# White Paper

**Title:** Indus “Joint Seal” Hypothesis & Cross‑Cultural Transmission Claims — A Transparent, Pre‑Registered Attempt to Falsify

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## Executive Summary

This white paper documents a rigorous, falsifiable investigation into three related ideas that appear in our internal draft (“The Æon Knowledge Project”):

1. **H1 — Indus “Joint Seal” Hypothesis:** some Indus stamp seals were intentionally manufactured as **paired, interlocking halves** retained by different parties (contractual tokens), rather than only used to make impressions on clay.
2. **H2 — Indus → Maya Transmission:** iconographic/script parallels reflect **trans‑Pacific contact** conveying Indus traditions into the Maya sphere.
3. **H3 — Rongorongo ↔ Semitic:** Easter Island’s **Rongorongo** script derives from (or is closely related to) **Phoenician/Aramaic** alphabets.

**Bottom line so far:**

* We built a **pre‑registered** plan, a **lightweight triage pipeline**, museum outreach templates, and a full **artifact bundle**.
* Using **synthetic data**, the triage pipeline behaves as expected (it reliably surfaces constructed complementary pairs).
* **No real‑world evidence** has yet been produced that confirms H1, H2, or H3. Our literature‑anchored assessment places **H1 as possible but unproven**, and **H2/H3 as not supported** by current consensus. These are provisional conclusions pending primary data acquisition (micro‑CT, FTIR, provenience checks).

We explain the precise tests that could change our minds and the thresholds required to do so.

## Background & Prior Work (Concise)

* **Indus seals**: Mainstream scholarship interprets square stamp seals and their impressions (clay sealings) as **administrative tools** used in trade/record‑keeping. Hundreds of sealings are attested across Indus sites.
* **Maya script**: An **independently developed** logosyllabic writing system; substantially deciphered; no accepted Old‑World parent.
* **Trans‑Pacific contact**: Robust evidence exists for **Polynesia ↔ coastal South America** interaction during the last millennium, but this concerns South America, not the Maya region, and occurs millennia after the Indus urban florescence.
* **Rongorongo**: The script is **undeciphered**; at least one tablet now appears **pre‑contact** by radiocarbon dating; there is **no accepted Semitic derivation**.

**Implication for our work:** Any positive claim must meet a **very high evidentiary bar** that overcomes strong null models (chance visual similarity, independent invention, later contamination, or misread context).

## Research Questions & Hypotheses

### H1 — Indus “Joint Seal” (paired halves)

**Question:** Do any Indus seals represent two intentionally manufactured halves that were **kept by different parties** and physically **dock**?  
**Predictions if true:** - ≥1 **complementary pair** with **3D fracture surfaces** that match far beyond chance,  
- **Residue** consistent with adhesives/resins on mating faces,  
- **Use‑wear** patterns from docking (not stamping),  
- **Contextual linkage** (co‑occurrence, ledger notes),  
- **Absence** of half‑impressions among clay sealings for those halves.

### H2 — Indus → Maya transmission

**Question:** Is there traceable **pre‑Columbian** contact leading to sign/icon transfer from the Indus to Mesoamerica?  
**Strong evidence would include:** pre‑Classic **South Asian genetic signal** in Mesoamerica, stratified **Old‑World artifacts** with geochemical provenance, or **testable epigraphic mappings** that predict readings across unseen texts.

### H3 — Rongorongo ↔ Semitic

**Question:** Does Rongorongo **derive** from a Semitic alphabet?  
**Strong evidence would include:** pre‑contact chronology **plus** a **predictive** grapheme–phonology mapping (e.g., acrophony) that generalizes across multiple tablets.

## Methods Overview

We separate **fast, low‑cost triage** from **slow, decisive tests**.

### Phase 1 — Triage (implemented)

* **Image edge extraction** (dependency‑light): detect edges in top‑down photos of seals/halves.
* **Complementarity heuristic**: mirror one candidate, align both via **PCA** on edge points, compute a **bidirectional Chamfer** distance, convert to a 0–1 **score** (1 = best).
* **Ranking**: compute all pairwise scores within a corpus; export the top‑K for expert vetting and overlay visualization.

**Deliverables produced:** - **Code & Docs**: a runnable triage script; README; pre‑registration doc; museum request templates; checklists; report template; OSF prereg text. - **Synthetic demo**: generated pseudo‑seals split by a jagged line; pipeline successfully ranks the true pairs at the top. - **Overlays**: side‑by‑side panels (A / mirrored‑B / overlay) to accelerate human review.

Note: Triage **does not prove** a pair; it only proposes **candidates** for lab testing.

### Phase 2 — Expert Vetting (planned)

* Human inspection of top‑scoring pairs with overlays; elimination of false positives; selection of **N** best candidates for lab work.

### Phase 3 — Strong Tests (planned)

* **Micro‑CT**: reconstruct meshes of candidate halves; compute **RMS surface distance** and surface overlap after registration; pre‑registered pass threshold: **≤ 0.15 mm RMS** and **Bayes factor ≥ 10** vs null pairing.
* **FTIR‑ATR** (and, if approved, **GC‑MS** micro‑sampling): check for **adhesive/resin** signatures on mating faces; control against non‑mating faces.
* **Use‑wear microscopy**: edge‑wear consistent/inconsistent with **docking** vs stamping.
* **Context audit**: provenience logs, locus/stratum, any ledger cross‑references.
* **Clay sealing cross‑check**: confirm **absence** of corresponding half‑impressions.

### Bias Control & Reproducibility

* **Pre‑registration** with fixed thresholds and stopping rules.
* **Site‑stratified null models** and **synthetic controls**.
* **Blinding**: lab staff blind to triage scores during microscopy/chemistry.
* **Open materials**: code under MIT; anonymized outputs shared; raw museum data per agreements.

## Results to Date (Transparent)

* **Triage pipeline**: implemented and tested on **synthetic** data only; it ranked constructed complementary pairs at the top, as designed.
* **Real corpus**: **no museum images analyzed yet** (awaiting permissions). No claims are made about actual Indus objects at this time.
* **Pre‑registration**: written and parameterized (thresholds, Bayes plan, stopping rules).
* **Operational docs**: museum request email, non‑destructive MOU draft, lab checklist, short report template, and OSF prereg text are ready for use.

**Interim scientific verdicts (provisional, subject to change with data):** - **H1 (Joint Seal):** *Unproven.* The hypothesis is biologically/technically plausible in principle but currently **unsupported** by published specialist literature we are aware of. We have articulated **clear tests** that could validate or falsify it. - **H2 (Indus → Maya):** *Not supported.* No convergent genetic/archaeological/epigraphic evidence presently substantiates this route. We would require **multiple independent lines** (aDNA + artifacts + predictive epigraphy) to reconsider. - **H3 (Rongorongo ↔ Semitic):** *Not supported.* Even with a likely pre‑contact date for at least one tablet, there is **no accepted** Semitic derivation; only a **predictive** reading across tablets would be persuasive.

## What Would Change Our Minds (Decision Criteria)

* **For H1:** at least one independently replicated **matched pair** with (a) **≤ 0.15 mm RMS** after registration, (b) **adhesive/resin** signatures on both mating faces (control‑corrected, FDR ≤ 5%), (c) **contextual linkage**, and (d) no contradicting **half‑impressions**.
* **For H2:** pre‑Classic **South Asian admixture** signal in Mesoamerica **plus** stratified **Old‑World artifacts** with South Asian provenance **plus** a **predictive** mapping from Indus signs to early Mesoamerican texts.
* **For H3:** pre‑contact chronology **plus** a **graphemic/phonological mapping** that produces **correct readings** on held‑out Rongorongo texts.

If these criteria are **not** met after adequately powered searches, we will **withdraw** the corresponding claims.

## Limitations & Risks

* **Triage ≠ proof**: The current pipeline is a heuristic; real seals have varied wear, lighting, and restoration history.
* **Data access**: Non‑destructive analysis depends on museum permissions and conservation constraints.
* **Contamination/confounding**: Residue signals can reflect conservation treatments; rigorous controls are required.
* **Publication bias**: Negative results are valuable here and will be reported.

## Next Steps & Timeline (Indicative)

1. **Outreach (Weeks 1–4):** Send museum request package; schedule micro‑CT/FTIR sessions for shortlisted collections.
2. **Corpus Ingestion (Weeks 2–8):** Acquire high‑res imagery for triage; run pipeline; produce ranked lists and overlays.
3. **Lab Phase (Weeks 6–16):** Micro‑CT, FTIR‑ATR (and optional GC‑MS) on N best candidates; document with lab checklist; return short reports to museums.
4. **Synthesis (Weeks 14–20):** Compute Bayes factors; finalize verdicts and archive all code/data/decisions.

**Stopping rule:** Halt the project if no triage scores exceed **0.82** across a representative corpus **or** after **N = 30** lab tests yield **no** BF ≥ 10.

## Transparency & Data Availability

All project artifacts produced so far are available in the working bundle (code, docs, overlays, CSVs). Museum‑derived raw data will be governed by institutional agreements; anonymized derivatives and code will be public.

* Triage outputs (synthetic) and overlays
* Pre‑registration (markdown)
* Museum request email template, non‑destructive MOU, lab checklist, short‑report template
* OSF preregistration text

Upon request, we will export a **PDF** of this white paper and deposit all non‑restricted materials in an open repository.

## Ethical Stance & Conflict Disclosure

* We commit to **publish negative results**.
* We will not perform destructive testing without explicit written consent from collections staff.
* No known conflicts of interest at this time. Funding/affiliations will be disclosed if they arise.

## Acknowledgments

We thank collection professionals and conservators whose expertise and stewardship make rigorous tests possible. Any errors or oversights in this document are ours, and we welcome corrections.

## References (indicative anchors; full bibliography to be compiled post‑permissions)

* Indus seals & sealings: excavation reports and syntheses by leading Indus scholars.
* Maya script: standard decipherment literature and overviews.
* Polynesia ↔ South America contact: recent population genetics and archaeology syntheses.
* Rongorongo: sign catalogs, typology studies, and recent radiocarbon work.

(*A properly formatted reference list will be inserted after we align museum permissions with citable sources and finalize the corpus list.*)

## Appendix A — Triage Scoring (Technical Summary)

**Edge extraction:** grayscale → edge filter → adaptive threshold → sample ≤ 200 edge points.  
**Normalization & alignment:** scale to unit box; principal‑axis alignment via PCA.  
**Complementarity:** mirror candidate B in X, compute **Chamfer distance** A↔B, convert to score ∈ [0,1].  
**Ranking:** compute all pairwise scores; export top‑K for vetting; generate overlays (A | mirrored‑B | blended with red/blue edge overlays).

**Synthetic validation:** constructed pairs consistently occupy the top ranks, demonstrating the pipeline’s capacity to surface complementary shapes for human review. Real‑world validation remains pending museum access.

## Appendix B — Pre‑Registration (Key Thresholds)

* **T1 (Triage pass):** score ≥ **0.82**
* **T2 (3D pass):** RMS ≤ **0.15 mm** and **BF ≥ 10** vs null
* **Chemistry:** adhesive/resin signature on **both mating faces**, absent on non‑mating controls (FDR ≤ 5%)
* **Context:** co‑occurrence/ledger linkage
* **Contradiction check:** lack of matching half‑impressions among known clay sealings

*Contact:* [Your email]  
*Project page / repository:* [Link to be added]