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A Little Flood Geology

Part III: A False Dilemma

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Abstract

Floods are a key category of geologic processes. Parts I and II of this series provided some examples of geologic work by floods and related processes in Central Montana as witnessed by the author and how these may apply to the study of earth history. In Part III, geologic processes associated with these engineering projects are presented that are not flood processes. Evolutionists tend to overlook or resist evidence for catastrophic, large-scale processes (especially diluvial processes), while creationists can be tempted to overlook or downplay the role of smaller-scale processes that are presently active. This is a false dilemma, as these examples illustrate. The problem is one of philosophy and method, not of evidence.

Introduction

Part I of this series (Klevberg, 2019) introduced some basic hydraulic equations that apply to floods to show that these processes are nonlinear, with energy thresholds. Observation shows that nearly all geologic work occurs *during* floods, with very little occurring between them. Part II (Klevberg, 2020) provided examples of flood impacts, small mass wasting events, and ground water effect on surface water processes in Central Montana in 2011 (Figure 1). While these episodic processes are very important in producing geologic effects, there are some ongoing processes that are important at a smaller scale. In this paper (Part III), some of these are illustrated using examples from Central Montana.

How Conflicting Paradigms Affect Field Work

In recent decades, there has been a healthy increase in attention to what the "scientific method" is (or if there is such a thing). The idea of innate objectivity has been largely dispelled.

> No analysis is done outside of some sort of theoretical construct. Theory does not evolve in isolation from a research program…. In this view of the scientific method, evidence and theory are interwoven through data models that direct the researcher as to the type of information to collect and the appropriate modes of analysis. (Inkpen, 2011, p. 321)

This applies as much to uniformitarians (which most evolutionists are) as it does to catastrophists (which creationists generally are). We tend to see what we look for. This is known as verification science.

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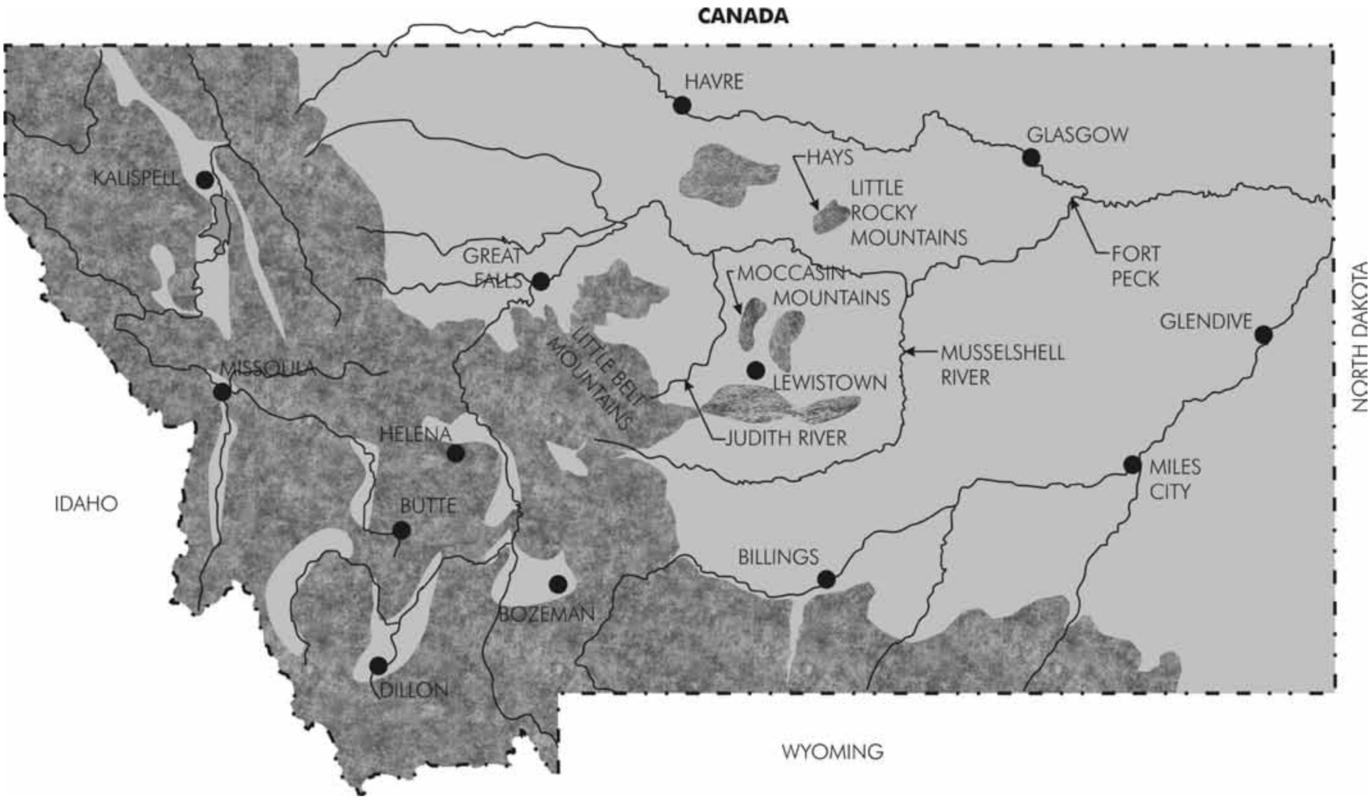

Figure 1. Map of Montana showing major rivers and mountainous areas.

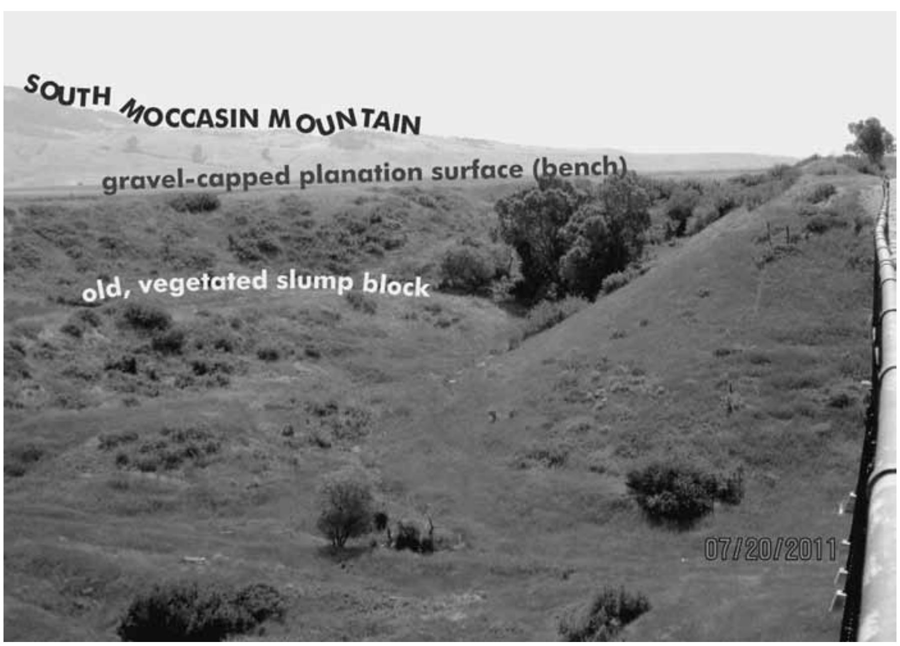

Figure 2. View east from east-southeast end of Central Montana Rail bridge over Judith River Valley. Some geologic features can be linked to extant processes while others cannot.

A False Dilemma

While uniformitarianism has been scientifically discredited for decades, rigid catastrophism is not the only alternative. Some of the events from the distant past appear to be of a different character from modern ones, but others appear similar, though often larger than more recent events (Figure 2). Not all geologic phenomena have formed from floods or other catastrophes. Many of the claystone and shale strata in the Judith Basin are montmorillonite rich, and some are even bentonite (nearly pure montmorillonite). These provide planes of weakness that can be mobilized when infiltrated by ground water. Even when slopes are nearly horizontal, movement can occur as landforms are deformed. A lower energy state is reached through very slow landsliding analogous to creep,

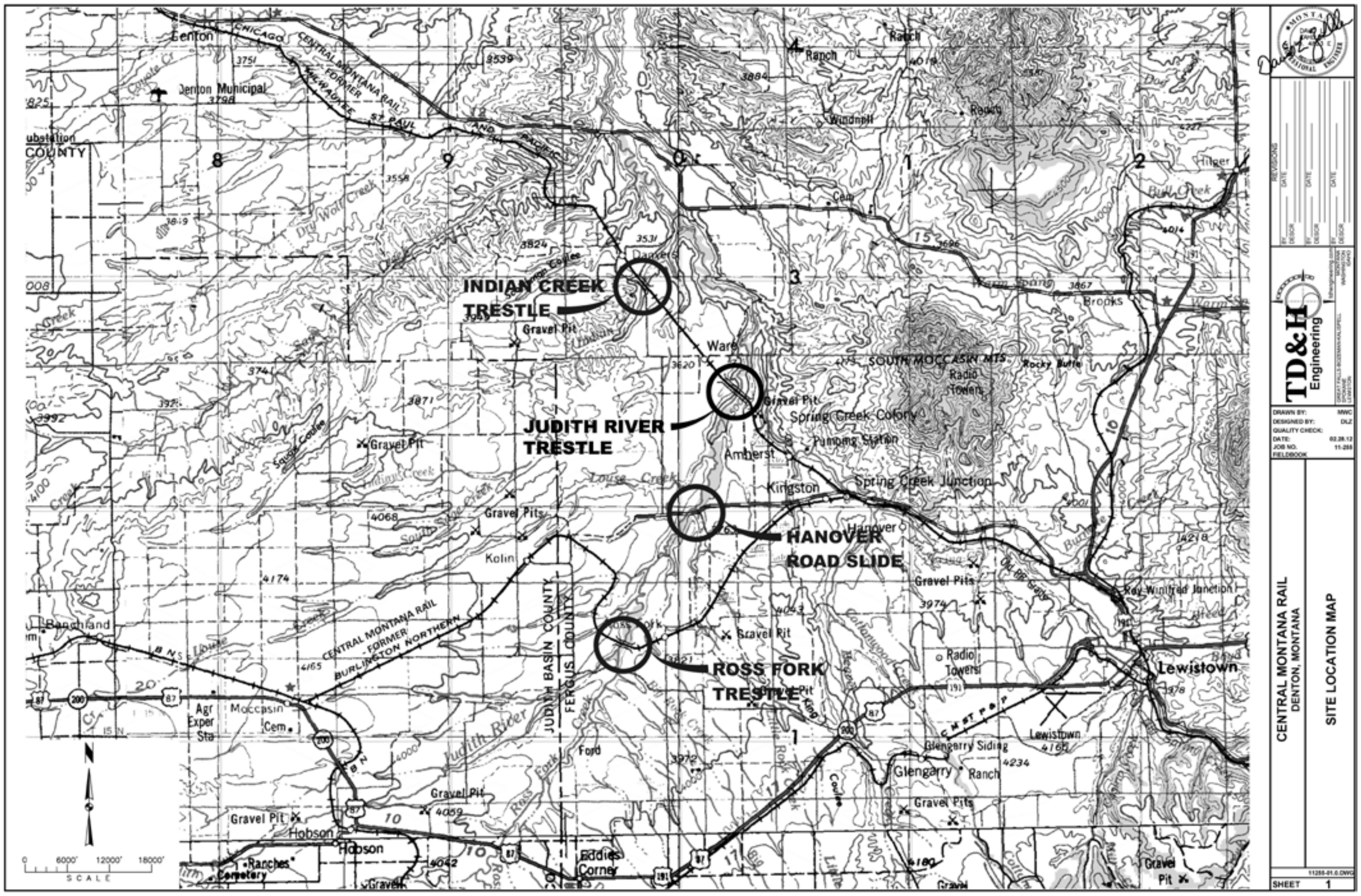

Figure 3. Map of Judith Basin project sites. Base courtesy TD&H Engineering.

even during relatively dry years. This has been a problem at two major steel trestles on Central Montana Rail's line: the Ross Fork Bridge and the Indian Creek crossing (Figures 3–5).

The Ross Fork Bridge is a viaduct that was built by the Great Northern Railway and is similar to the Milwaukee Road bridges. It is set on the same geologic formations. In addition to less dramatic damage from the Ross Fork of the Judith River in 2011, creep or slow landsliding had been an ongoing problem, eventually necessitating support of some of the Ross Fork trestle bents on timber cribbing (Figure 5). The Ross Fork Bridge is undergoing more substantial repair work (Figure 6), while the Indian Creek viaduct underwent significant repairs a couple of decades ago. The footings for both of these trestles had gradually moved downslope, and when steel members of the Indian Creek Bridge were supported using a crane and sequentially unbolted from each set of footings, the bents (towers) sprang back to their proper positions. New footings were poured to support this bridge. Slope inclinometers and horizontal drains were installed to monitor slope movement and reduce pore pressures to slow the movement (Figures 4 and 7). These measures have been largely effective at Indian Creek.

Recent work at Ross Fork indicates a different failure mechanism than at Indian Creek, even though the geology is the same (Figure 8). Slope inclinometer data from the Ross Fork site intimates a curved failure surface typical of a slump. Unlike slumps shown in Figure 9, this mass wasting feature appears to be slow and ongoing, though apparently stochastic (fits and starts). The failure surface is larger and broader than what is typical for the valley.

My supervisor many years ago designed the repairs for the Indian Creek viaduct and told me about the history of the project. He also described a similar circumstance with Saint Ann's Cathedral in Great Falls, Montana (Figure 10). Excavation of a pipe trench in front of the heavy sandstone building induced

Figure 4. Central Montana Rail bridge over Indian Creek southeast of Danvers, Montana.

Figure 5. Central Montana Rail trestle over Ross Fork of the Judith River.

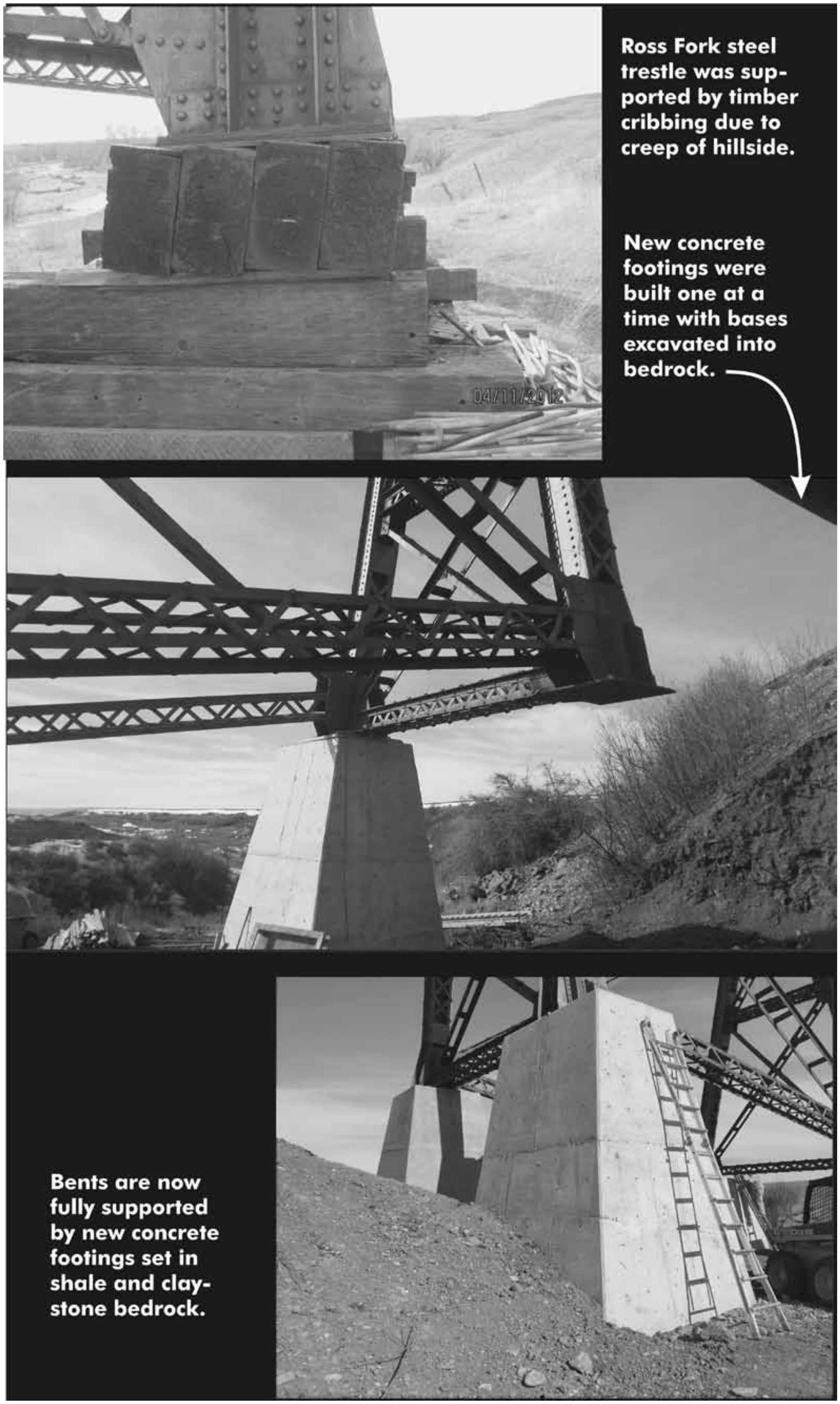

Figure 6. Foundation reconstruction for Ross Fork Trestle to compensate for mass wasting of valley slopes.

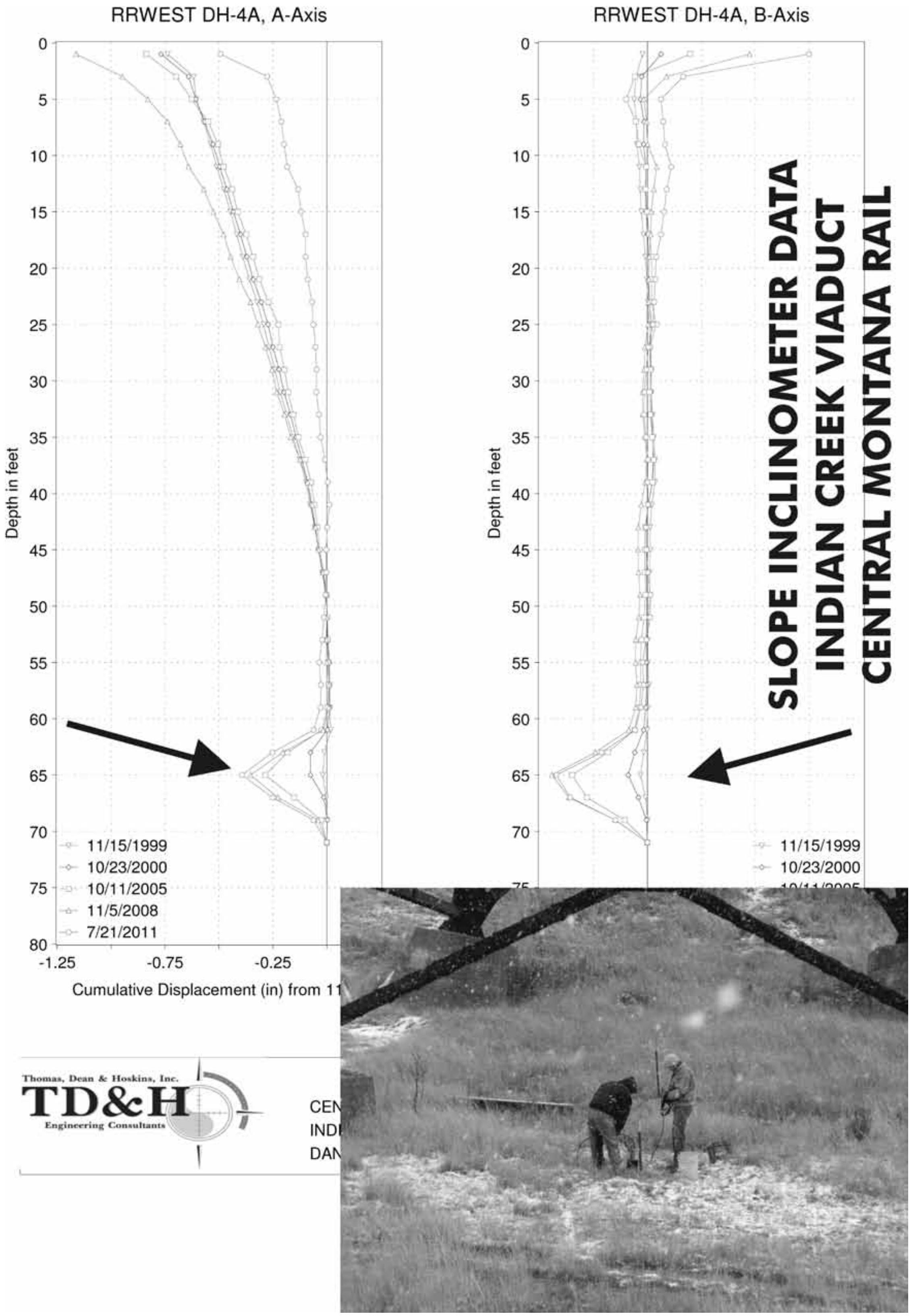

Figure 7. Data for one inclinometer at Indian Creek. Arrows draw attention to bedding plane failure surface indicated by displacements. Inset: author and boss monitoring Indian Creek trestle slope inclinometer ten years ago during spring snowfall, typical weather for Central Montana.

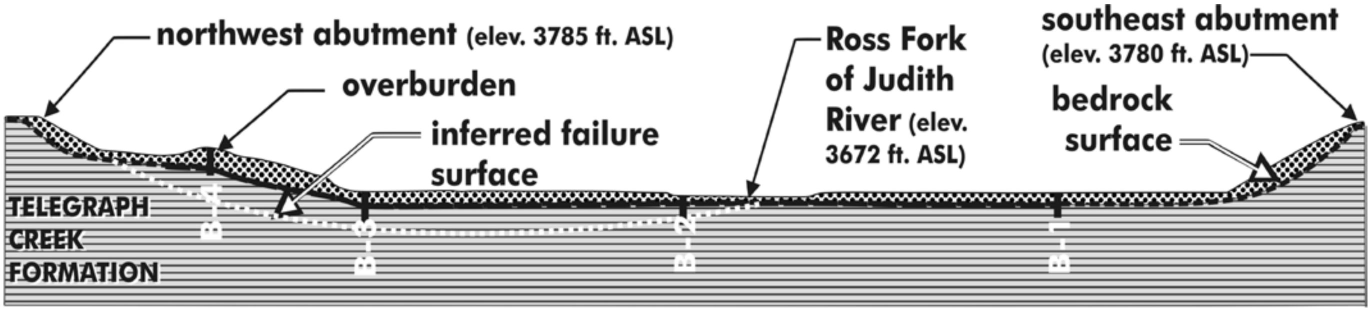

Figure 8. Cross section of valley of Ross Fork of the Judith River where Central Montana Rail viaduct crosses based on TD&H Engineering survey data (no vertical exaggeration). Auger borings B-1 through B-4 are indicated. Failure surface is inferred from inclinometer data collected starting in 2013. Failure appears to be a very slow, erratically moving landslide probably influenced by removal of material at toe by the Ross Fork, virtually all of which occurs during floods.

Figure 9. Small mass wasting events on the valley sides of the Ross Fork of the Judith River are relatively common.

horizontal movement that threatened to damage the structure. This was quickly noted and corrected, but it shows how readily movement may occur along horizontal or subhorizontal planes of weakness, especially when softened or lubricated by water and when pore pressures are elevated. The bedrock on which Saint Ann's rests is a relatively weak, smectite-illite-rich claystone of the Kootenai Formation. Water incorporated into the crystal structure of smectite physils (e.g. bentonite and other moisture-sensitive clay-size mineral particles) can greatly change their rheology, sometimes creating a plastic mass with relatively low viscosity.

The Central Montana Rail bridges appear to be founded on lower strata of the Telegraph Creek Formation (Porter and Wilde, 1999) based on the Ross Fork excavations (Figure 11). The Telegraph Creek Formation is dominated by fissile shale. Predictably, at Indian Creek the high soil moisture in 2011 destabilized slopes and accelerated the creep of the slope (Figure 12). Such events are not rare in this part of the world. Elevated pore pressures induced by ground water likely caused the Bighorn Mountains landslide in Wyoming ("The Gash," Figure 13) that made a splash in the media in October of 2015 (see responses at Powell *Tribune*, American Geophysical Union, or similar web sites).

While geologically "instantaneous" from the perspective of millions and billions of years of alleged earth history, they are gradual processes from a catastrophist or more episodic viewpoint. While very strongly influenced by water, many times they are not flood related. Many times, these processes are stochastic—not gradual or constant.

Effects from one type of process can be superimposed on effects from another (Figures 14 and 15). Each location needs to be researched on its own merits. When multiple processes have been involved—sometimes simultaneously—oversimplification can be a grievous temptation. This has long been a besetting sin among geologists.

Figure 10. Saint Ann's Cathedral, Great Falls, Montana.

Geotheorizing

Another besetting sin is a "top down" mindset. This may be said to have begun at least three hundred years ago with the growth of "geotheory," an attempt to concoct a "theory of everything" and then apply it to natural observation (Rudwick, 2005; Reed and Klevberg, 2011). This mindset is reminiscent of the "armchair" science of classical times, which was intended to be deductive, not the observational science that characterized the scientific revolution of Reformation Europe (Schaeffer, 1976). While pure induction has been properly debunked as the sole basis of the scientific method (Cleland, 2009), and many disputes whether there is such a thing as "scientific method," it is actually an iterative process, as has been pointed out elsewhere (Klevberg, 1999). Unfortunately, this iterative process often breaks down in practice (Miall, 2004). Of the three extreme errors—pure deduction, pure induction, and denial of a basic scientific method—the first is arguably most likely to lead one astray. In order for the iterative process to work, there must be a conscious effort to separate deductive predictions from inductive data analysis and only then to compare them (Figure 16).

Geotheorizing may amount to the development of a new "Flood Model," or belief in "megasequences," or just belief in the traditional use of the geologic column (i.e., "geologic ages"). But anytime geologic data must be forced into a preconceived natural history paradigm that dictates how the data *must* appear, there is the risk of greatly increasing the probability of error and missing or misinterpreting historical evidence (Ben-Menahem, 2009; MacDonald and MacDonald, 2011; Reed, 2013). An enthusiastic diluvialist or "Flood Model" proponent may easily see the lateral regional extent of strata and vast planation surfaces but miss evidence for smaller processes like local mass wasting and creep. A stratigrapher may note the pervasive strata but miss the associated geomorphology and local phenomena within and on top of them. A uniformitarian may attempt to explain regional strata and planation surfaces by extrapolating modern effects of rivers and mass wasting, with ludicrous results.

History and science require different methods (Adler, 1965; D'Amico, 2009; Reed and Klevberg, 2014a, 2014b) and necessarily lack certainty in their results (i.e., they are primarily inductive methods), despite three centuries of effort to conflate them and perpetrate the fable of "scientific certainty" (Reed and Williams, 2012). As an example, a "Flood Model" that assumes the biblical Deluge (or equally enormous megaflood) has the advantage of an available mechanism to explain the formation and preservation of the planation surface across the benches of the Judith Basin and likely

Figure 11 *(left)*. The new bridge piers for the Ross Fork trestle are founded in freshly excavated bedrock of the Telegraph Creek Formation.

Figure 12 *(below)*. Saturated soil conditions in 2011 initiated several small mass wasting events (slumps and slides) on the slopes of the Indian Creek Valley southeast of Danvers, Montana.

Figure 13. Three images of "The Gash," which formed in 2015 in the Bighorn Mountains of Wyoming. These images were spread on the internet and published in the *Powell Tribune*.

the deposition of the Telegraph Creek Formation, but it does not facilitate explanation of current processes of lateral motion or creep. Even a good theory does not explain all of the data. While some geologic paradigm or philosophy of history is necessary to provide an interpretive framework, researchers who attempt a "bottom up," "mixed question" way of thinking that acts iteratively with their "top down" natural history paradigms (Klevberg, 1999) will be less likely to miss important geologic features than those who are strictly theory driven. This "bottom up" mindset whereby each area is examined with openness to various historical scenarios—Chamberlin's "multiple working hypotheses" (Chamberlin, 1890)—is a superior approach in attempting to envision the possible history of Central Montana geology, or natural history speculation for any other region. A "mixed question" or "multiple working hypotheses" mindset may also encourage more effective observation of geologic features in the field.

Conclusions

Knowledge gained from observation of floods and geologic processes not related to floods has significance for geologic paradigms that guide research and data interpretation. Particular points from the Central Montana projects featured in this series follow.

1. Ground water can influence strata high in montmorillinite and other smectite physils via lubrication, crystal entrapment, and pore pressure increases to mobilize movement on very low angle faults or creep planes.
2. Movement and mass wasting are often observed on the relatively steep sides of valleys. Persistence of these steep slopes indicates "youthful" ages relative to traditional old-earth thinking. The slopes provide an op-

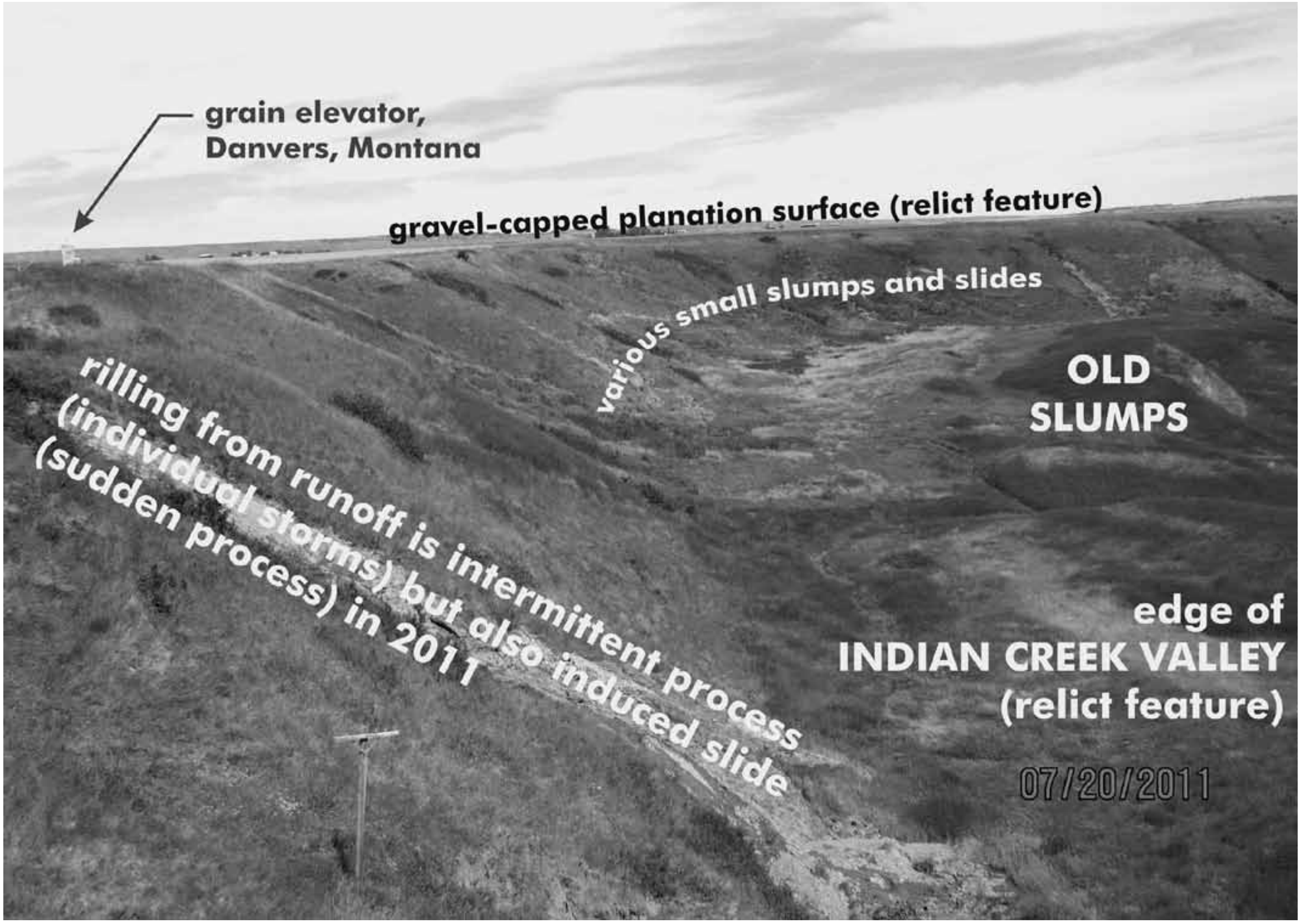

Figure 14. View toward Danvers from west-northwest end of Indian Creek viaduct. Danvers grain elevator helps provide scale of bench, a relict ("widowed") feature disconnected from any ongoing process. Mass wasting events of various ages and scales are evident on west side of valley; these are episodic events. Rilling is an intermittent process, with the amount of erosion proportional to the amount of precipitation during storms; however, in 2011, a small landslide was induced at this location (episodic process).

portunity for large amounts of earth materials to lose potential energy through mass wasting processes.

3. Enthusiasm for particular natural history paradigms or geologic theories may cause researchers to see what they want to see, missing valuable geologic data. This "top down" paradigmatic approach can greatly hamper correct understanding.
4. While many features of the Earth's crust indicate a catastrophic origin, not all do. Some of the processes observed in the current environment are adequate to explain some of the geologic effects. In general, these are much less extensive than the catastrophically formed features—often orders of magnitude (10^n) less. However, they must not be ignored. Each geologic locale must be investigated for itself, and researchers need to recognize the likelihood of polygenetic formations and features.
5. Historical geology is a "mixed question" that properly belongs in the category of natural history. For progress in understanding the "mixed question" of earth history, deductive geologic paradigms must be tempered by considerable inductive field work and "multiple working hypotheses" in an iterative process (i.e., the scientific method). Geology as a science can contribute to efforts to address this "mixed question," but results will always be tentative natural history speculations. A "multiple working hypotheses" perspective

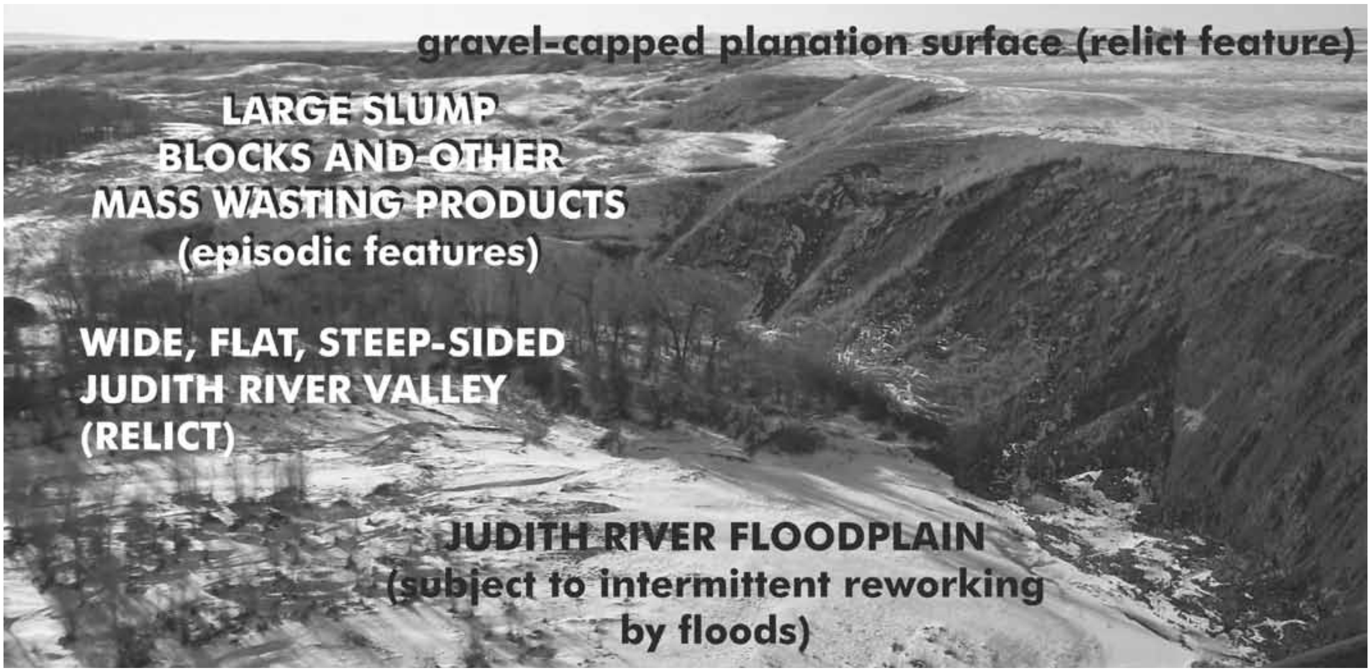

Figure 15. View southwest from near west-northwest end of the Judith River Bridge. Note that slope instability induces processes unrelated to those that must have formed the bench (planation surface) and valley; in fact, the episodic mass wasting events are gradually destroying these relict features. Flooding intermittently reworks the flood plain surface without altering the basic geometry of the Judith Valley.

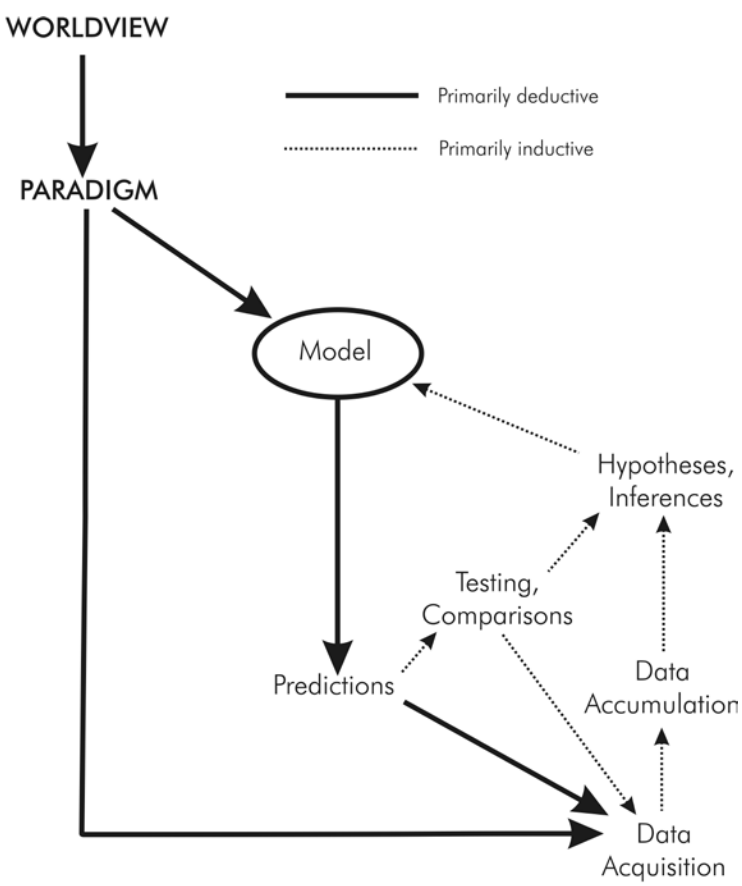

Figure 16 (*left*). The scientific method is a complex, iterative process that cannot be distilled into either deductive or inductive modes of logic. Application to forensic questions is similar. Figure modified from Klevberg (1999).

and bottom-up field research as opposed to top-down-only approaches can help maintain openness and a greater degree of objectivity, but in the end, historical speculation remains speculation.

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