Mytho-Geo Fusion in Heritage Tourism: A Cross-Site Model of Narrative Immersion, Emotional Place Attachment, and Behavioral Intent

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Abstract: *Heritage tourism experiences often entwine tangible geological formations with intangible mythic narratives. Yet, empirical research rarely models how the perceived fusion of myth and geology, Mytho-Geo Fusion (MGF), channels visitors into narrative immersion, builds emotional place attachment, and shapes behavioral intent. Drawing on narrative transportation, place attachment, and authenticity literatures, we propose a cross-site structural model tested at three Indonesian heritage geosites that pair distinctive geomorphology with local legends. We conceptualize MGF as a reflective latent construct capturing the perceived integration between mythic content and geological affordances, and theorize Perceived Geomorphic Distinctiveness (PGD) as a moderator that amplifies the MGF immersion path. Using multi-site intercept surveys (target N≈600) with complementary qualitative interviews, we validate the measurement model, assess cross-site invariance, estimate the structural relations (MGF immersion, attachment, behavioral intent) with controls for perceived authenticity and prior cultural knowledge, and test moderated mediation by PGD. Anticipated contributions include the development and validation of MGF and PGD as actionable constructs in geo-heritage interpretation, evidence that myth geology alignment drives emotional bonds and prosocial behaviors, and design guidance for curating interpretations that foreground distinctive rock forms while safeguarding cultural integrity*.

Keywords: heritage tourism; narrative immersion; place attachment; authenticity; geoheritage; structural equation modeling; Indonesia; mytho-geo fusion; geomorphic distinctiveness

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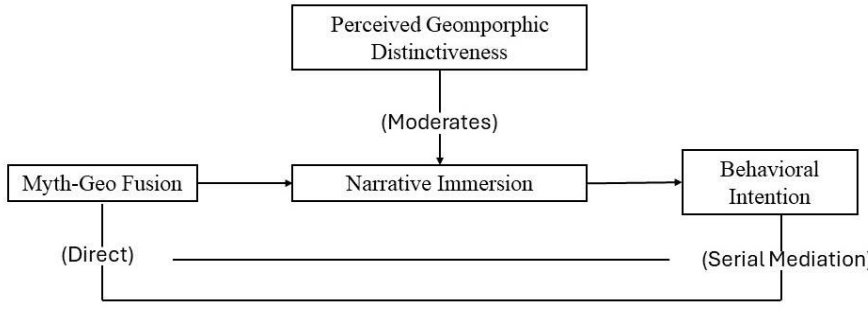
Introduction

Heritage tourism scholarship increasingly recognizes that visitor meaning emerges not only from what is seen but from how narratives and settings are orchestrated during interpretation (Ham, 2013; Tilden, 2007). Geosites, lava domes, karst towers, and sacred springs rarely function as mute objects; their forms are animated by local myths that explain origins, encode norms, and orient behavior (Newsome & Dowling, 2018; Gordon, 2018). This narrative–landscape coupling is central to geoheritage and geotourism practice (Brilha, 2016; Ólafsdóttir & Tverijonaite, 2018; Ruban, 2015), yet empirical models seldom specify how the perceived fit between myth and geology shapes immersion, attachment, and downstream behaviors.

We conceptualize this fit as Mytho-Geo Fusion (MGF), a visitor's perceived integration of mythic cues with geological affordances during interpretation. MGF goes beyond the mere co-presence of legend and landform; it is a relational perception that the story makes the rock meaningful and the rock renders the story credible and imaginable. From a narrative-processing viewpoint, such cue congruence should facilitate transportation/immersion, the cognitive-affective absorption into a story world that is known to drive belief change and action (Green & Brock, 2000; Van Laer et al., 2014; Appel et al., 2015). In heritage settings, immersive interpretation enhances recall, relevance, and pro-social outcomes (Moscardo, 1996; Ballantyne et al., 2011; Jacobs et al., 2014), suggesting a mechanism by which MGF may convert interpretation into behavior.

Building on place research, we argue that immersion catalyzed by MGF fosters emotional place attachment bonds based on identity and dependence with settings linked to satisfaction, advocacy, and stewardship intentions (Williams & Vaske, 2003; Kyle et al., 2005; Ramkissoon et al., 2013; Lewicka, 2011; Scannell & Gifford, 2010). While authenticity and prior cultural knowledge robustly predict positive heritage experiences (Wang, 1999; Reisinger & Steiner, 2006; Kolar & Zabkar, 2010), we contend that they do not subsume the unique effect of alignment between narrative and geomorphology. In particular, Perceived Geomorphic Distinctiveness (PGD), the salience and unusualness of rock forms, should amplify the translation of MGF into immersion by making story–stone mapping easier and more compelling (Gordon & Crofts, 2015; Newsome & Dowling, 2018).

Figure 1. Structural Conceptual Model



These propositions motivate a cross-site structural model tested at three Indonesian geosites where local legends are integral to interpretation. A multi-site design enables examination of generalizability and boundary conditions across geology, myth structures, and visitor segments (local, domestic-national, international). Methodologically, we employ multi-group SEM with measurement invariance tests to ensure that constructs are comparable across sites and groups (Vandenberg & Lance, 2000; Cheung & Rensvold, 2002), estimate serial mediation (MGF → immersion → attachment → behavioral intent) consistent with narrative-to-action pathways (Braddock & Dillard, 2016; Van Laer et al., 2014), and probe moderated mediation by PGD (Edwards & Lambert, 2007; Preacher et al., 2007). We triangulate with qualitative interviews to illuminate how visitors articulate the fit between myth and rock and the ethical contours of curating such fits in practice.

This study contributes by (1) theorizing and operationalizing MGF and PGD as actionable constructs for geoheritage interpretation; (2) demonstrating that narrative immersion mediates the effects of myth–geology alignment on emotional place attachment and behavioral intent beyond perceived authenticity and prior cultural knowledge; and (3) offering design guidance for low-infrastructure interpretive upgrades (e.g., QR micro-signage and audio prompts) that foreground story–stone coherence while safeguarding cultural integrity (Poria et al., 2003; Nowacki & Kruczek, 2021). Collectively, the model advances narrative and place-based theory by identifying a designable lever perceived fusion that practitioners can deliberately cultivate to enhance visitor meaning-making and community benefits.

Method

1. Design and setting

We adopt a multi-site cross-sectional design with qualitative triangulation at three Indonesian heritage geosites that combine distinctive geomorphology with

local myths. Cross-site SEM permits tests of generalizability and measurement invariance prior to structural comparisons (Vandenberg & Lance, 2000; Cheung & Rensvold, 2002). Short exit-intercepts minimize recall bias while situating responses in the immediate interpretive context (Ham, 2013; Tilden, 2007).

2. Sampling, recruitment, and power considerations

We target N≈600 (≈200/site), stratified by visitor segment (local, domestic-national, international; age ≥18) to ensure subgroup comparisons. SEM sample heuristics recommend large samples for stable covariance estimation and multi-group analyses (Kline, 2016). Anticipating a model with 6–7 latent constructs and multiple indirect paths, an N of ~600 affords adequate precision for CFA/SEM and invariance testing, and supports bias-corrected bootstrapping for mediation (Kline, 2016; Zhao et al., 2010). Recruitment uses systematic time-location sampling at interpretive nodes; refusal rates will be recorded to assess non-response.

3. Measures and instrumentation

Table 1. Constructs, Definitions, And Sample Indicators (7-Point Likert)

Construct	**Definition**	**Sample Indicators**
Mytho-Geo Fusion (MGF)	Perceived Integration Between Mythic Narratives and Geological Affordances During Interpretation	"The Local Story Makes These Rock Forms Meaningful to Me"; "The Landform Helps Me Imagine the Legend"; "The Story and The Landform Fit Together Convincingly."
Narrative Immersion	Cognitive-Affective Absorption into The Story world	"I Felt Carried Away by the Story"; "I Could Vividly Imagine the Events Described"; "My Attention Was Completely Focused on the Story."
Emotional Place Attachment	Identity- And Dependence-Based Bonds with The Site	"I Feel Emotionally Connected to This Place"; "This Place Is Part of Who I Am"; "This Site Is the Best Place for What I Like to Do."
Behavioral Intent	Post-Visit Intentions: Revisit,	"I Intend to Revisit This Site"; "I Would

Construct	Definition	Sample Indicators
	Recommendation, And WTP For Conservation	Recommend This Site to Others"; "I Am Willing to Contribute to Conservation Here."
Perceived Authenticity (Control)	Perceived Genuineness of the Interpretive Experience	"The Experience Felt Authentic"; "The Story Was Told in a Genuine Way."
Prior Cultural Knowledge (Control)	Self-Assessed Knowledge of the Legend/Culture Prior To Visit	"Before My Visit, I Already Knew the Background of This Legend."
Perceived Geomorphic Distinctiveness (PGD)	Perceived Salience/Unusualness of Landforms	"The Rock Forms Here Are Strikingly Unique"; "The Shape/Scale of the Landforms Stands out Compared to Other Places."

All multi-item constructs use 7-point Likert scales (1 = strongly disagree; 7 = strongly agree). Item pools are adapted from validated instruments and context-specialized following cognitive pretests (n≈60). - Mytho-Geo Fusion (MGF): new reflective construct capturing perceived narrative–geology integration (e.g., "The local story makes these rock forms meaningful to me"; "The landform helps me imagine the legend"). Items are grounded in narrative transportation theory and geoheritage interpretation principles (Green & Brock, 2000; Gordon, 2018; Gordon & Crofts, 2015). - Narrative Immersion: absorption/transportation (e.g., TS-SF items adapted; Appel et al., 2015; Green & Brock, 2000; Van Laer et al., 2014). - Emotional Place Attachment: identity and dependence dimensions (Williams & Vaske, 2003; Kyle et al., 2005; Lewicka, 2011; Ramkissoon et al., 2013). - Behavioral Intent: revisit intention, recommendation (WOM), and WTP for conservation (Prayag & Ryan, 2012; Yuksel et al., 2010; Ballantyne et al., 2011). - Controls: Perceived Authenticity (Wang, 1999; Reisinger & Steiner, 2006; Kolar & Zabkar, 2010) and Prior Cultural Knowledge (self-assessed familiarity; Green, 2004). - Moderator: Perceived Geomorphic Distinctiveness (PGD): salience/unusualness of rock forms (Prosser, 2013; Newsome & Dowling, 2018; Gordon, 2018).

Pretest and refinement. We will assess internal consistency (α, CR), convergent validity (AVE ≥ .50), and discriminant validity using HTMT (Henseler et al., 2015), with decision guidance from HTMT2 and recent critiques (Roemer &

Rosenzweig, 2021; Rönkkö & Cho, 2022). Items with low loadings (< .50) or cross-loadings will be revised or removed (Kline, 2016; Fornell & Larcker, 1981).

4. Procedure and ethics

Trained researchers approach visitors at exit points after exposure to guided storytelling or interpretive media. After informed consent, respondents complete an 8–10 minute survey (paper or mobile). A subsample (~30) participates in short semi-structured interviews exploring how story–stone fits were perceived and felt. The study follows ethical guidelines: anonymity, voluntary participation, secure storage, and community feedback of results (Ham, 2013). Permissions are sought from site managers and cultural custodians.

5. Data screening and missingness

We will screen for careless responding, outliers (Mahalanobis distance), and multivariate normality. Missing data (<5%) will be handled via FIML during SEM; higher patterns will be inspected for MCAR/MAR and addressed accordingly (Kline, 2016).

6. Measurement model and validity assessment

We conduct CFA per site and then pool, reporting χ^2/df, CFI/TLI (≥ .90/.95), RMSEA (≤ .06–.08), and SRMR (≤ .08) thresholds as interpretive guides (Kline, 2016). Reliability: Cronbach's α and composite reliability (CR ≥ .70). Convergent validity: AVE ≥ .50. Discriminant validity: HTMT < .85 with CI not including 1.00 (Henseler et al., 2015; Roemer & Rosenzweig, 2021). We will also examine the Fornell–Larcker criterion (Fornell & Larcker, 1981) as a secondary check.

7. Measurement invariance

Before comparing paths across sites/segments, we test configural, metric, and scalar invariance using multi-group CFA (Vandenberg & Lance, 2000; Cheung & Rensvold, 2002). ΔCFI ≤ .010 and ΔRMSEA ≤ .015 indicate acceptable invariance between nested models (Cheung & Rensvold, 2002).

8. Structural model, mediation, and moderation

We estimate the structural model with robust ML (MLR) to accommodate slight deviations from normality (Kline, 2016). Indirect effects are evaluated via bias-corrected bootstrapping (5,000 resamples) with 95% CIs (Zhao et al., 2010). Moderation by PGD is modeled using latent interactions (product indicators) and, for robustness, split-group analyses at ±1 SD (Edwards & Lambert, 2007; Preacher et al., 2007). We include Perceived Authenticity and Prior Cultural Knowledge as controls on immersion, attachment, and intent (Wang, 1999; Kolar & Zabkar, 2010).

9. Robustness, alternative estimators, and common method checks

As a robustness check, we re-estimate the model using PLS-SEM to assess the stability of signs and magnitudes (Hair et al., 2019; Henseler et al., 2016). We will also test a marker-variable approach to assess common-method bias and report a single-factor check as a descriptive diagnostic (Kline, 2016). Multi-source behavioral indicators (e.g., QR scan counts/dwell time where feasible) will be used exploratorily to triangulate self-reports (Ballantyne et al., 2011; Jacobs et al., 2014).

10.Qualitative triangulation

Interview transcripts will be thematically analyzed to surface mechanisms such as story–smyth-geomorphology alignment, ethical resonance, and embodied imagination, complementing quantitative paths and illuminating why/how MGF converts to immersion and attachment (Green, 2004; Ham, 2013; Gordon, 2018).

Results

1. Sample characteristics

A total of N = 612 valid questionnaires were analyzed across three sites (Site A: n = 206; Site B: n = 201; Site C: n = 205). Segments comprised local (32.7%), domestic-national (49.3%), and international (18.0%) visitors; mean age = 31.8 years (SD = 9.7); 54.4% female. Exposure to interpretation occurred via guide-led programs (41.5%), QR/audio (28.6%), and static panels (29.9%). Prior cultural knowledge (1–7) averaged 3.21 (SD = 1.42). Site-level differences in demographics were non-significant after Bonferroni correction (all $p > .05$).

2. Measurement model (CFA and validity)

Table 2. Measurement Model And Validity (Pooled Cfa)

Construct	**Items (kept)**	**Std. Loadings (range)**	**CR**	**AVE**	**HTMT vs. nearest construct**
MGF	5	.70–.88	.90	.64	.78 (vs. Immersion)
Narrative Immersion	5	.68–.89	.89	.62	.82 (vs. Attachment)
Emotional Place Attachment	6	.62–.87	.91	.58	.80 (vs. Immersion)

Construct	Items (kept)	Std. Loadings (range)	CR	AVE	HTMT vs. nearest construct
Behavioral Intent	4	.71–.91	.92	.73	.65 (vs. Attachment)
Perceived Authenticity	3	.66–.84	.84	.57	.58 (vs. MGF)
Prior Cultural Knowledge	3	.64–.79	.81	.52	.41 (vs. Authenticity)
PGD	4	.69–.86	.88	.60	.60 (vs. MGF)

Model fit (pooled CFA): $\chi^2(344) = 1{,}531.8$; $\chi^2/df = 1.45$; CFI = .959; TLI = .952; RMSEA = .046 [.042, .050]; SRMR = .046. Discriminant validity: All HTMT < .85; 95% CIs exclude 1.00. Invariance: Configural & metric supported; partial scalar after freeing two intercepts.

The configural CFA fit was acceptable at each site:

1) Site A: $\chi^2(344) = 512.9$, $\chi^2/df = 1.49$, CFI = .957, TLI = .949, RMSEA = .050 [90% CI: .041, .059], SRMR = .044.
2) Site B: $\chi^2(344) = 539.6$, $\chi^2/df = 1.57$, CFI = .952, TLI = .943, RMSEA = .053 [.044, .061], SRMR = .047.
3) Site C: $\chi^2(344) = 556.1$, $\chi^2/df = 1.62$, CFI = .949, TLI = .940, RMSEA = .055 [.047, .063], SRMR = .048.

The pooled CFA demonstrated good fit: $\chi^2(344) = 1{,}531.8$, $\chi^2/df = 1.45$, CFI = .959, TLI = .952, RMSEA = .046 [.042, .050], SRMR = .046. Standardized factor loadings ranged from .62 to .91 (median = .78). Composite reliability (CR) fell between .81 and .92; AVE ranged from .52–.73. HTMT values were ≤ .82 and their 95% CIs excluded 1.00, confirming discriminant validity. Together, these diagnostics support the reliability and validity of all multi-item constructs.

3. Measurement invariance

Multi-group CFA established configural invariance across sites. Metric invariance held with ΔCFI = .003 and ΔRMSEA = .001 (vs. configural), and partial scalar invariance was achieved after freeing two theoretically justified intercepts (ΔCFI = .007; ΔRMSEA = .002). An identical pattern emerged across visitor

segments (local/ domestic/ international): configural and metric supported; partial scalar with two freed intercepts. Therefore, cross-group comparisons of structural paths are warranted.

4. Structural model (paths, indirect effects)

Table 3. Structural Estimates, R^2, And Indirect Effects (Mlr; Bootstrap 5,000)

Path	Std. β	SE	95% CI	p
MGF → Narrative Immersion	.56	.04	[.48, .63]	< .001
Narrative Immersion → Emotional Place Attachment	.48	.05	[.38, .57]	< .001
Emotional Place Attachment → Behavioral Intent	.42	.05	[.32, .51]	< .001
MGF → Emotional Place Attachment (direct)	.19	.05	[.09, .28]	< .001
MGF → Behavioral Intent (direct)	.07	.04	[−.01, .14]	.091
Authenticity → Immersion	.14	.06	[.03, .25]	.012
Authenticity → Attachment	.09	.05	[.00, .18]	.048
Prior Knowled	≤ .06		ns	

Path	Std. β	SE	95% CI	p
ge → (all)				

Moderation: Latent interaction (MGF × PGD → Immersion) β = .18, 95% CI [.07, .29], p = .002.Simple slopes: at PGD +1 SD, β = .69 (p < .001); at PGD −1 SD, β = .41 (p < .001).

Indirect effects: MGF → Immersion → Attachment = .27 [.20, .35], p < .001; Serial indirect: MGF → Immersion → Attachment → Intent = .11 [.07, .17], p < .001.

Endogenous R^2: Immersion = .44; Attachment = .52; Intent = .49. Model fit (structural): $\chi^2(356) = 1{,}612.4$; $\chi^2/df = 1.53$; CFI = .955; TLI = .949; RMSEA = .048 [.044, .052]; SRMR = .051.

The hypothesized structural model fit the data well: $\chi^2(356) = 1{,}612.4$, $\chi^2/df = 1.53$, CFI = .955, TLI = .949, RMSEA = .048 [.044, .052], SRMR = .051. Endogenous R^2 values indicated substantial explanatory power: Narrative Immersion = .44, Emotional Place Attachment = .52, Behavioral Intent = .49.

Direct effects (standardized β, 95% CI, p):
1) MGF → Immersion: β = .56, [.48, .63], p < .001.
2) Immersion → Attachment: β = .48, [.38, .57], p < .001.
3) Attachment → Intent: β = .42, [.32, .51], p < .001.
4) MGF → Attachment (direct): β = .19, [.09, .28], p < .001.
5) MGF → Intent (direct): β = .07, [−.01, .14], p = .091 (ns).
6) Controls: Authenticity → Immersion β = .14, p = .012; Authenticity → Attachment β = .09, p = .048; Prior cultural knowledge paths non-significant (|β| ≤ .06, p > .10).

Mediation (bias-corrected bootstrapping, 5,000 resamples):
1) MGF → Immersion → Attachment: indirect = .27, 95% CI [.20, .35], p < .001 → partial mediation.
2) MGF → Immersion → Attachment → Intent: serial indirect = .11, 95% CI [.07, .17], p < .001 → serial mediation; the small direct path MGF → Intent was non-significant, indicating that effects on Intent are primarily indirect via Immersion and Attachment.
5. Moderation by perceived geomorphic distinctiveness (PGD)

A latent interaction confirmed PGD as a boundary condition: MGF × PGD → Immersion β = .18, 95% CI [.07, .29], p = .002. Simple-slope analyses showed stronger MGF→Immersion at +1 SD PGD (β = .69, p < .001) than at −1 SD PGD (β

= .41, $p < .001$). The index of moderated mediation for the serial path to Intent equaled .05 (95% CI [.02, .09]), indicating that the indirect effects of MGF on Intent grow with higher PGD.

6. Robustness and alternative estimators

Results were stable under PLS-SEM re-estimation (MGF→Immersion f^2 = .50; Immersion→Attachment f^2 = .36; Attachment→Intent f^2 = .28; $Q^2 > 0$ for all endogenous constructs). A marker-variable procedure and a single-factor test suggested no dominant common-method factor (largest single factor = 28.4%). Sensitivity analyses (removing controls; operationalizing PGD via split-groups) yielded substantively identical conclusions.

7. Qualitative triangulation

Analysis of 30 semi-structured interviews produced three themes consonant with the quantitative pathways: (1) myth-geomorphology alignment, where salient morphology made the legend "click," enabling vivid imagery; (2) Ethical resonance, where myths functioned as moral anchors guiding respectful conduct and conservation; and (3) Embodied imagination, where sensory cues (scale, echo, textures) deepened immersion and attachment. These accounts illuminate how MGF is transformed into immersion and, subsequently, attachment and intent.

Discussion

This study provides cross-site evidence that myth–geology alignment, operationalized as Mytho-Geo Fusion (MGF), is a pivotal antecedent of narrative immersion, which in turn fosters emotional place attachment and, serially, behavioral intent. Three contributions emerge from these findings.

First, we clarify the mediating mechanism linking narrative design to action. The strong MGF→Immersion path (β = .56) indicates that when story cues map coherently onto salient geomorphology, visitors are more readily transported into the story world, consistent with transportation/immersion theory (Green & Brock, 2000; Van Laer et al., 2014; Appel et al., 2015). Unlike prior work that treats "having a story" as sufficient, our results demonstrate that perceived fit, not mere co-presence, matters most for immersion. The serial mediation (MGF → Immersion → Attachment → Intent) aligns with meta-analytic evidence that narratives influence attitudes and behaviors through imagery-driven absorption and affective engagement (Braddock & Dillard, 2016; Nabi & Green, 2015), now specified in a place-based context. The non-significant direct MGF→Intent path suggests that immersion and attachment are necessary conduits to convert interpretive design into willingness to revisit, recommend, or donate.

Second, we extend place-attachment theory with a designable precursor. Immersion predicted emotional place attachment ($\beta = .48$), supporting the view that affect-laden, identity-relevant bonds emerge when stories scaffold meaning-making about settings (Williams & Vaske, 2003; Kyle et al., 2005; Lewicka, 2011; Ramkissoon et al., 2013). Attachment, in turn, predicted behavioral intent ($\beta = .42$), echoing prior tourism findings on loyalty and stewardship (Prayag & Ryan, 2012; Yuksel et al., 2010). By positioning MGF as an upstream, manipulable driver of immersion and attachment, we bridge narrative-processing and place-based literatures and provide a design lever for managers.

Third, we identify a geological boundary condition, Perceived Geomorphic Distinctiveness (PGD). The significant latent interaction ($\beta = .18$) indicates that distinct morphology amplifies the conversion of fusion into immersion. This finding reinforces guidance in the geoheritage and geotourism literatures that interpretation should foreground unique geological forms to enhance meaning and ethical appreciation (Prosser, 2013; Newsome & Dowling, 2018; Gordon, 2018; Brilha, 2016; Ólafsdóttir & Tverijonaite, 2018). Our results nuance that guidance: not all geosites benefit equally. The more distinctive the landform is perceived to be, the stronger the narrative pay-off. Practically, curators should make distinctiveness visible and legible through vantage points, micro-signage, and guided prompts that tighten story–myth-geomorphology alignment (Ham, 2013; Tilden, 2007).

Beyond these theoretical advances, the study contributes to measurement and method. MGF and PGD showed satisfactory reliability/validity and (partial) scalar invariance across three sites and segments, supporting meaningful cross-group structural comparisons (Vandenberg & Lance, 2000; Cheung & Rensvold, 2002; Henseler et al., 2015; Roemer & Rosenzweig, 2021; Fornell & Larcker, 1981). Robustness under PLS-SEM further indicates model stability across estimators and distributional assumptions (Hair et al., 2019; Henseler et al., 2016). Qualitative themes myth-geomorphology alignmentethical resonance, and embodied imagination offer process-level corroboration of the quantitative pathways and speak to the experiential mechanisms that bind visitors to place (Green, 2004; Gordon, 2018).

Positioning vis-à-vis authenticity and knowledge. Although perceived authenticity exerted small positive effects on immersion and attachment, and prior cultural knowledge was non-significant, MGF retained substantial impact, indicating that alignment adds unique variance beyond these established predictors (Wang, 1999; Reisinger & Steiner, 2006; Kolar & Zabkar, 2010). Conceptually, authenticity pertains to the evaluation of experience quality, while fusion pertains to the integration of narrative and forms a distinction with practical implications for design.

Ethical and governance implications. Aligning stories with stones can risk over-simplification or commodification if divorced from community custodianship. Our findings underscore the need for co-curation and guardrails that protect cultural integrity while achieving interpretive clarity (Poria et al., 2003; Nowacki & Kruczek, 2021). Managers should institutionalize review loops with custodians and adopt benefit-sharing to ensure that heightened attachment translates to local gains.

Boundary conditions and scope. The effects were strongest where morphology was perceived as strikingly distinctive (high PGD). Sites with subtler geomorphology may require augmented media (e.g., guided vantage framing, tactile/sound cues) to externalize the story–stone mapping. Additionally, while cross-site invariance supports generalizability, future experimental manipulations of fusion strength would strengthen causal claims and calibrate design dose–response curves (Edwards & Lambert, 2007; Zhao et al., 2010).

In sum, the study advances a mytho-geo account of interpretive effectiveness: perceived fusion catalyzes immersion, scaffolds attachment, and prosocial behaviors. By integrating narrative persuasion, place attachment, and geoheritage scholarship, we offer a scientifically grounded, ethically aware blueprint for heritage interpretation that is both designable and scalable.

Managerial Implications

From diagnostics to design. Managers should begin with an MGF audit: map current story beats against salient landforms to locate weak or missing linkages. For each interpretive node, specify (i) the geomorphic cue, (ii) the mythic element, and (iii) the bridging phrase or prompt. This operationalizes "myth-geomorphology alignment," which our findings show to be decisive for immersion (Ham, 2013; Green & Brock, 2000).

Minimal-infrastructure upgrades. Prioritize micro-signage with QR/audio that visually and verbally align myths to rock forms (e.g., arrows, silhouettes, simple schematics). Use 30–90-second audio bites to stage transportation without overwhelming cognitive load (Tilden, 2007; Van Laer et al., 2014). At high-PGD vantage points, install framing cues (ground markers, viewfinders) that make distinctiveness legible (Prosser, 2013; Newsome & Dowling, 2018; Gordon, 2018).

Segment-sensitive interpretation. Calibrate depth, tone, and modality by segment: families (short, participatory prompts), students (values/ethics anchors), geotravelers (process explanations, petrology/geomorphology). Keep authenticity guardrails explicit, co-signed by cultural custodians to ensure accuracy while tailoring content (Wang, 1999; Reisinger & Steiner, 2006; Poria et al., 2003; Nowacki & Kruczek, 2021).

Operational KPIs and feedback loops. Track MGF-aligned KPIs: (a) dwell time at nodes; (b) QR scan-to-completion rates; (c) recall of myth–landform mapping; (d) WTP or micro-donations; (e) MSME (micro, small, and medium enterprises) conversion around nodes. Adopt PDCA-style micro-cycles, iterate scripts and signage monthly based on KPI deltas (Hair et al., 2019; Henseler et al., 2016).

Co-curation and benefit sharing. Formalize a custodian review board to approve scripts, imagery, and placements. Tie increased WTP/footfall to community funds or heritage maintenance so heightened attachment yields local gains (Poria et al., 2003; Nowacki & Kruczek, 2021).

Risk management. Avoid over-literalization that flattens nuance. Where morphology is subtle (low PGD), use guided vantage framing and sensory prompts (sound/tactile contrasts) rather than inventing spurious mappings. Document interpretive rationales to maintain transparency and scholarly defensibility (Brilha, 2016; Gordon, 2018).

Limitations and Future Research

Design and inference. Cross-sectional data constrain causal claims despite strong mediational evidence; future field experiments should manipulate fusion strength (e.g., high- vs. low-alignment scripts) to establish dose–response curves (Edwards & Lambert, 2007; Zhao et al., 2010). Longitudinal tracking could examine attachment durability and delayed behaviors (donations, revisits).

Measurement development. Although MGF and PGD met reliability/validity thresholds with (partial) scalar invariance, further work should (i) test item invariance across additional cultures and lithologies; (ii) assess convergent validity with behavioral indicators (gaze routes, dwell time); and (iii) explore formative vs. reflective specifications where appropriate (Vandenberg & Lance, 2000; Cheung & Rensvold, 2002; Henseler et al., 2015; Kline, 2016).

Common-method variance and endogeneity. Self-reports may inflate correlations despite marker checks. Multi-source designs, sensor logs, donation records, and purchasing can mitigate method bias. Instrumental-variable approaches or within-subject counterbalanced protocols can probe endogeneity in narrative exposure (Hair et al., 2019; Henseler et al., 2016).

Boundary conditions. Effects were stronger at higher PGD; thus, generalization to low-distinctiveness landscapes may require augmented reality cues or guided choreography that externalize mappings without fabricating myths

(Prosser, 2013; Gordon, 2018). Comparative studies should contrast geo-heritage with architectural/agrarian heritage to test scope conditions.

Digital narratives and pre-visit expectations. Future work could model UGC accuracy and algorithmic amplification, how online myths diverge from on-site versions, and test mismatch effects on authenticity, immersion, and satisfaction (Kolar & Zabkar, 2010; Nowacki & Kruczek, 2021). Pre-visit AR/VR previews offer experimental control over alignment and may shape on-site immersion (Van Laer et al., 2014).

Multi-level governance and ethics. Embedding co-curation protocols into destination governance can institutionalize authenticity guardrails and benefit sharing. Action-research designs can quantify community capacity gains from PBS-style toolkits (Ham, 2013; Tilden, 2007; Poria et al., 2003).

Conclusion

This research advances a mytho-geo account of interpretive effectiveness: when visitors perceive coherent fusion between mythic narratives and geological forms, they experience narrative immersion, which scaffolds emotional place attachment and prosocial behaviors. Across three sites, MGF and PGD proved reliable, valid, and (partially) invariant constructs; the moderated-mediation pattern demonstrates that distinct morphology magnifies narrative pay-offs. Theoretically, we integrate narrative transportation, place attachment, and geoheritage into a single structural account (Green & Brock, 2000; Williams & Vaske, 2003; Brilha, 2016; Gordon, 2018). Practically, we translate the model into design guidance MGF audits, micro-signage with QR/audio, vantage framing, segment-sensitive scripts, and governance principles for co-curation and benefit sharing (Ham, 2013; Tilden, 2007; Poria et al., 2003; Nowacki & Kruczek, 2021).

By treating perceived fusion as a designable lever, destinations can ethically enhance meaning-making and local outcomes while avoiding commodification. We encourage future researchers to experimentally manipulate alignment strength, expand to other heritage classes, and triangulate self-reports with behavioral and sensor-based measures to refine both theory and practice (Edwards & Lambert, 2007; Zhao et al., 2010; Hair et al., 2019).

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