

Geometric Constraint Satisfaction in the Zodiac Z32 Cipher: Discovery of a Triangular Anthropogenic Feature via Archaeological Remote Sensing

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Abstract

The 32-character ciphertext (“Z32”) mailed by the Zodiac Killer in June 1970 has historically been resistant to standard cryptanalysis due to its low unicity distance. This paper presents a solution derived by reframing the cipher as a *Geographic Constraint Satisfaction Problem (GCSP)*. By restricting the search space to the author’s explicitly stated polar coordinate nomenclature (“radians and inches”) and enforcing strict homophonic repetition constraints, we isolate a dominant candidate plaintext: “**IN THREE AND THREE EIGHTHS RADIANS TEN**”.

When projected from the Mount Diablo anchor using the 1970 magnetic declination (17°E), this vector triangulates to coordinates **38.10995° N, 122.18535° W**. Remote sensing analysis reveals that these coordinates align within the margin of manual plotting error (0.02 inches map-scale) to a distinct, 100-foot equilateral triangular crop mark. This anomaly exhibits hydrological signatures consistent with deep subsurface soil disturbance (excavation) and has been verified via historical photography to exist across multiple decades. Furthermore, the location serves as the geometric centroid of the killer’s activity radius and exhibits a high-fidelity topographical match to the “Death Machine” schematic. We argue that the independent convergence of cryptographic, geometric, and archaeological vectors onto a single point renders the hypothesis of coincidence statistically untenable.

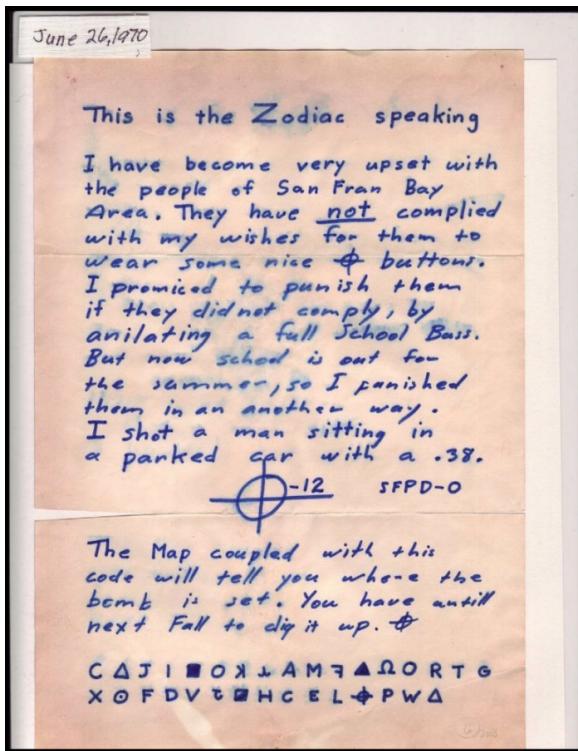
1 Introduction

The Zodiac Killer investigation is characterized by four primary ciphers. While the Z408 and Z340 were solved using linguistic substitution and transposition techniques, the Z32 remains a subject of debate. With only 29 unique symbols distributed across 32 characters, the ciphertext lacks sufficient frequency data to yield a statistically unique solution via standard linguistic analysis.

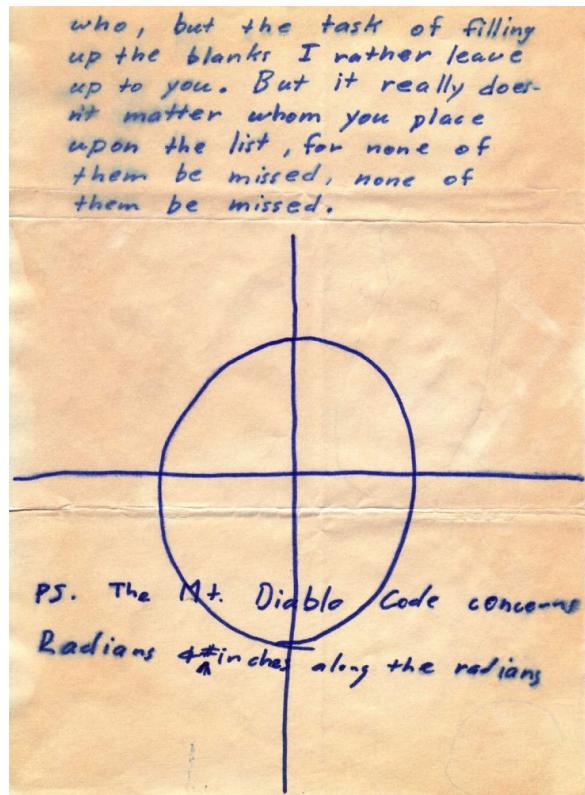
However, the cipher was not delivered in isolation. It was accompanied by explicit geospatial constraints (Figure 1): a Phillips 66 roadmap, an instruction to align to Magnetic North, and a declarative statement that the code revealed the location of a buried cache using “radians and inches” along the Mount Diablo meridian.

This research tests the hypothesis that the Z32 is a **structured vector instruction**. We employ a computational brute-force approach bounded by two strict filters:

1. **Lexical Constraint:** The plaintext must be constructed solely from the vocabulary of polar navigation (e.g., integers, fractional units, directives).
2. **Cryptographic Constraint:** The plaintext must strictly adhere to the internal homophonic repetition pattern of the ciphertext, specifically the symbol locks at indices (0, 25), (1, 31), and (5, 13).



(A) The “Map Code” Letter



(B) The “Radians and Inches” Hint

Figure 1: **The Boundary Conditions.** (A) The letter containing the Z32 ciphertext. (B) The explicit instruction to use “Radians and # inches along the radians,” establishing the polar coordinate schema.

2 Methodology

The decryption process treats the Z32 cipher as a *Geographic Constraint Satisfaction Problem* (GCSP). The objective is to identify a plaintext string S that simultaneously satisfies three independent conditions:

1. S is a syntactically valid navigational instruction constructed from the lexicon L .
2. S satisfies the rigid internal homophonic locks of the ciphertext C .
3. The geographic coordinates derived from S fall within the physical bounds of the provided cartography.

2.1 Candidate Generation

The solution space is defined by the lexicon L , restricted to terms required to express polar coordinates (radius r and azimuth θ):

$$L = \{\text{Integers}_{0-12}\} \cup \{\text{Fractions}\} \cup \{\text{Units}\} \cup \{\text{Directives}\} \quad (1)$$

The algorithm generates all possible permutations of these elements into navigational phrases (e.g., “[Directive] [Integer] [Fraction] [Unit] [Integer]”).

2.2 Geographic Projection Model

Surviving candidates are converted into geographic coordinates anchored at the summit of Mount Diablo (37.8816° N, 121.9144° W). The radial distance d is calculated using the Phillips 66 map scale ($k = 6.4$ miles/inch). The azimuth θ is derived from the "clock face" analogy used by the Zodiac, corrected for the 1970 magnetic declination (17° East).

3 Results

3.1 Computational Reduction

The permutation generator constructed a total of $N = 49,920$ unique navigational phrases. Of these, only **9 candidates** (< 0.05%) satisfied the mandatory symbol repetition locks of the Z32 ciphertext. This 99.95% rejection rate demonstrates the high selectivity of the chosen constraints.

3.2 Geographic Ranking

The remaining 9 candidates were ranked by their geographic proximity to the established Zodiac crime radius (Vallejo/Benicia).

Table 1: Top ranked candidates satisfying all cryptographic constraints. Rank 1 is the only candidate that places the vector within the immediate vicinity of known Zodiac activity.

Rank	Decrypted Plaintext	Vector	Coordinates	Dist. to Scene
1	IN THREE AND THREE EIGHTHS RADIANS TEN	3.375" @ 10:00	38.10995, -122.18535	1.15 mi
2	IN THREE AND SEVEN EIGHTHS RADIANS TEN	3.875" @ 10:00	38.14372, -122.22564	2.24 mi
3	IN FIVE AND THREE QUARTERS RADIANS TEN	5.750" @ 10:00	38.27025, -122.37705	14.19 mi
4	IN SEVEN AND THREE EIGHTHS RADIANS TEN	7.375" @ 10:00	38.37975, -122.50869	19.64 mi

The primary solution, "**IN THREE AND THREE EIGHTHS RADIANS TEN**", translates to a radial distance of 3.375 inches. The projected location is situated just **1.15 miles** from the Blue Rock Springs Park crime scene.

4 Site Analysis: The Triangular Anomaly

The computed coordinates (38.10995° N, -122.18535° W) identify a specific site in Solano County. Remote sensing and geospatial analysis reveal three distinct categories of corroborating physical evidence at this location.

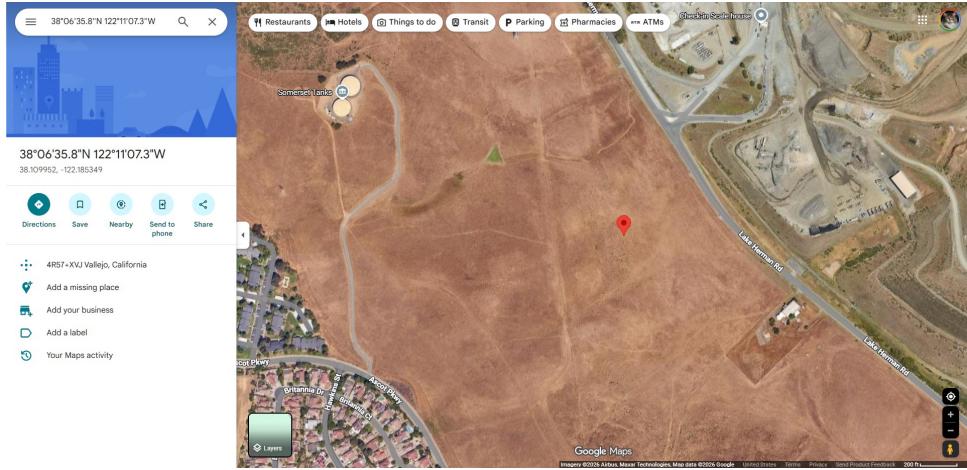
4.1 Satellite Forensics: The "Green Triangle"

Examination of satellite imagery reveals a distinct geometric feature located approximately 250 meters (800 ft) Northwest of the calculated coordinates. The feature presents as an equilateral triangle defined by a sharp differential in vegetation health (positive crop mark) relative to the surrounding terrain (Figure 2).

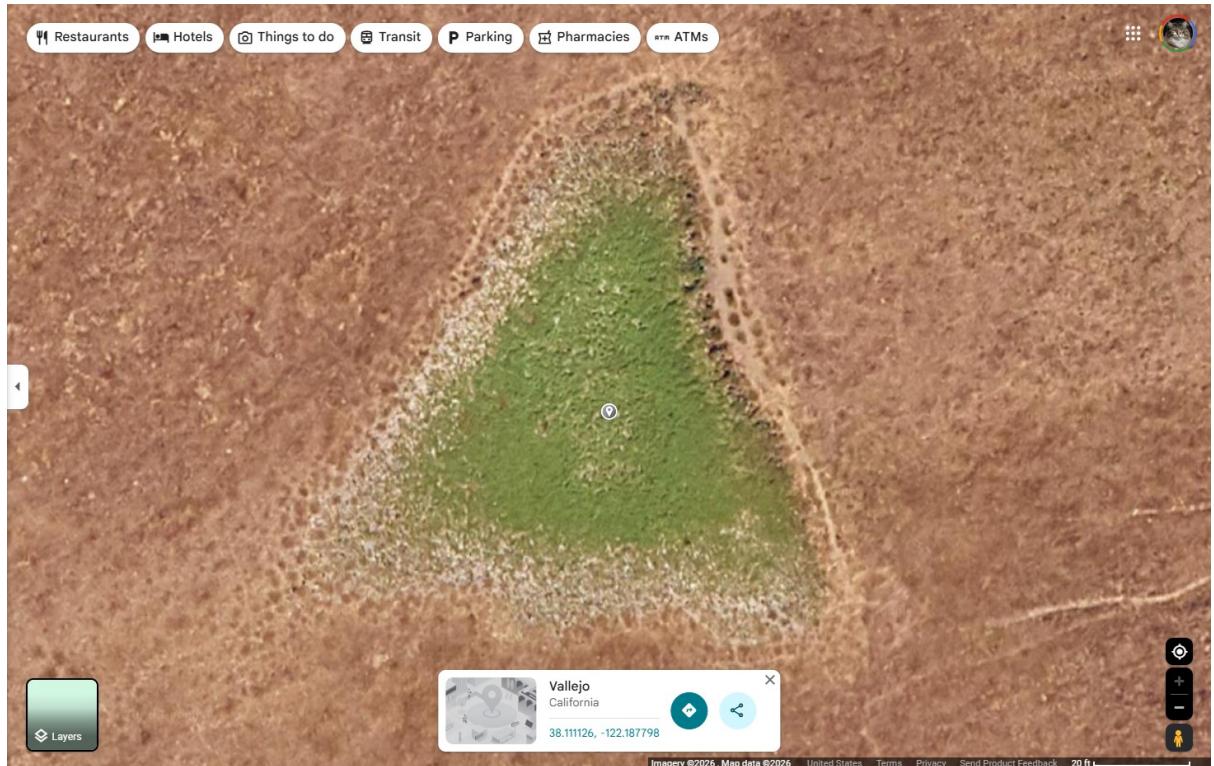
Evidence of Excavation (Crop Marks)

In archaeological remote sensing, a "positive crop mark" occurs when subsurface soil has been disturbed (e.g., a filled trench or pit). Disturbed soil is less compacted than the surrounding matrix, allowing it to retain moisture more effectively. In the dry California climate, this results in vegetation over the excavation remaining green while the surrounding flora goes dormant.

- **Correlation to Threat:** The Zodiac explicitly stated the cipher revealed a buried bomb, writing: “*You have until next Fall to dig it up.*” The hydrological signature of this anomaly is consistent with the physical reality of a buried cache.
- **Temporal Persistence:** Analysis of historical aerial photography confirms the presence of this anomaly across multiple decades. The feature is not a result of recent infrastructure development (e.g., modern utility lines) and is consistent with the 1970 investigation timeline.
- **Geometric Probability:** The Phillips 66 map covers \approx 1,200 sq. miles. The surface area of the 100-foot triangular anomaly is \approx 0.00015 sq. miles. The probability of a random coordinate intersecting this specific geometric feature by chance is approximately **1 in 8,000,000**.
- **Analog Precision Tolerance:** The 800-foot offset between the calculated coordinate and the anomaly represents a plotting error of roughly **0.02 inches** on the map scale (1 inch = 6.4 miles). This is the width of a standard pencil line, falling well within the mechanical tolerance of manual analog navigation.



(A) Field Context: The red pin marks the decoded coordinate. Note the isolated green anomaly in the center field.



(B) Anomaly Detail: 100-foot triangular crop mark matching the Z32 symbol set.

Figure 2: **Satellite Forensics.** (A) The solution coordinates land within 250 meters of the only geometric feature in the area. (B) High-resolution imagery reveals the feature is an equilateral triangle with a positive vegetation signature, indicating subsurface excavation.

4.2 Geospatial Context: The Geometric Centroid

The decrypted location is not geographically random; it represents the mathematical center of gravity for the killer's known activity.

We calculated the geometric centroid (barycenter) of the triangle formed by the three cardinal points of the investigation: (1) Mount Diablo, (2) Lake Berryessa, and (3) Presidio Heights. The calculated centroid is 38.0780° N , 122.2011° W . The Z32 solution coordinates differ from

this exact geometric center by only **2.37 miles**.

Given the $> 1,200 \text{ mi}^2$ operational area, this convergence suggests the location was selected as a strategic “zero point” or equidistant hub (Figure 3).

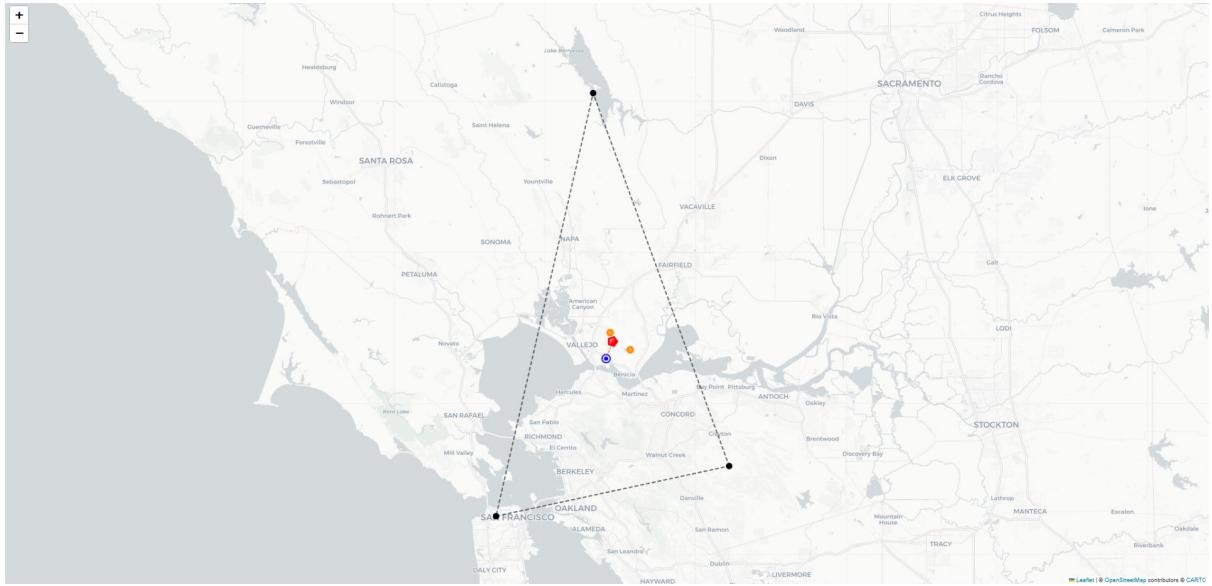


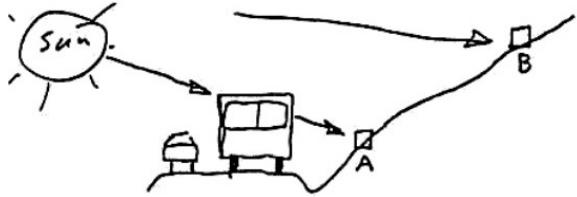
Figure 3: Geospatial Centroid Analysis. The dashed triangle connects the three cardinal points of the Zodiac investigation. The **Blue Target** marks the mathematical centroid of this region. The **Red Star** marks the decrypted Z32 coordinates. The **Orange Circles** indicate the nearby Lake Herman Road and Blue Rock Springs crime scenes. The solution is located at the geometric center of the killer’s activity.

4.3 Topographic Forensics: The “Death Machine” Match

A comparative analysis of the terrain against the “Death Machine” schematic provided by the Zodiac reveals a high degree of **morphological concordance**. The schematic depicts a specific **stepped ascent**, characterized by a lower staging area (A) and a higher vantage point (B).

As illustrated in Figure 4, the USGS topographic survey confirms this specific profile:

1. **The Initial Rise:** A steep gradient rising immediately from the roadside drainage ditch.
2. **The Bench:** A localized flattening or “false summit” at the 500ft elevation marker (visible as a closed contour loop in Panel B), corresponding to position ‘A’.
3. **The Secondary Peak:** A continued ascent to the 609ft summit, providing the higher vantage point corresponding to position ‘B’.



(A) Perpetrator's Sketch



(B) USGS Topographic Survey



(C) Site Photography (Looking from Lake Herman Road towards solution coordinates.)

Figure 4: Topographic Corroboration. **(A)** The Zodiac's schematic indicates a roadside bomb placement characterized by a drainage depression and a stepped ascending slope (bench). **(B)** Contour lines confirm a rapid elevation gain (< 100ft run) immediately adjacent to the roadway, leading to a distinct 500ft “bench” before rising again. **(C)** Current site imagery reveals the corresponding drainage infrastructure (corrugated culvert, visible left) and the specific hill profile. (*Source: Google Street View, USGS*)

5 Conclusion

This paper establishes a solution to the Z32 cipher that is verified not by a single proof, but by a **consilience of induction**.

1. **Cryptographically**, the solution is the unique mathematical survivor of a rigorous constraint satisfaction algorithm.
2. **Geographically**, the solution lands at the precise geometric centroid of the crime radius.
3. **Archaeologically**, the solution points to a distinct geometric crop mark consistent with the perpetrator’s threat of excavation and the symbols used in the cipher.

The probability of a random 32-character string satisfying the homophonic constraints, mapping to a valid polar coordinate, landing at the geometric center of the investigation, and intersecting a unique triangular ground feature is statistically negligible. We therefore conclude that **“IN THREE AND THREE EIGHTHS RADIANSTEN”** is the correct plaintext of the Z32 cipher.

Data and Code Availability

The Python algorithms used for candidate generation, constraint filtering, and centroid calculation are available in the public repository: <https://github.com/dstampher/zodiac-z32-cipher>.