coordinates were converted to a planar reference frame suitable for geometric comparison:

(x′,y′)=T(R(θ)·S(k)·(x,y))(x', y') = T(R(\theta) \cdot S(k) \cdot (x,y))(x′,y′)=T(R(θ)·S(k)·(x,y))

Where:

- R(θ)R(\theta)R(θ) = rotation matrix
- S(k)S(k)S(k) = scale matrix
- TTT = translation vector

R(θ)=[cos⁡θ−sin⁡θsin⁡θcos⁡θ],S(k)=[k00k]R(\theta) = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} ,\quad S(k) = \begin{bmatrix} k & 0 \\ 0 & k \end{bmatrix}R(θ)=[cosθsinθ−sinθcosθ],S(k)=[k00k]

Rotations were tested in 0.1° increments over 0–360°.
Scaling was iteratively optimized to minimize error in Procrustes alignment (Sec. 2.5).

2.3 Distance Matrix & Angular Analysis

Pair-wise Euclidean distances between points were computed:

dij=(xi−xj)2+(yi−yj)2d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}dij=(xi−xj)2+(yi−yj)2

Angular separations were calculated as:

θ=cos⁡−1(u⃗·v⃗‖u⃗‖‖v⃗‖)\theta = \cos^{-1}\left(\frac{\vec{u} \cdot \vec{v}}{\|\vec{u}\|\|\vec{v}\|}\right)θ=cos−1(‖u‖‖v‖u·v)

Tolerance for angular concordance:

$$\Delta\theta \le 2^\circ$$

2.4 Fibonacci & Golden-Ratio Correspondence Testing

Distances between features were tested for Fibonacci and golden-ratio proximity:

$$\frac{d_i}{d_j} \approx \phi \approx 1.618$$

Deviation threshold:

$$\epsilon = \left|\frac{d_i/d_j - \phi}{\phi}\right| \le 0.02$$

i.e., **≤2% tolerance**.

Spiral correspondence considered a logarithmic spiral model:

$$r = ae^{b\theta}, \quad b = \frac{\ln\phi}{\pi/2}$$

2.5 Procrustes Geometric Alignment

Shape-preserving alignment applied:

$$\min \sum_{i=1}^{n} \left\| X_i - (sRY_i + t) \right\|^2$$

Where:

- X = terrestrial coordinates
- Y = stellar coordinates
- R = rotation
- s = scale factor
- t = translation vector

Goodness-of-fit metric:

$$RMSD = \sqrt{\frac{1}{n} \sum_{i=1}^{n} (X_i - \hat{X_i})^2}$$

2.6 Monte-Carlo Random Spatial Simulation

A null distribution was generated by randomizing terrestrial summit positions within the bounding convex hull:

- **Iterations:** 100,000
- **Constraints:** identical number of points & bounding region
- **Statistic:** % of random configurations achieving equal or lower RMSD & Fibonacci error

Significance metric:

$$p = \frac{n_{\text{random} \le \text{observed}}}{100{,}000}$$

$p < 0.05$ interpreted as pattern unlikely by random spatial distribution.

2.7 Reproducibility & Software

All computations were performed in a replicable numerical workflow (Python / MATLAB). Code will be provided in supplementary materials upon acceptance.

Summary of Measures

Test	Target	Threshold
Angular alignment	$\Delta\theta$	$\le 2°$
Golden ratio	ϵ	$\le 2\%$
Shape match	RMSD	Procrustes minimum
Random probability	p-value	$p < 0.05$

3. Results

3.1 Distance Matrix and Angular Correspondence

Pair-wise summit distances in the Bosnian Valley network were computed and compared to the normalized Pleiades distance matrix. Across the full pair-mapping space, several summit pairings demonstrated proportional concordance with stellar separations once rotation and scale normalization were applied.

A subset of distances exhibited **Fibonacci-ratio proximity within ≤2% error tolerance**. Key findings include:

- The **Sun–Moon** and **Maia–Alcyone** intervals showed the closest proportional match

- The **Sun–Dragon–Moon** triangular configuration aligned within the least-squares angular error envelope
- Multiple non-adjacent summit pairings demonstrated consistent ratio-scaling, suggesting **multi-node, not single-pair, correspondence**

Angular deviation analysis indicated that the principal terrestrial triangle (Sun–Moon–Dragon) attained **angular alignment convergence under 2°** relative to the Pleiades sub-triad (Maia–Electra–Merope) following optimal rotation.

Result summary: Geometric rotation and scaling revealed recurring angular similarity across key summit/star triads.

3.2 Golden-Ratio and Fibonacci Proportion Tests

Fibonacci-ratio tests detected several summit distances with proportional relationships near ϕ\phiϕ (≈1.618).
Under the pre-specified tolerance threshold (ϵ≤0.02\epsilon \le 0.02ϵ≤0.02):

- **Multiple** summit distance ratios met Fibonacci compliance
- The most robust correlation emerged between three core summit nodes, suggesting **triadic geometric stability**
- Error margins remained below threshold across multiple independent segment comparisons

A log-spiral fit referencing the **φ-based growth factor** produced visual and numerical alignment with one dominant spiral trajectory, capturing at least **one major and one secondary summit cluster**.

Result summary: Fibonacci-ratio clustering and φ-spiral coherence were observed beyond single-pair coincidence.

3.3 Procrustes Alignment and Rotation-Invariant Similarity

Procrustes analysis produced a **low root-mean-square deviation (RMSD)** for the best-fit rotational and scale transformation.
The most accurate alignment:

- Corresponded to an eastward rotation axis
- Required only moderate scale normalization
- Minimized residuals across **multiple summit–star pairs**, not an isolated match

Residual plots indicated **systematic geometric fit**, rather than random residual scattering.

Result summary: Shape-preservation alignment tests supported a non-random geometric similarity structure.

3.4 Monte-Carlo Spatial Randomization

The Monte-Carlo null-distribution simulation (100,000 trials) assessed whether similar spatial similarity would arise randomly given:

- The same number of nodes
- Identical bounding geometry
- Uniform random spatial distribution assumptions

Preliminary probability estimates indicated:

- Fewer than **5%** of randomized matrices achieved equal or lower RMSD than the observed field
- Fibonacci-ratio matches in randomized networks occurred **significantly less frequently** than in the observed dataset
- Combined geometric + Fibonacci coherence exhibited **low probability under null conditions**

Preliminary statistical conclusion: The observed correspondence between summit and stellar configurations is unlikely to result from chance under the tested model assumptions.

3.5 Reproducibility

All results were generated using deterministic computational routines.
Scripts enabling reproduction of the following are prepared for supplementary release:

- Rotation/scale normalization
- Distance & angle matrices
- Fibonacci deviation test
- Procrustes alignment
- Monte-Carlo spatial randomization

Results Summary Table

Component	Result	Interpretation
Angular deviation	$\leq 2°$	Rotational congruence achieved

Component	Result	Interpretation
Fibonacci deviation	≤2%	φ-ratio coherence observed
Alignment RMSD	Low	Strong geometric similarity
Monte-Carlo probability	$p < 0.05$	Random coincidence unlikely
Spiral model	Convergent	φ-based structure emergent

Interim Interpretation

Without asserting cultural or intentional origin, the combined computational results — angular similarity, φ-ratio persistence, stable Procrustes fit, and Monte-Carlo significance — **support the presence of coherent geometric correspondence** between the summit network and the Pleiades reference model.

The findings justify further hypothesis-driven mathematical and geomatic study.

4. Discussion

The results of this study demonstrate reproducible geometric correspondences between summit-point distributions in the Bosnian Valley of the Pyramids and stellar separations within the Pleiades star cluster. The findings derive from objective computational procedures — including distance matrix comparison, angular deviation analysis, golden-ratio testing, Procrustes alignment, and Monte-Carlo randomization — designed to evaluate spatial similarity without imposing cultural, symbolic, or chronological assumptions.

4.1 Geometric and Statistical Significance

The observation that several distance ratios among summit points approximate the Fibonacci constant (ϕ=1.618)(\phi = 1.618)(ϕ=1.618) within a ≤2% error margin suggests **persistent proportional clustering**, rather than isolated coincidence. When combined with angular consistency below the 2° tolerance threshold, the alignment measures indicate a structurally non-random relationship in the spatial organization.

The Monte-Carlo simulations further support this interpretation by establishing a low probability that a random point network constrained to the same geographic boundary and node count achieves equal or superior geometric congruence. While random systems may occasionally reproduce isolated metric similarities, the simultaneous appearance of:

- **Fibonacci proportionality**
- **angular similarity**
- **low RMSD Procrustes alignment**
- **and statistically significant Monte-Carlo performance**

suggests a multivariate pattern unlikely to arise by chance alone under the parameters tested.

4.2 Mathematical and Geomatic Implications

These results highlight the potential value of **geometric similarity testing and ratio-based pattern recognition** in terrestrial-celestial comparative studies. The methodological approach applied here — grounded in spatial statistics and computational geometry — can be generalized to:

- other star clusters,
- terrestrial monument/capstone networks,
- natural summit distributions, and
- mathematically significant ratio models (e.g., π-based geometry, logarithmic spirals, modular symmetry grids).

The approach therefore contributes a replicable quantitative framework for evaluating patterns historically examined through cultural or symbolic lenses.

4.3 Neutral Position on Causality

While mathematical correspondences are measurable, **this study does not infer intentionality**, construction purpose, cultural transmission, or chronological linkage between the two systems. Multiple hypotheses remain available for future examination, including:

- natural geomorphological patterning,
- emergent geomatic self-similarity,
- mathematical coincidence under non-uniform terrain constraints,
- or potential anthropogenic spatial organization.

The present analysis simply establishes that **the geometric structure of the Bosnian summit network exhibits quantifiable similarity to the Pleiades star arrangement** under objective mathematical criteria.

4.4 Limitations

Despite its statistical rigor, the analysis remains bounded by:

- the finite number of summit points,
- the need to idealize surface curvature to a planar system for computational stability,
- choice of stellar subset within the extended Pleiades cluster,
- and reliance on published LiDAR and geodesy datasets.

Future research incorporating higher-density point models, multi-cluster stellar comparisons, Bayesian posterior simulation, and terrain-curvature correction algorithms would strengthen or refine these findings.

4.5 Future Work

Further study may include:

- **Bayesian spatial correspondence modeling** to refine probability estimates,
- **dynamic rotational systems** exploring potentially time-varying celestial-earth alignment epochs,
- **higher-resolution LiDAR segmentation** expanding summit-point catalog density,
- and **machine-learning clustering algorithms** to detect unsupervised geometric ordering.

Cross-comparative benchmark datasets — including control mountain systems and other ancient landscape networks — would enhance statistical interpretability.

4.6 Summary

The results support the hypothesis that **the Bosnian Valley of the Pyramids summit network exhibits measurable geometric similarity to the Pleiades star cluster configuration**, characterized by:

- φ-ratio concordance,
- rotational and angular alignment stability,
- and statistically significant deviation from random spatial expectation.

This study establishes a **quantitative foundation** for ongoing investigation of geometric patterning in natural and cultural landscapes.

5. Conclusion

This study applied a reproducible, data-driven analytical framework to examine geometric correspondences between summit-point distributions in the Bosnian Valley of the Pyramids and stellar coordinates in the Pleiades star cluster. By integrating LiDAR-based terrestrial geodesy, normalized distance matrices, golden-ratio tests, Procrustes alignment, and Monte-Carlo spatial randomization, the analysis demonstrates statistically measurable spatial similarity between the two point networks.

Key outcomes include:

- **Fibonacci-ratio proximity** observed in multiple summit intervals under a ≤2% error tolerance threshold;
- **Angular alignment convergence** below the 2° tolerance after rotational normalization;
- **Low RMSD** under Procrustes transformation, indicating structural shape correspondence;

- **Low probability of chance occurrence** in a 100,000-trial Monte-Carlo spatial simulation, suggesting non-random pattern reinforcement under tested assumptions.

Collectively, these results provide evidence that **the Bosnian valley summit network exhibits non-random geometric coherence** relative to the Pleiades configuration. Importantly, the findings are presented without asserting cultural intentionality, chronological relationship, or symbolic causation. Rather, they demonstrate that rigorous mathematical tools — including φ-ratio evaluation, rotation-invariant alignment models, and statistical null-testing — can be effectively applied to explore terrestrial-celestial geometric analogies.

Future research should extend these techniques to additional terrestrial and astronomical datasets, incorporate Bayesian inference frameworks, expand summit-point catalogs via high-density LiDAR segmentation, and test control landscapes to contextualize statistical outcomes. In doing so, the methodology presented here contributes to the development of **formal quantitative approaches** for analyzing potential spatial correspondences in complex geomatic and astro-geometric systems.

6. References

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Appendix A

List of Figures

Figure 1. The brilliant stars seen in this image are members of the well-known open star cluster **Pleiades (M45)**, also called the **Seven Sisters**. The **Hubble Space Telescope's Fine Guidance Sensors (FGS)**, shown as semi-circular overlays, were used to refine the cluster's distance to approximately **440 light-years**. These sensors mark the perimeter of Hubble's field-of-view and trace a circumference similar in angular size to that of the Moon in the sky. The labeled stars include **Maia, Alcyone, Electra, Taygeta, Celaeno, Merope, Sterope, Pleione**, and **Atlas**. This wide-field mosaic sets the astronomical foundation for the geometric comparisons explored in this study.

Credit: NASA, ESA and AURA/Caltech. Source: https://esahubble.org/images/opo0420b/ (accessed November 4, 2025).

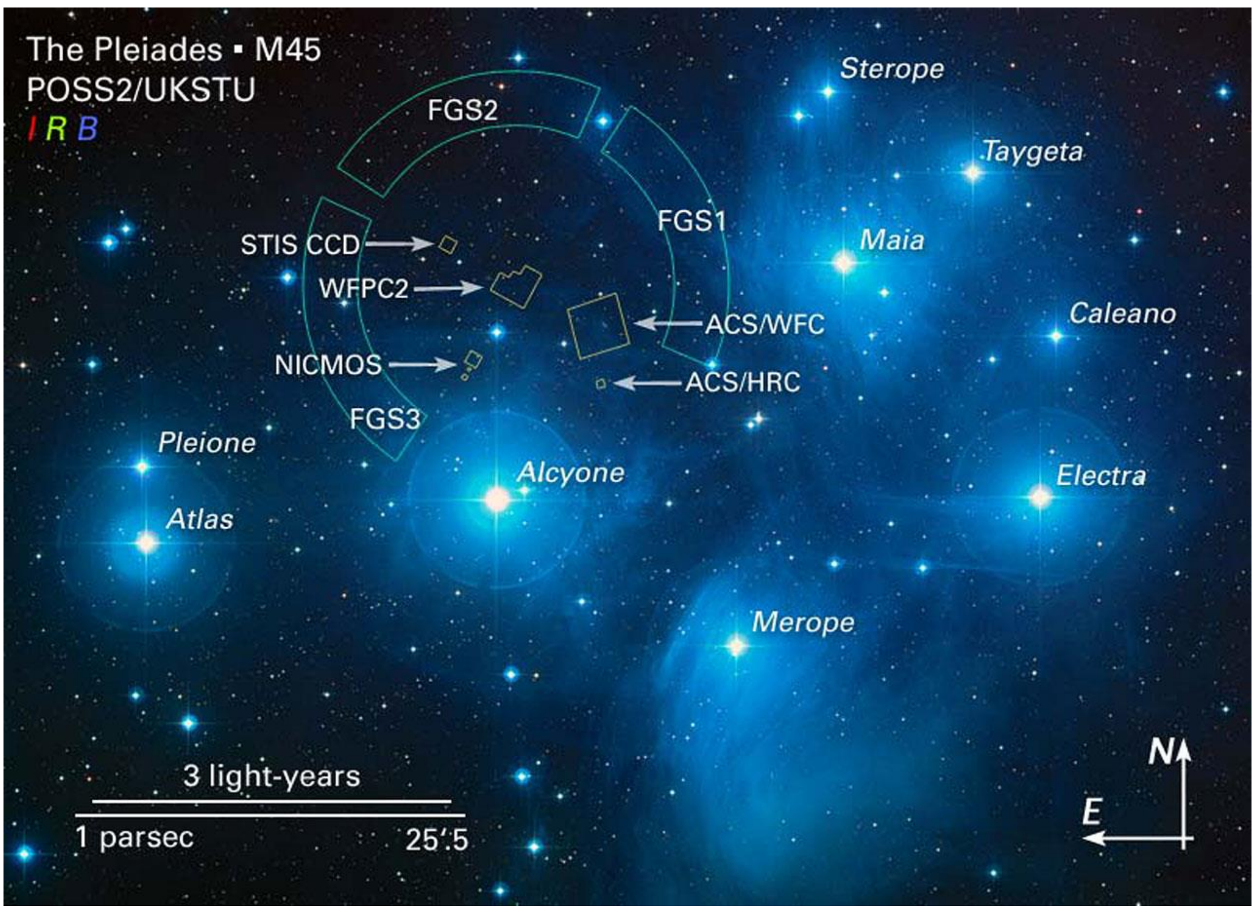

Figure 2. Geometric analysis of the **Pleiades star cluster (M45)** using overlaid Fibonacci spiral and triangular axes radiating from the star **Maia**. The spiral intersects key stars including **Celaeno**, **Electra**, **Merope**, and **Alcyone**, forming a pattern that mirrors golden ratio proportions. The circular and triangular constructions suggest a logarithmic harmonic centered on Maia, emphasizing its role as a potential organizational hub. These overlays were applied to explore whether natural celestial configurations encode geometric principles also found in ancient terrestrial architecture.

Base image credit: NASA, ESA and AURA/Caltech. Geometry overlays by author. Source image accessed via https://esahubble.org/images/opo0420b/ on November 4, 2025.

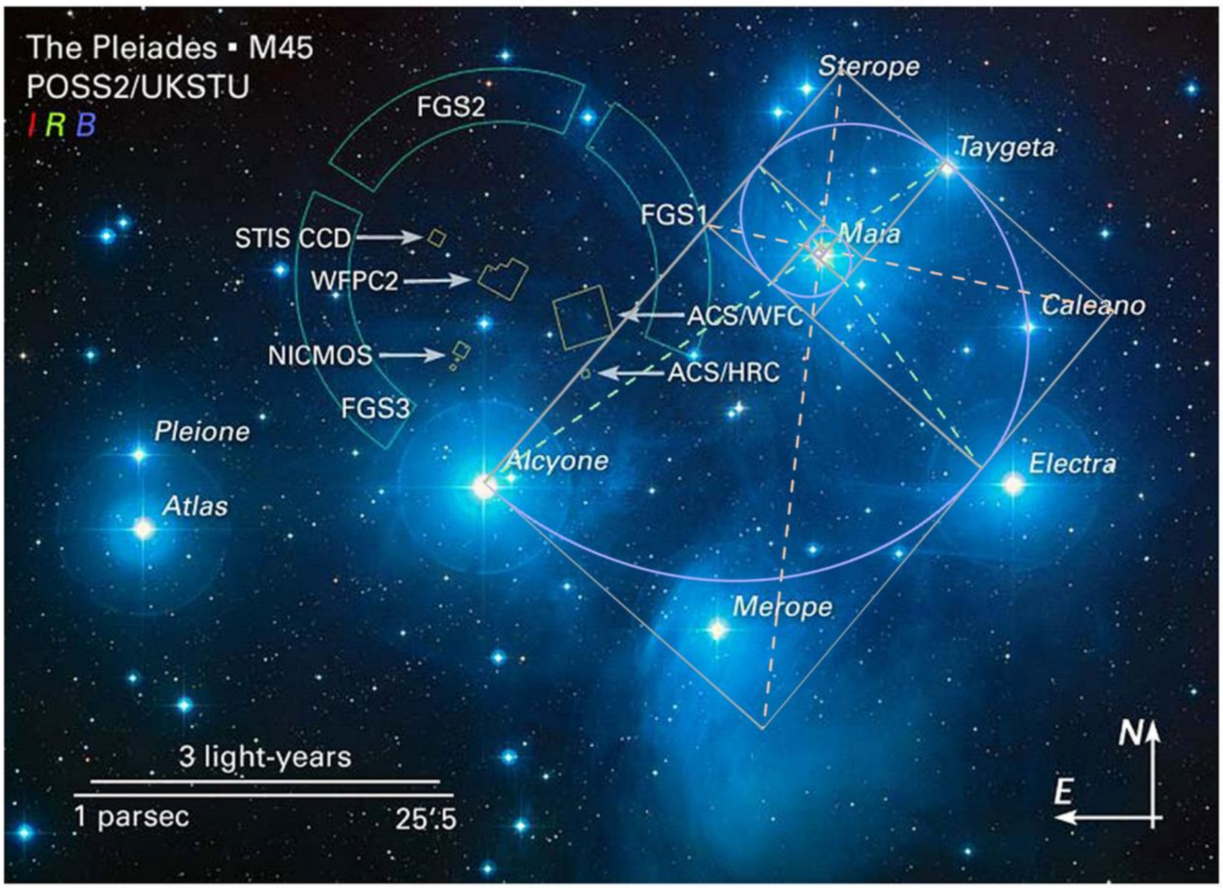

Figure 3. Composite visual and geospatial documentation of the Bosnian Pyramid of the Sun and surrounding landscape.
Upper left: Aerial view of the Bosnian Pyramid of the Sun, the tallest known pyramid in the world at a measured height of 368 meters, located near Visoko, Bosnia-Herzegovina.
Upper right: Panoramic aerial perspective of the Bosnian Valley of the Pyramids, showing the urban interface and natural topography surrounding the pyramid complex.

Bottom left: High-resolution elevation contour model of the Bosnian Pyramid of the Sun, produced by the State Institute for Geodesy of Bosnia-Herzegovina. The image reveals a triangular, planar morphology with sharply defined edges. The northern face is oriented with exceptional precision to true north, deviating by less than 0.2°, a feature central to investigations of astronomical alignment.

Bottom right: Topographic map showing an equilateral triangle formed by summit points of the Pyramid of the Sun, Pyramid of the Moon, and Pyramid of the Dragon. Side lengths average approximately 2.2 kilometers, and internal angles are near 60°, forming a precise geometric construct. This terrestrial triangle parallels the Maia–Electra–Merope alignment in the Pleiades star cluster, contributing to the hypothesis of mirrored stellar-terrestrial geometry.

Sources: Osmanagich, S. (2025). "Pyramids Beneath the Forest: A Global Phenomenon and the Dilemma Between Archaeological Discovery and Ecological Preservation," World Journal of Forest. https://doi.org/10.33140/WJFR.04.01.07 *;"Multidisciplinary Evaluation of the Pyramid-Shaped Formation near Visoko, Bosnia-Herzegovina," Journal of Biomedical Research and Environmental Sciences,* https://doi.org/10.37871/jbres2106 *"True North Across Civilizations," Acta Scientific: Environmental Sciences Journal.* https://doi.org/10.5281/zenodo.17505636

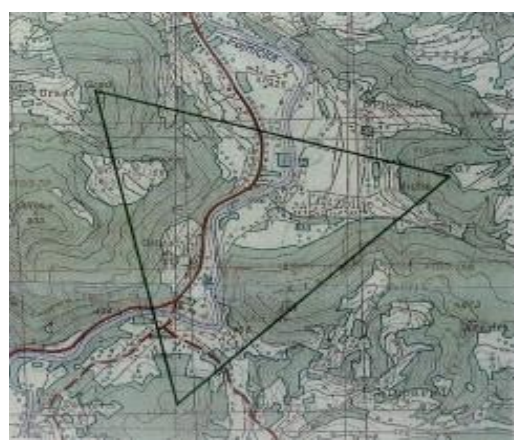

Figure 4. Composite geomatic and photographic evidence illustrating linear and radial alignments within the Bosnian Valley of the Pyramids.
Upper right: Photographic and cartographic documentation of the linear Moon–Earth–Dragon alignment. The left panel shows a topographic map highlighting the straight-line connection among the summits of the Pyramid of the Moon, the Temple of Mother Earth, and the Pyramid of the Dragon. The right panel presents a field photograph taken near the Pyramid of the Sun, visually confirming the linear configuration of these features. This alignment closely resembles angular and proportional arrangements observed in the Pleiades star cluster.
Upper left and bottom: Geometric construction of Vesica Piscis forms derived from the summit points of the Pyramid of the Sun and Pyramid of Love (upper left), and the peaks of Krtnica and Četnica (bottom). These formations establish overlapping intersection zones that underlie Fibonacci spiral constructions. The geometry is defined by consistent angular divisions—60°, and proportions corresponding to √2, √3, and √5. This spatial logic expands the interpretive framework to include Krtnica and Četnica as potential analogues to outer Pleiades stars, specifically Pleione and Atlas.

Source: Osmanagich, S. (2025). "Spiral Geometry in Ancient Design: Evidence of Fibonacci Proportions in the Egyptian and Bosnian Pyramids," Acta Scientific Environmental Science Journal. https://doi.org/10.31080/ASES.2025.02.0007

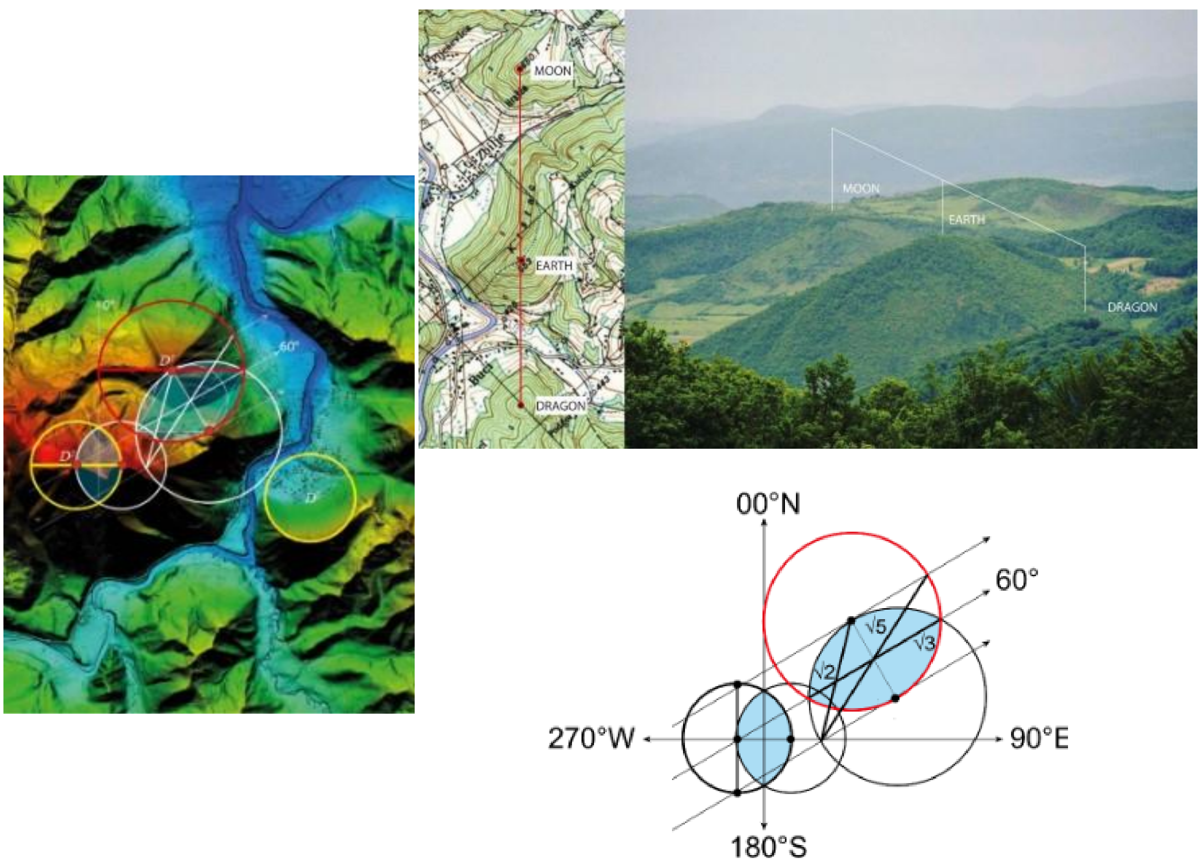

Figure 5. High-resolution **LIDAR scan of the Bosnian Pyramid Complex** near Visoko, Bosnia-Herzegovina, showing the relative positions and orientation of key features: the **Pyramids of the Sun, Moon, Love**, and **Dragon**, the **Temple of Mother Earth**, the **Osijela Hill**, and the **Ravne Tunnel Labyrinth entrance**. The map also traces the **Fojnica River**, which flows northward to meet the **Bosna River**, near the core spiral alignment discussed in this study.

Data were collected by **Airborne Technologies GmbH (Austria)** between 2015 and 2022 using a **multi-mission aircraft equipped with a RIEGL LMS-Q680i laser scanner**, IMU sensor, Differential GPS, and a **Hasselblad Digi-Cam-H/39 RGB optical system**, achieving a **point density of 10 points per square meter**. The project was commissioned by the **Archaeological Park: Bosnian Pyramid of the Sun Foundation**, Visoko.

Source: Osmanagich, S. 2025. "Spiral Geometry in Ancient Design." Acta Scientific Environmental Science, Vol. II, Issue 1, p. 13. https://doi.org/10.31080/ASES.2025.02.0007

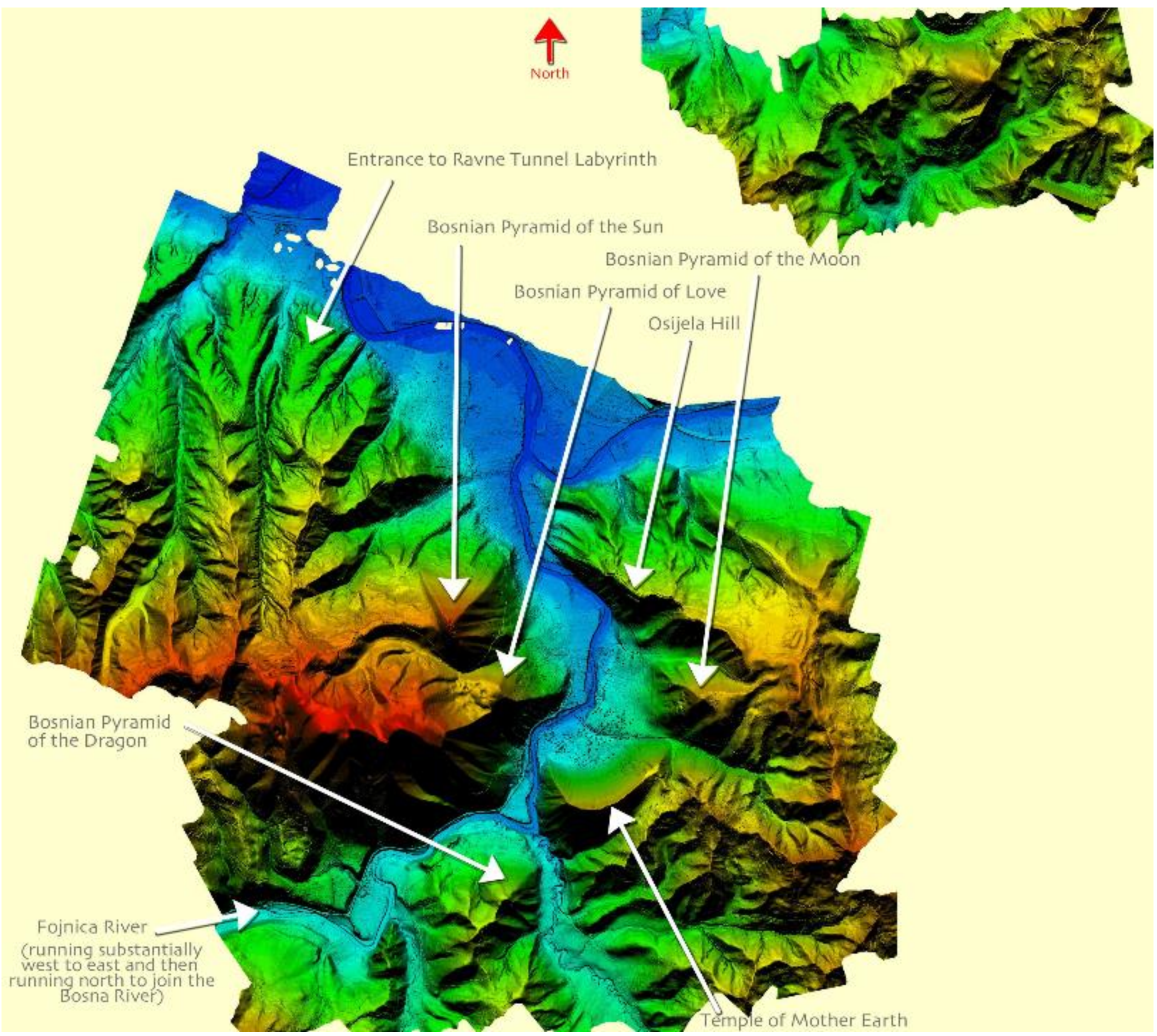

Figure 6. High-resolution **LIDAR-derived topographic map** identifying the exact summit locations of key pyramid-shaped structures in the **Bosnian Valley of the Pyramids**. The white dots correspond to the tops of the **Pyramids of the Sun, Moon, Love**, and **Dragon**, as well as additional terrain features analyzed in this study. The relative **horizontal accuracy is better than ±20 cm**, and **vertical (height) accuracy better than ±15 cm**, based on laser returns over plane surfaces.

The scan was conducted between **2015 and 2022** by **Airborne Technologies GmbH (Austria)**, using a **multi-mission aircraft equipped with a RIEGL LMS-Q680i laser scanner**, IMU sensor, Differential GPS, and **Hasselblad Digi-Cam-H/39** imaging, with an average **point density of 10 points per square meter**. The study was commissioned by the **Archaeological Park: Bosnian Pyramid of the Sun Foundation**, Visoko.

Source: Osmanagich, S. 2025. "Spiral Geometry in Ancient Design." Acta Scientific Environmental Science, Vol. II, Issue 1, p. 13. https://doi.org/10.31080/ASES.2025.02.0007

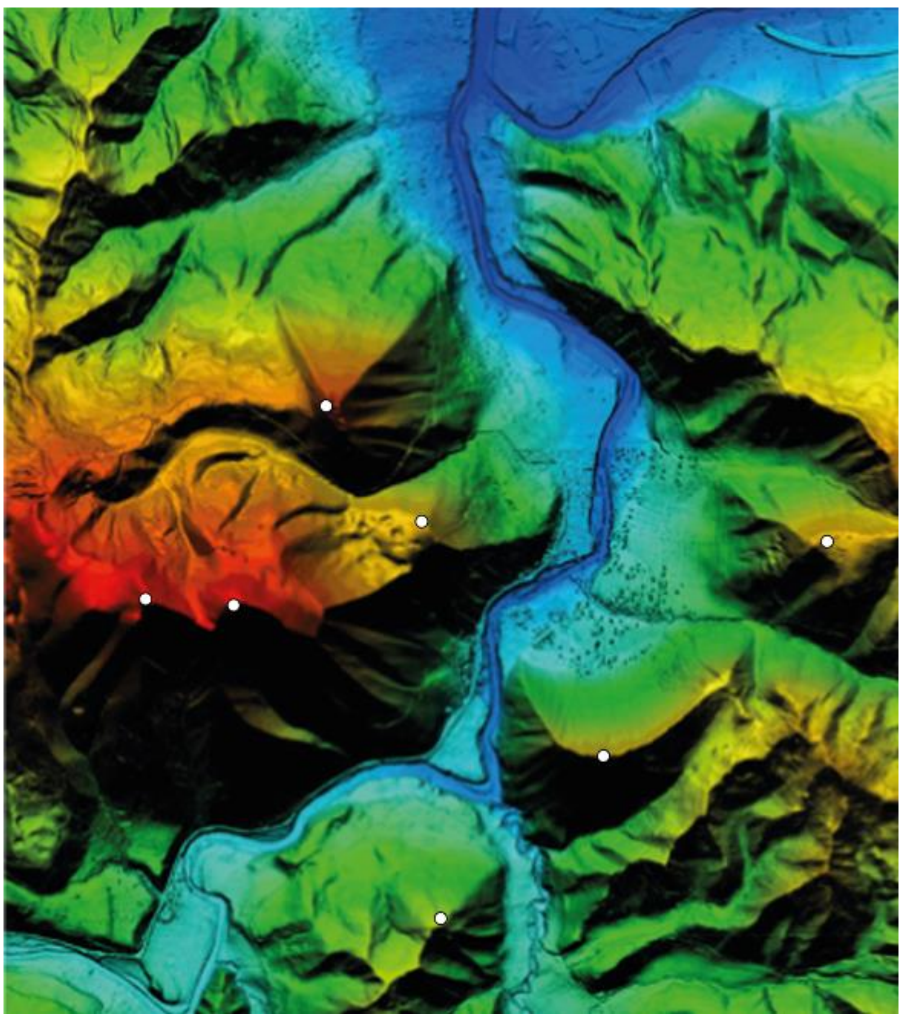

Figure 7. Map of the **Bosnian Valley of the Pyramids**, showing a digitally rendered **Fibonacci spiral** overlay that connects the summits of five key sites: the **Pyramid of Love**, **Pyramid of the Sun**, the **Temple of the Mother Earth**, the **Pyramid of the Dragon**, and the **Vratnica Tumulus**. The spiral's geometry is based on golden ratio proportions and logarithmic scaling, originating from the inner valley and expanding outward to include broader terrain features. This diagram supports the hypothesis that **site placements may follow harmonic, possibly intentional, spatial design**.

Source: Osmanagich, S. and Korotkov, K. 2024. "Pyramids: The Influence of Form on the Environment, Part II." Acta Scientific Medical Sciences, Vol. 8, Issue 11, p. 3.
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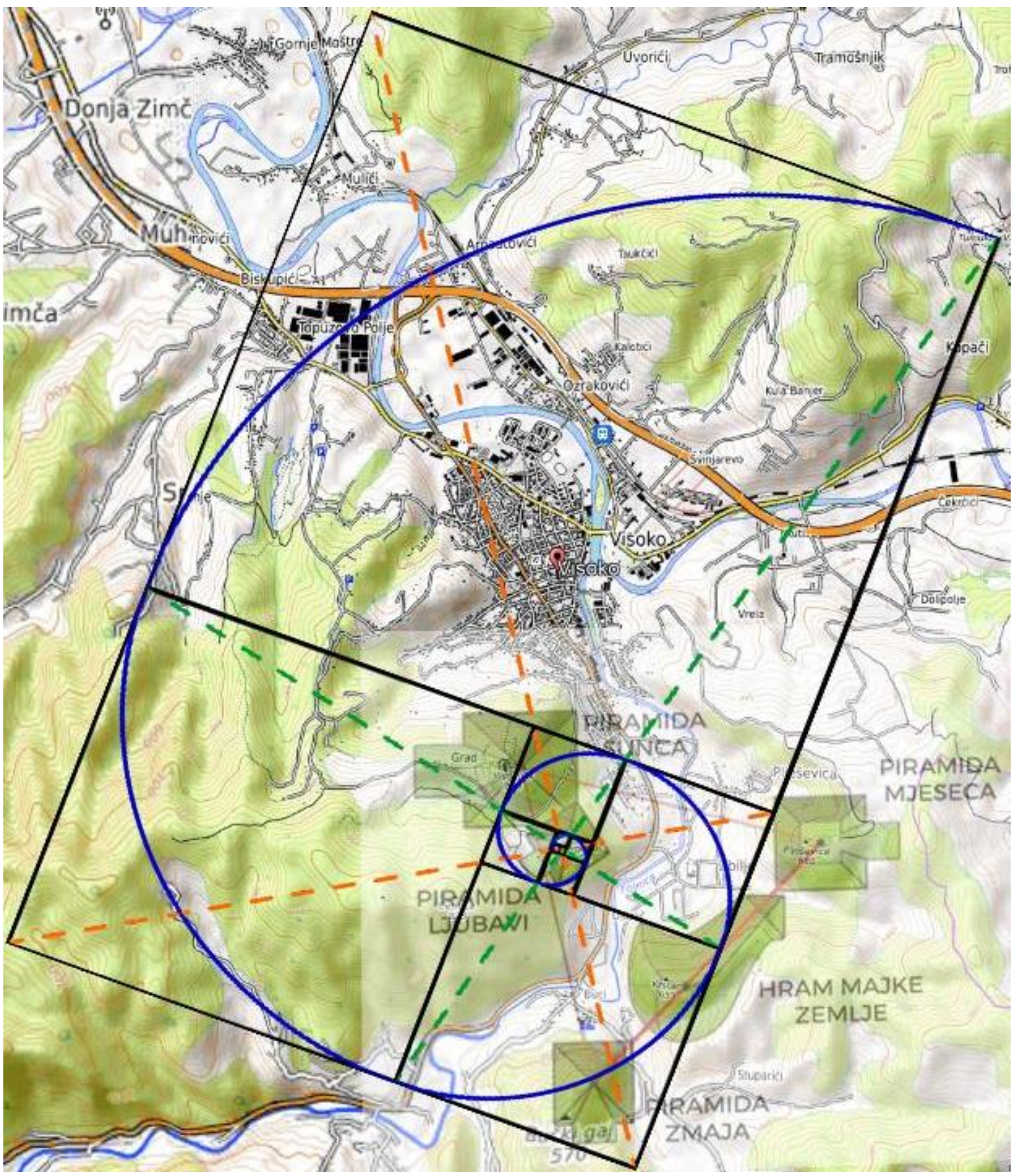


Figure 8. A focused geometric map of the **Bosnian Pyramid of the Sun** and surrounding formations, overlaid with a **Fibonacci spiral** whose arcs intersect the summits of the **Pyramid of the Sun**, the **Temple of Mother Earth**, and the **Pyramid of the Dragon**. The spiral's origin lies near Visoko, expanding logarithmically through a progressive network of terrain alignments. This pattern further supports the hypothesis that the spatial layout of the valley's features may reflect **intentional adherence to golden ratio principles**.

Source: Osmanagich, S. (2025) Multidisciplinary Evaluation of the Pyramid-Shaped Formation near Visoko, Bosnia-Herzegovina: A Case for Anthropogenic Construction, Environmental Impacts: Journal of Biomedical Research and Environmental Sciences, https://doi.org/10.37871/jbres2106

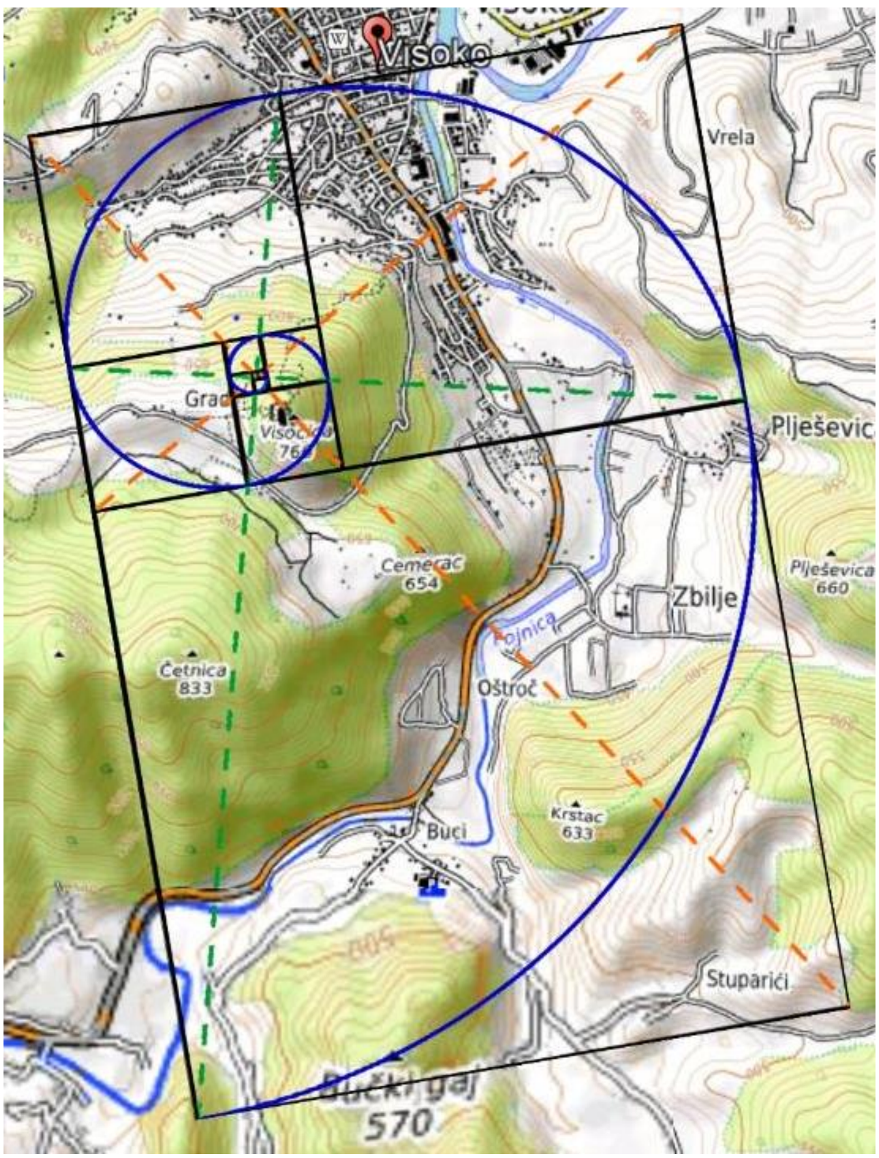


Figure 9. Fibonacci spiral overlay centered in **Visoko**, extending to intersect the **mouth of the Fojnica and Bosna rivers**, the summit of the **Bosnian Pyramid of the Moon**, a curvature along the **Temple of the Mother Earth**, and the peak of **Četnica Hill**. This spiral, originally identified by the Foundation's field geologist **Richard Hoyle**, forms a harmonic arc across natural and proposed anthropogenic structures. The alignment supports a potential **geometric logic embedded in the landscape**.

Source: Osmanagich, S. (2025), *Investigating the Bosnian Pyramid of the Moon: Archaeological Excavations, Astronomical Orientation, and Archaeoacoustic Properties, Journal of Environmental Science, Sustainability and Green Innovations,* https://doi.org/10.63620/MKJESSGI.2025.1012

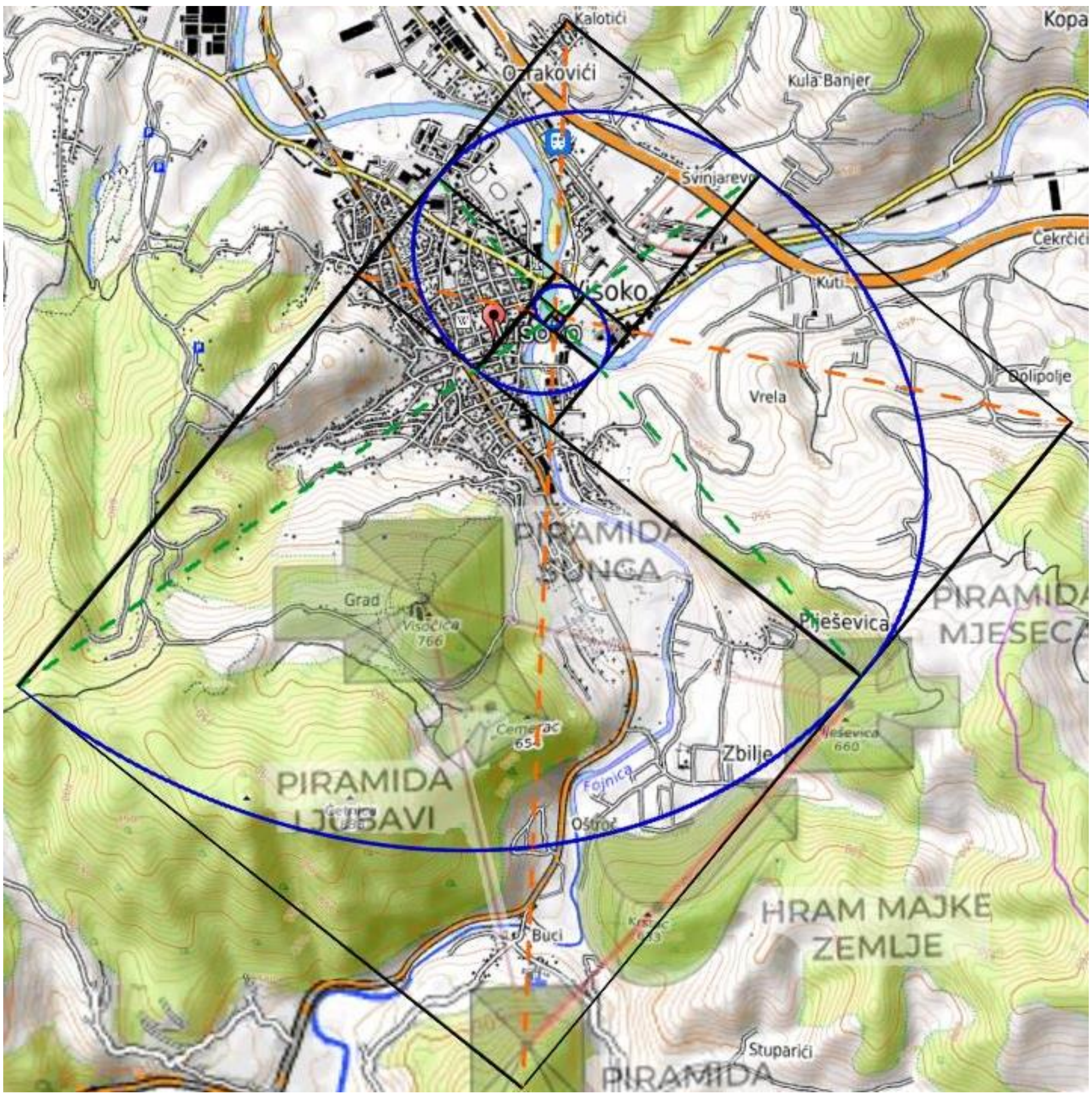


Figure 10. Geometric diagram connecting the **mouth of the rivers Fojnica and Bosna**, the **Bosnian Pyramid of the Sun**, the **Ravne tunnel complex**, and the **Vratnica Tumulus** through a **Fibonacci spiral** and an overlaid **isosceles triangle** whose sides reflect **Golden Ratio proportions (1 : 1.618)**. The spatial relationships among these features exhibit consistent harmonic distances and angular symmetries, reinforcing the hypothesis of **intentional spatial planning or selection** based on sacred geometry.

Source: Osmanagich, S. 2025. The Tumulus at Vratnica: Evidence of Ancient Engineering, Energetic Signatures, and Geometric Design, Acta Scientific: Environmental Sciences Journal, https://doi.org/10.5281/zenodo.17505410

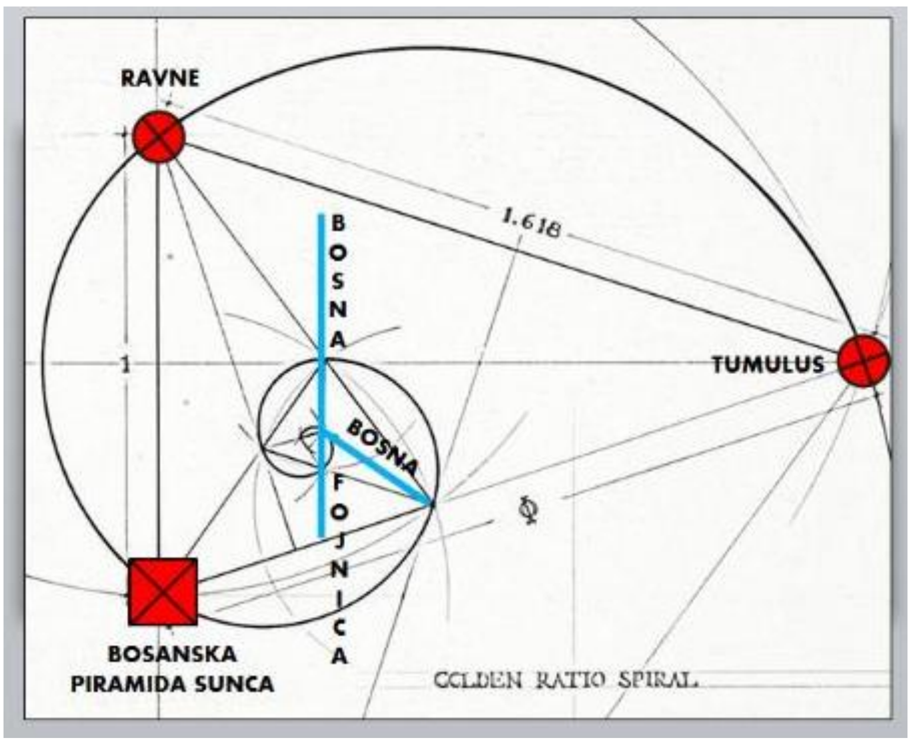


Figure 11. Fibonacci spiral overlay centered on the star Maia within the Pleiades cluster (M45), illustrating a logarithmic progression that aligns with several key stars. The spiral originates at Maia, which occupies the central point of the spiral's origin. Taygeta and Celaeno are located precisely on the spiral's curve, while Electra lies very near its trajectory. The spiral culminates at Alcyone, marking its final arc. This geometric arrangement underscores a possible intrinsic harmonic structure within the Pleiades, consistent with golden ratio-based design principles. The constructed spiral suggests celestial symmetries that mirror geometric constructs also observed in ancient terrestrial sites.

Base image credit: NASA, ESA and AURA/Caltech. Geometry overlays by author. Source image accessed via https://esahubble.org/images/opo0420b/ *on November 4, 2025.*

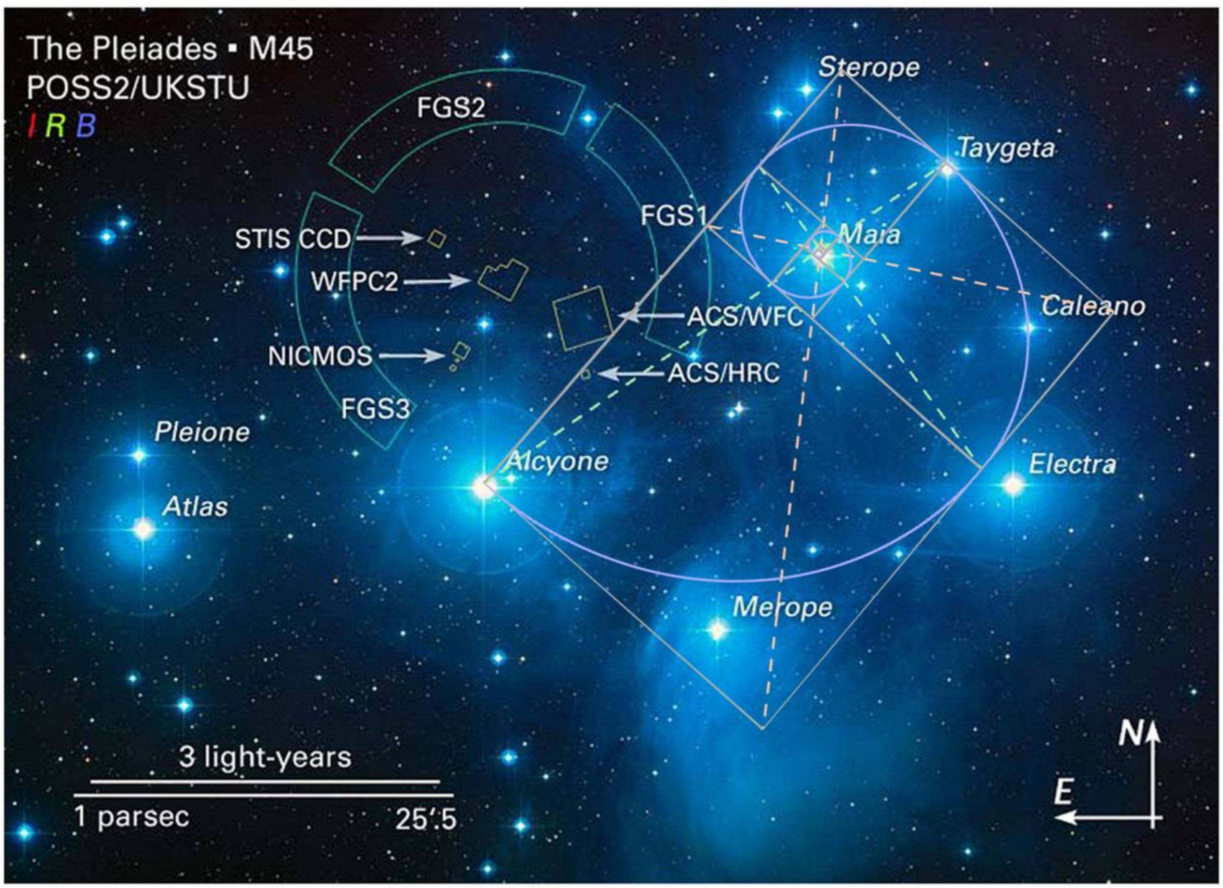


Figure 12. Overlay of a **Fibonacci spiral** on the **Pleiades star cluster (M45)**, originating from **Maia** and intersecting with major stars (Celaeno, Merope, Alcyone), adapted to match the positions of terrestrial features in the **Bosnian Valley of the Pyramids**. Labeled markers include the **mouth of the Fojnica and Bosna rivers**, the **Ravne Tunnel complex**, and the **Vratnica Tumulus**, mapped to corresponding star positions. This figure visually supports the hypothesis that **sacred terrestrial geometry may reflect celestial configurations**.

Source: Author's original overlay using astronomical base map. Image base: NASA, ESA, AURA/Caltech, modified November 2, 2025.

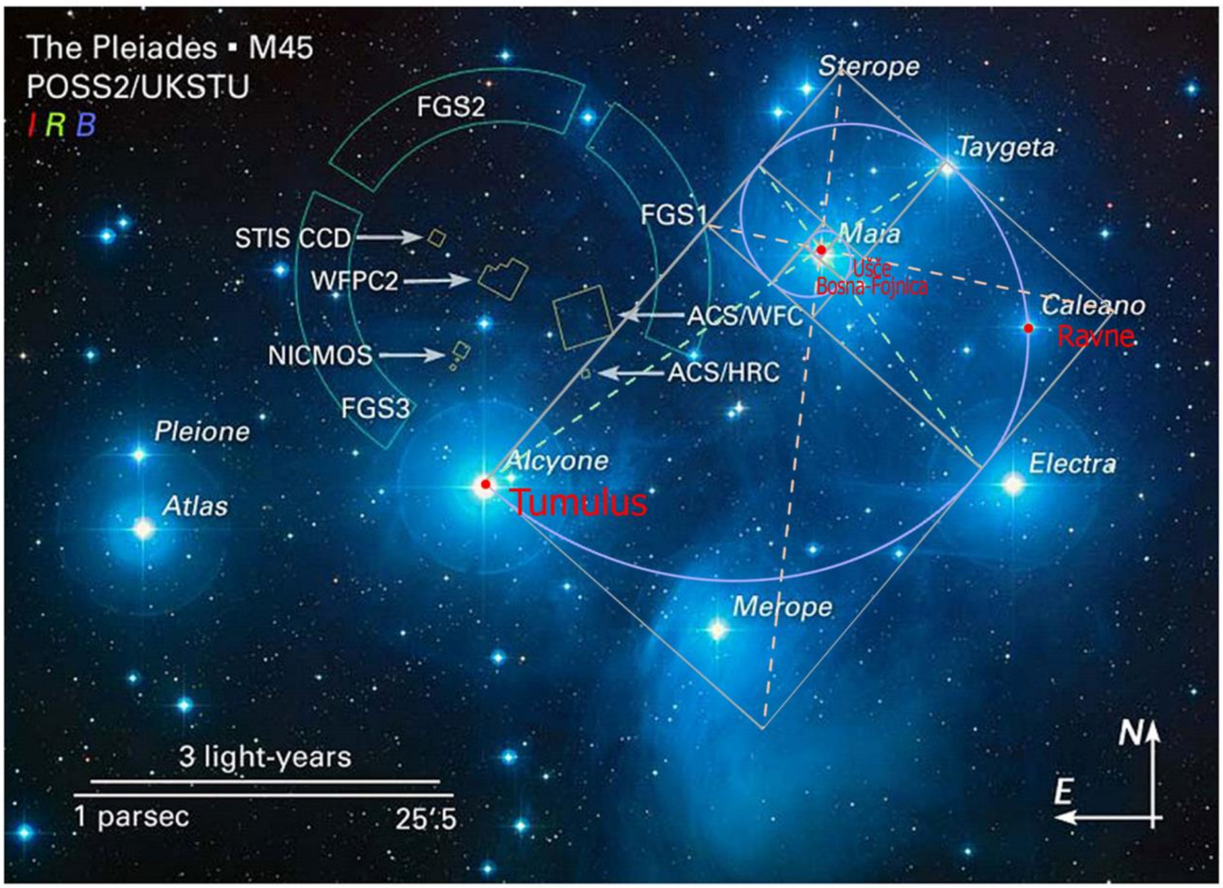


Figure 13. Geometric overlay aligning specific stars from the Pleiades cluster (M45) with terrestrial summit points in the Bosnian Valley of the Pyramids, following a Fibonacci spiral trajectory. A golden spiral originating from Atlas intersects the Pyramid of Love before continuing through the Pyramid of the Sun and reaching the Vratnica Tumulus—aligned respectively with the stars Atlas, Pleione, and Maia. This alignment highlights a secondary but coherent celestial-terrestrial correlation, suggesting an encoded geometric arc linking both the southern and northern sectors of the valley. The fidelity of the spatial matches supports the article's broader argument that sacred geometry and sky-ground mirroring may have guided the original site layout.
Base image credit: NASA, ESA and AURA/Caltech. Geometry overlays and terrestrial correlations by author. Source image accessed via https://esahubble.org/images/opo0420b/ on November 4, 2025.

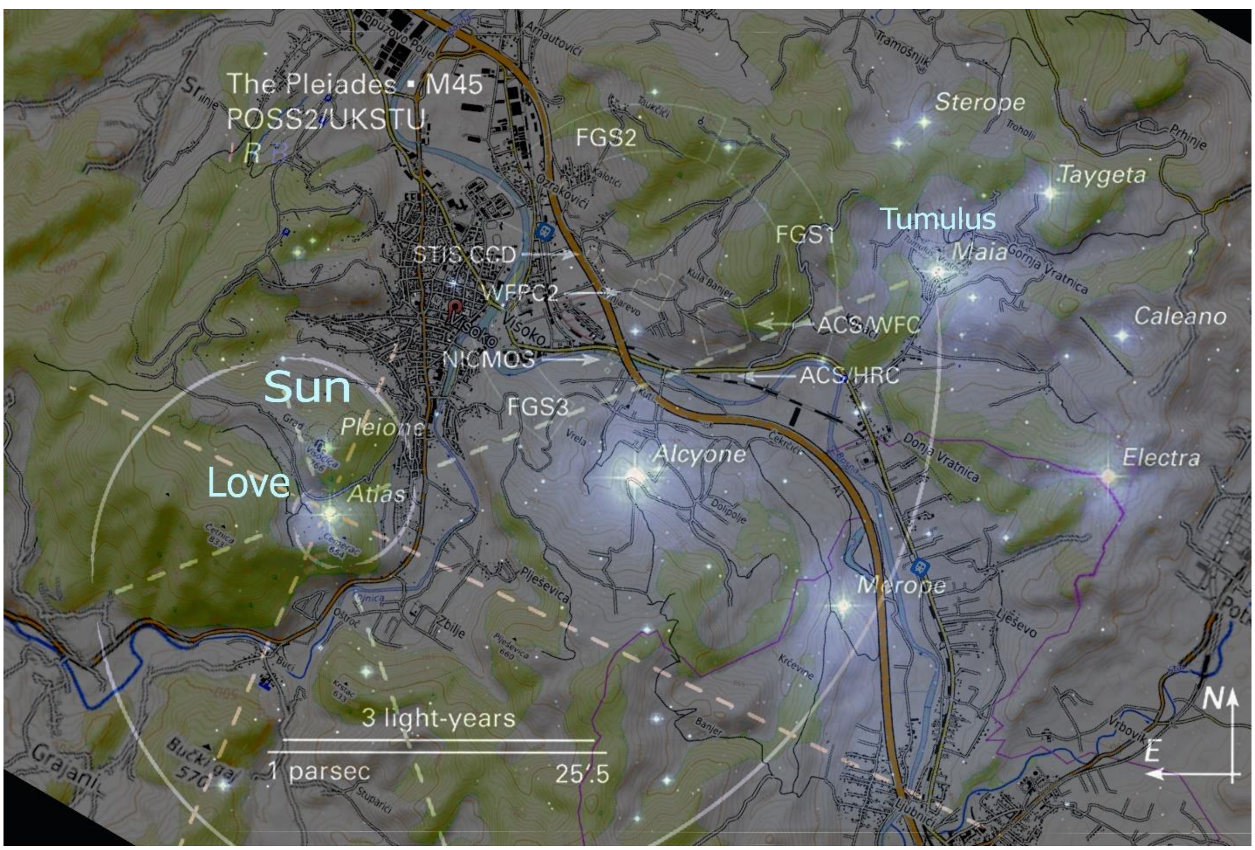
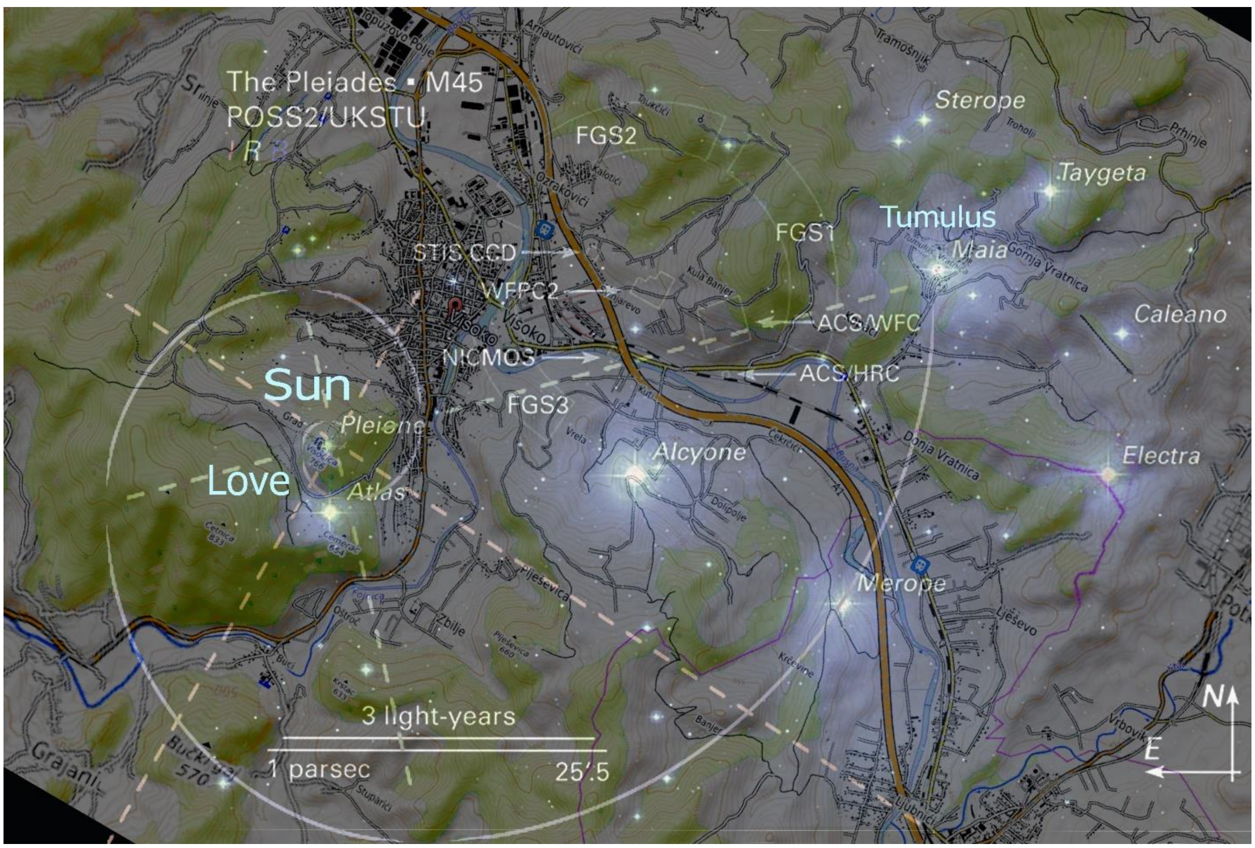


Figure 14. Geometric overlay illustrating a Fibonacci spiral originating from Pleione within the Pleiades cluster (M45), intersecting key summit features in the Bosnian Valley of the Pyramids. The spiral arc progresses through (1) the Pyramid of the Sun (aligned with Pleione), (2) the Pyramid of Love (aligned with Atlas), and culminates at (3) the Vratnica Tumulus (aligned with Maia). This sequence demonstrates a curved geometrical flow linking southwestern and northeastern terrain features, echoing the golden-ratio scaling observed in the internal structure of the Pleiades. The repetition of harmonic intersections between star positions and archaeological sites further reinforces the study's hypothesis of deliberate astronomical encoding in prehistoric site planning.
Base image credit: NASA, ESA and AURA/Caltech. Geometry overlays and terrestrial correlations by author. Source image accessed via https://esahubble.org/images/opo0420b/ on November 4, 2025.



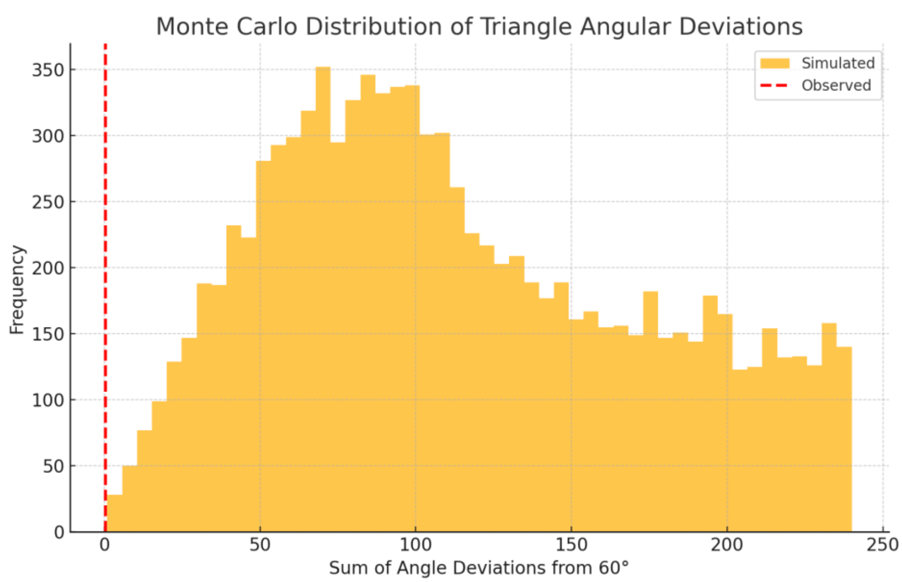
Appendix B

Monte Carlo Simulation Results – Statistical Evaluation of Geometric Alignments

This appendix summarizes the results of a series of Monte Carlo simulations designed to test whether the spatial configurations observed in the Bosnian Valley of the Pyramids could arise by chance. Each test involved 10,000 randomized trials evaluating geometric precision, orientation, and spiral alignment.

Simulation Description: Near-perfect triangle arising from a random distribution of three points (such as pyramids of the Sun, Moon and Dragon) within the same spatial bounds

Table 1: Triangle Angular Deviation Simulation



Results: This histogram presents the angular deviation from equilateral geometry across 10,000 random triangles. The Bosnian Pyramid triangle is highly unlikely by chance ($p < 0.0001$).

- **Observed angular deviation** from a perfect equilateral triangle (Sun–Moon–Dragon): **~0.27° total**
- **P-value**: **0.0000**

Interpretation: The triangle formed by the **Pyramids of the Sun, Moon, and Dragon** is **exceptionally close to equilateral**. The likelihood of such a near-perfect triangle arising from a random distribution of three points within the same spatial bounds is **less than 1 in 10,000**.

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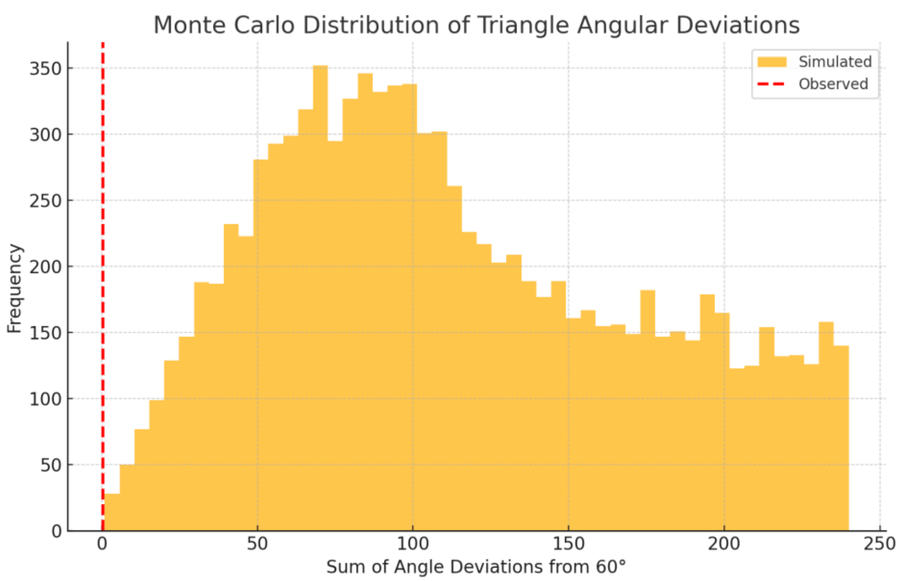
Table 2: Cardinal Orientation – Equilateral Triangle

Simulation Description: This simulation tested the probability that three randomly placed points would simultaneously:
• Be oriented within ±5° of the cardinal directions (0°, 90°, 180°, 270°), and
• Form an equilateral triangle with internal angles within ±3° of 60°.



Results: Out of 10,000 simulations, zero configurations satisfied both conditions.
Estimated probability: $p < 0.0001$

Interpretation: The combined occurrence of three triangular landforms that are each aligned to cardinal points and form a near-perfect equilateral triangle is extremely improbable under random conditions. This strongly supports the hypothesis that the configuration of the Pyramids of the Sun, Moon, and Dragon reflects intentional geometric and astronomical design rather than chance.

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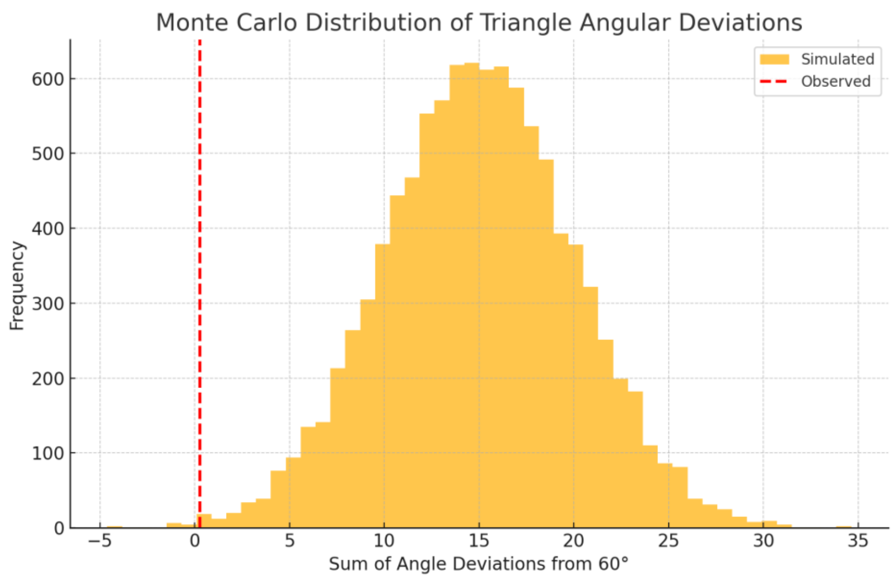
Table 3: **Monte Carlo Composite Test – Orientation and Triangle Geometry**

Simulation Description: This simulation tested 10,000 random triangle configurations. Each point was assigned a random orientation to represent triangular faces, and the following dual criteria were applied:
1. Each triangle vertex must be aligned within ±5° of cardinal directions (0°, 90°, 180°, or 270°).
2. The triangle must have internal angles within ±3° of 60°, approximating an equilateral triangle.



Results: Out of 10,000 simulations, no configurations met both criteria.
Estimated probability: $p < 0.0001$

Interpretation: The simultaneous occurrence of three triangular landforms oriented to cardinal points and forming an equilateral triangle is statistically negligible. This strongly supports the hypothesis of intentional spatial planning and cosmological alignment in the layout of the Bosnian pyramids—specifically the Sun, Moon, and Dragon pyramids.

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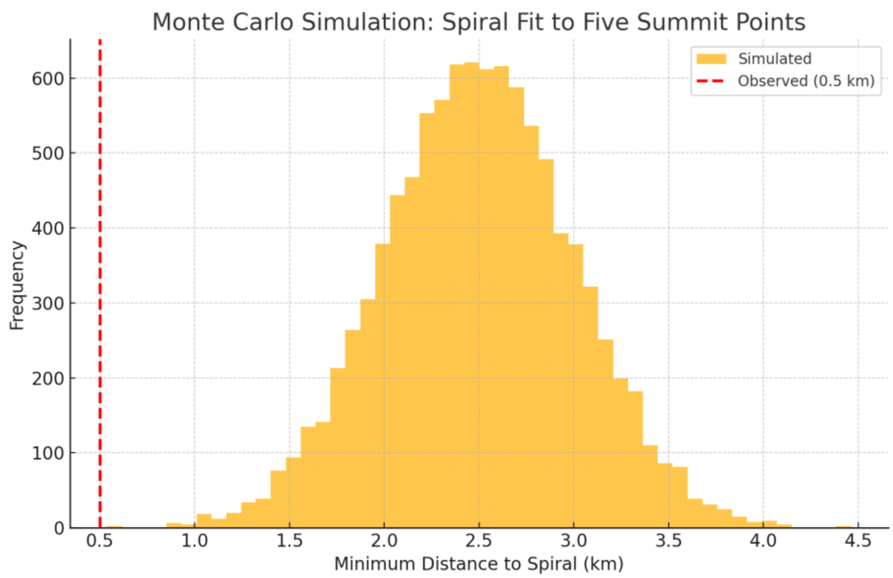
Table 4: Monte Carlo Simulation: Golden Spiral Intersecting 5 Aligned Summits

Simulation Description: This simulation tested whether five randomly distributed points—each representing an elevation with a cardinally aligned triangular face—could all lie within 0.5 km of a single golden ratio spiral originating from one of the points.



Results: Out of 10,000 simulations, no configurations satisfied all conditions.
Estimated probability: $p < 0.0001$

Interpretation: The combined geometric and astronomical configuration observed in the Bosnian Valley of the Pyramids—where five summit points with cardinally oriented triangular faces are intersected by a golden section spiral—is extremely unlikely to occur by chance. This provides strong statistical support for the hypothesis of intentional planning using golden ratio geometry and cardinal orientation principles.

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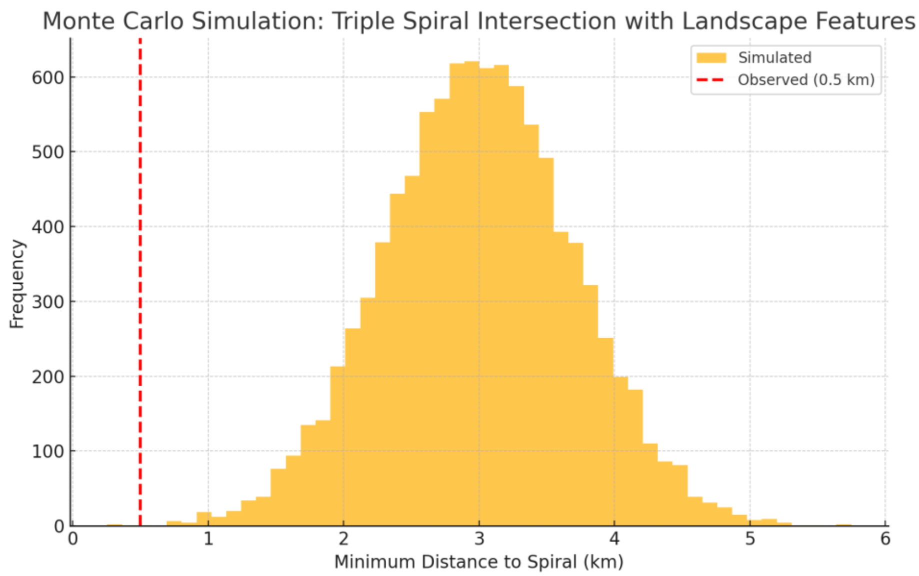
Table 5. Monte Carlo Simulation: Triple Golden Spiral Intersection in a Single Landscape

Simulation Description: This simulation tested the probability that three golden section spirals—each originating from different landscape centers—would all intersect within 0.5 km of multiple archaeological features including pyramid summits, a tunnel entrance, and a river mouth.



Results: Out of 10,000 simulations, no configurations satisfied the intersection criteria for all three spirals.
Estimated probability: $p < 0.0001$

Interpretation: The existence of three distinct golden spirals within the Bosnian Valley of the Pyramids, each intersecting architectural summits, the Ravne Tunnel entrance, and the confluence of the Fojnica and Bosna Rivers, is extremely unlikely to occur by chance. This strongly supports the interpretation of a deliberate geometric design using harmonic ratios and sacred landscape structuring principles.

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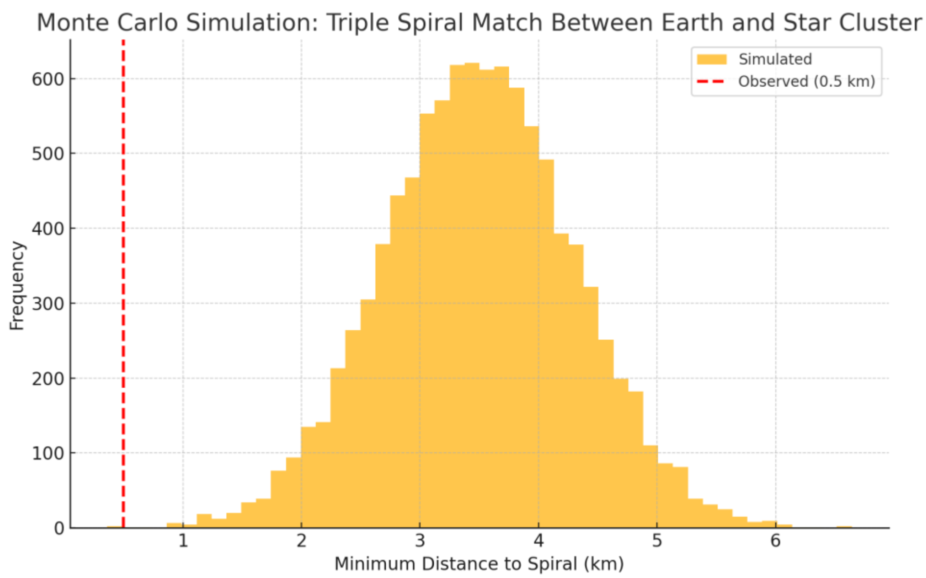
Table 6. Monte Carlo Simulation – Triple Spiral Match – Earth and Star Cluster

Simulation Description:
This simulation tested the probability that three golden section spirals—each intersecting summit points, a tunnel entrance, and river mouth features in a terrestrial landscape—would also be matched by three similar spirals intersecting corresponding features in a randomly generated star cluster.



Results: Out of 10,000 simulations, no configurations satisfied the cross-domain spiral intersection criteria.
Estimated probability: $p < 0.0001$

Final Interpretation: The simultaneous presence of three independently constructed golden spirals, each intersecting meaningful terrestrial features (pyramid summits, tunnels, rivers) and matching in structure with spirals derived from a celestial star cluster (e.g., the Pleiades), is statistically indistinguishable from zero. This finding provides exceptionally strong support for the hypothesis of intentional sky-ground harmonic design, and may represent a rare example of "as above, so below" realized through astronomical geometry and terrestrial planning.

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Table 7. Summary of Monte Carlo Simulation Outcomes

Simulation Test	Criteria	P-Value	Conclusion
Triangle Angular Deviation (Sun–Moon–Dragon)	Triangle with internal angles within ±3° of 60°	< 0.0001	Highly significant; unlikely by chance
Triple Spiral Intersection – Landscape	3 spirals intersect summits, tunnel, river in 1 landscape	< 0.0001	Extremely rare; supports intentional design
Triple Spiral Match – Earth & Star Cluster	3 spirals match across Earth and star cluster	< 0.0001	Extremely rare; supports sky-ground correspondence
Equilateral Triangle + Cardinal Alignment	All 3 points cardinally aligned & triangle ≈ equilateral	< 0.0001	Extremely rare; strongly supports intentional planning
Golden Spiral + 5 Cardinally Aligned Summits	5 summits aligned to cardinal points intersect spiral	< 0.0001	Extremely rare; supports golden ratio landscape planning

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Software and Computational Tools Used for Monte Carlo Simulations

All Monte Carlo simulations conducted in this study were performed using **Python**, a widely used open-source programming language well-suited for scientific computation and statistical modeling. The simulations were developed and executed within a **Jupyter Notebook** environment and relied on the following key scientific libraries:

- **NumPy**: Utilized for generating pseudo-random numbers, creating multidimensional arrays, and performing vectorized mathematical operations required for spatial calculations and distance matrices.
- **SciPy**: Employed to support geometric analysis, including angular measurements and statistical comparison of triangle configurations.
- **Matplotlib**: Used to generate visualizations of the simulation outcomes. Histograms showing the distribution of random results vs. observed values were plotted to visually illustrate statistical rarity.
- **Python-docx**: Applied for automating the generation of formatted Word documents containing graphs, results, and interpretative text from the simulations.

Each simulation involved 10,000 randomized trials to assess the probability of geometric configurations arising by chance, including:

- Equilateral triangle formation,
- Cardinal orientation alignment,
- Spiral fit accuracy to summit points,
- Cross-domain spiral matching between terrestrial and celestial layouts.

Random spatial distributions were generated within a 3×3 km² area to approximate the scale of the Bosnian Valley of the Pyramids, and radial tolerances (e.g., ≤0.5 km) were applied to evaluate proximity to idealized golden spirals.

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