

DOI: 10.5281/zenodo.8297673

POLYBIUS: DECODER OF HANNIBAL'S ALPINE INVASION ROUTE, AUTHOR OF A STRATIGRAPHIC ASSESSMENT OF THE FAMOUS BLOCKING ROCKFALL

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Received: 27/07/2023

Accepted: 10/11/2023

ABSTRACT

Following interviews and discussions with surviving soldiers of Hannibal's alpine invasion of Italia, Polybius, a Greek general serving as advisor to Scipio Aemilianus, retraced the Hannibalic invasion of 218 BC in great detail. Writing his *History - The Rise of the Roman Empire-* Polybius had the resource of Scipio's extensive library and freedom to visit large swaths of the Mediterranean. Considered by Scipio and others, a prime military tactician and strategist, Polybius participated in many military exercises and wrote a manual---*Tactics*---(now lost) up to the 2nd Century BC. Following Hannibal's trail on horseback, he later recounted Hannibal's route from Carthago Nova through the Pyrénées and Gaul (France) to the Rhône River, crossing near Arles, north to Orange, Drôme River to the Durance, diversion to the Guil River, and on to the Col de la Traversette (~3000 m asl), the highest col in the Western Alps. His *History* is actually a guidebook to the invasion route. The Traversette provides a vantage point overlooking the Po River and the vaunted, much discussed rockfall, a ~250 m wide rubble mass that blocked passage of Hannibal's elephants and horses. Soldiers could pass, but clearing a path for animals took three days to allow the army to recover in the wide valley plain below, prior to exfil onto the lower Po River plains. Polybius probably spent scant time at the rockfall but noted it was a two-stage event, older rock largely weathered, partly superposed by younger rock. This assessment qualifies Polybius as probably, if not the first, certainly one of the earliest stratigraphers in history, his separation of rockfall lobes on weathering/tonal contrasts, marking a seminal event in earth science history.

KEYWORDS: Polybius; Hannibalic invasion of Italia; Landslide vs. rockfall assessment; Mass wasting deposit; Relative age identification.

1. INTRODUCTION

The Rise of the Roman Empire, Polybius' massive reconstructed epic, might never have been written had he not been ordered to Rome, along with hundreds of Achaean leaders. As insurance against insurrection in Greece, and later welcomed into the home of Scipio Aemilianus, he might not have written his *History*. Adopted by Publius Scipio, the eldest son of Publius Scipio Africanus, Scipio Aemilianus befriended Polybius convincing the Senate to broaden his quarantine, allowing him to stay within the Scipio household. From there he had the resource of an immense library and freedom to accompany his host on military missions across the western and eastern Mediterranean (Şengör, 2020). His attraction to the Punic invasion of Italia during the Second Punic War (219-202 BC) arose from his own military experience and later encounter with Hannibal's veterans of the Punic Army. He was present at the close of the Third Punic War (149-146 BC).

Some ~60 years after the Hannibalic invasion of 218 BC, or around 146-150 BC, Polybius, relying on his sketched invasion route (Fig. 1), started from Nova Carthago on the Mediterranean Coast, passed the Col du Perthus (1256 m asl) in the Pyrénées, on to Perpignan in present day southern France, region of the western Volcae, the main Gallic tribe in the area. From Perpignan, Polybius ventured on to the Rhône Crossing near Arles, to where Hannibal had defeated the Eastern Volcae

(tribe allied with Rome), thence on to Orange, Hannibal's main resupply depot and friendly lowland Gallic tribes. From Orange, Hannibal had three choices outlined on Fig. 1: a) north toward the Isère River (present day Grenoble) leading to Mt Cenis/Col du Clapier; b), marching south from Grenoble towards Gap regrouping near the Durance south of the Col de la Genèvre; c) following the Drôme River to the Durance crossing south of the Col de la Genèvre (~1830 m asl). Choosing the Drôme River to the Durance and taking the Guil tributary from the Durance (Fig. 1), as recounted to Polybius by veterans of the 218 campaign, Hannibal again would have had three choices: Col de Agnel (2755 m asl), Col de la Croix (2298 m asl) and Col de la Traversette (2940 m asl). And so he chose the latter, the highest, most difficult, and most direct route to meet the Po Plains, his strategic target (Hart, 1967). Of all cols named in antiquity, the Genèvre became known as Pompey's Col, Rome's later use by consular armies entering Gaul in the first century BC; the Traversette became known as Hannibal's Col during the same time frame or earlier. This was Polybius' target, recounted to him by Hannibal's veterans, the invasion survivors, later sketched out in his massive, reconstructed *History*. Polybius knew the route precisely, all preserved in his book, which took him across the Traversette to the massive rockfall blockade where he made his fortuitous observations of two separate mass wasting events, the younger of which presented with the most robust rubble mass that hindered progress to the lowland.

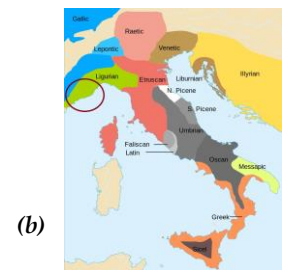
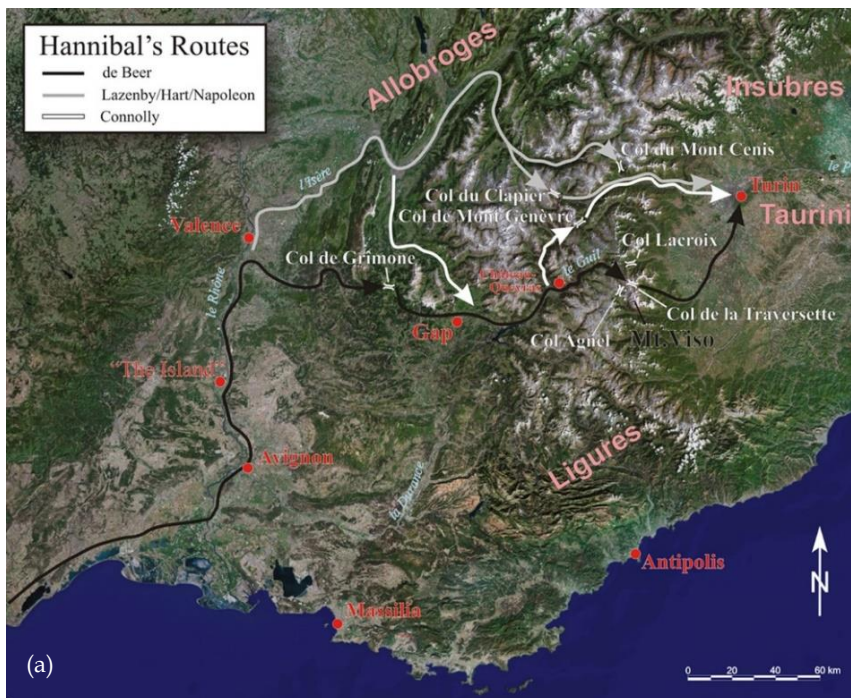


Figure 1. a) Satellite image of the Western Alps showing possible routes followed by the Hannibalic Army during the invasion of Italia during the Second Punic War. Major tribes, friends and foes alike, are shown astride various routes (credit JPL, NASA/USGS), b) The wider region of the western Alps, where the brown circle indicates the Fig. 1a region. This is an ethnolinguistic map of Italy in the Iron Age, before the Roman expansion and conquest of Italy ca. 6th c. BC., (CC BY-SA 3.0) *Magna Graecia*. (2023, December 4). In Wikipedia. https://en.wikipedia.org/wiki/Magna_Graecia.

2. BACKGROUND

Retracing the Hannibalic Army invasion across the Alps at the opening of the Second Punic War, as postulated by classicists, historians and archaeologists, theories over the last two millennia have followed many routes, all more or less based on previous interpretations, viz speculations for the most part. Ancient historians who actually visited individual approach routes are few in number and include such notables as: Dodge (1891), de Beer (1969), Proctor (1971), Cottrell (1992), Seibert (1993), Lazenby (1998), and Bagnall (1999) with almost no agreement that Hannibal actually used the Traversette, despite Polybius' roadmap in his *History* (trans Scott-Kilvert, 1979) that provides nearly point-by-point markers from Orange on the Rhône to the Traversette. Historians, namely, Livy (trans. de Selincourt, 1972), Walbank (1990), and Appian (trans. White, 2002) among others, wrote about, but never visited the cols in question. This, however, did not stop them from laying claim to the northern route (Fig. 1), and among these Lamb (1958), Brown (1963), and Lancel (1999) stand out. Some even took Hannibal across cols (Great St. Bernard's Pass) in Switzerland (Terrell, 1922). Aside from these various historical sources the first attempt to fit the landscape onto Polybius' narrative came from de Beer (1969) who used flood times to argue for the Traversette Route and Mahaney (2008a) who surveyed geological and geomorphological data embedded in Polybius (trans., 1979), Livy (trans., 1972) and Walbank (1990). Of these sources, Polybius is the only authority to be trusted because he used primary, onsite data, as summed up, includes: long (~15 km) defile and large (4 x 3 m) light-colored boulder on the lower approach, timberline position, frozen ground (including permafrost), tundra, view onto Po Plains, and blocking rockfall. The blocking rockfall, the only such deposit found below the Traversette, absent below all other cols on the lee side, provides conclusive evidence as to the pass described in Polybius' *Histories*.

Arguments against the Traversette focus on the rugged, steep descent from the Traversette to the Po plains, the trail down considered by many not negotiable to elephants and horses, even though elephants are commonly used at very high elevation in the Himalaya, and up to ~4800 m on Mt. Kenya (Mahaney, 1990, and personal observations before poaching exterminated a herd of 2200). Arguments for the Traversette point to superbly trained horses and war elephants, with handlers, guiding along steep stretches of the route. Hannibal's horses were so well trained they could lie down on command. However, all 37 of Hannibal's elephants

made it over the Alps, some used at the Ticinia and Trebbia engagements of late 218 (Polybius, III, 74); others dying off the next year (217). Surus, Hannibal's own personal surviving elephant, traversed the Etrurian swamps according to Polybius (III, 79). His and other remains were unearthed along the Arno River near Florence by Italian paleontologists (Romano and Palombo, 2017) and have been AMS C14 dated to within the Hannibal time window.

Beyond the rockfall, proof of the Traversette Col passage resides in an alluvial mire in the upper Guil Valley, at the base of the Traversette cirque, now laced with talus and recent rockfall, dating to the Little Ice Age (LIA). Hence the trail to the Traversette would have been across bare rock in Hannibal's time making access to the col rather easy. Using sediment samples recovered from successive cores and trenches, it proved possible to demonstrate reproducible order of magnitude increases of bacteria related to horse and mule dung. This evidence, combined with fractured and offset fluvial beds dated by AMS C14 to precisely the Hannibal invasion (Mahaney et al., 2017a, 2017b), provided interlocked sedimentary and isotopic dates affirming Polybius' road map in the *Histories*. Passing along the projected route, and over the only massive rockfall to the lee of the Alps, more recent excavation of alluvial fans in the upper Po catchment, namely successive compressed, fractured and offset alluvial beds AMS C14 dated to ~2200 yr (Mahaney et al., 2018). Evidence from the mire, blocking rockfall, and upper Po alluvial fans combined, provide irrefutable evidence that Hannibal's Army passed over the Traversette, highest of all possible cols in the Western Alps, hereafter called 'Hannibal's Pass'.

Polybius, in his *History*, draws attention to Hannibal's avoidance of the Allobroges, a fierce mountain Gallic tribe massed in the Genèvre Col, blocking access to the lowlands of the Po plains. After leaving Orange and the friendly lowland Gauls Polybius is definite Hannibal led a night action to secure a low col (probably Col de Griimone) that was followed by Allobroges shadowing the army with Hannibal in command of his rear units. Any attempt by Hannibal to force the Genèvre, with infantry alone, his cavalry inoperative, and the Allobroges at his rear would have been a bloodbath. Crossing the Durance, Hannibal had three choices: The Col de la Croix, steepest exit into Italia would not take him to the Po Plains; the Agnel too far south to meet his objective; the Traversette, highest of all three cols was his only exit to the Po. Unfortunately, a rockfall blocking his descent (Fig. 2), lay across the trail down out of

the high pass. While a blockade to passage of large animals, he could move his infantry through to low pasture. Causing derision among his troops, Polybius recounts Hannibal attempted to force another route, but having failed at this, he turned to complete the infantry passage, setting others to widening the path, which after three days allowed horses and elephants passage to the lowlands. It is here the rockfall passage begins with Livy picking up on the myth of boulder firing, stones cracked with sudden bursts of sour wine, the story building over centuries recounted by countless others including Jonathan Swift and Napoleon. Polybius,

however, is mute on the rock firing, which means it never happened. However, Polybius' observation of the rockfall, includes details of the material within, comprising two separate mass wasting events, an older deposit superposed by a younger and fresher, more robust mass that places him well within the first to recognize separate deposits by surface weathering features alone. He is probably the first stratigrapher of the ancient world to separate deposits from the source area at higher elevation, age dependent on tonal contrast and position.



Figure 2. Screenshot from Google showing the Traversette Col (marked in red to the left), trail down out of the Col, position of the rockfall marked with yellow pins, and the upper rockfall with vegetated lobes either side of massive younger rock (in grey) (Fink et al., 2024, in progress).

3. MATERIALS AND METHODS

The materials making up the bulk of the rockfall are comprised of metabasalt and biotite schist, described in detail elsewhere (Mahaney et al., 2008a). The methods involved include search by satellite imagery, Google Earth (Fig. 2), and topographic maps of the Italian Survey. To test the proposed rockfall firing event, a search for carbonized rock specimens was unsuccessful, and this despite the record of the black mat impact/airburst

in the area (Mahaney et al., 2022), which apparently did not conflagrate the subject area. If successfully found, such carbonized rock would offer dating by AMS C14 to establish age separating the two events—either comet airburst (12.8 ka) or Hannibal's projected rock firing.

The samples collected were analyzed in laboratories at Quaternary Surveys (Toronto), the University of Toronto, the University of Tartu, Estonia and Queens Uni-

versity Belfast. The relative dating method used by Polybius is described and discussed in Mahaney (2008a, and Mahaney et al., 2008d).

4. RESULTS AND DISCUSSION

Aside from surficial geological evidence in the two-event rockfall, it is recent work by Mahaney et al. (2008d) that highlights the soil stratigraphic evidence (Figs. 3A, 3B) which supports a two-tier event buildup of the rockfall mass. In particular, Fig. 3B keys in two groups of soils: Entisols (Viso 2, 4, and 8) with Ah/C/or Cox horization, depth centered on 20-30 cm; and the Inceptisol grade (Viso 9) carrying a Bw horizon (w=weathered to some degree) with a ~50 cm depth representative of other Late Glacial (LG-15-12.8 ka) and Younger Dryas (YD-12.8-11.6 ka) paleosols in the research area (Mahaney et al., 2022). Birkeland (1999), highlights color as a useful aid in qualitatively identifying soil horizons—A or Ah, commonly the surface or subsurface organic-rich layer carrying 10YR 2/1 to 2/4 grades of organic material (2/1 the strongest; YR=yellow-red color); Bw, usually the lowest grade of advanced weathering, 10YR 4/4 brown in this case, along with low grades of soil structure (clods of clay encased mineral grades) termed blocky. C level horizons carry the 'ox' identifier which has slightly higher grades of oxihydroxides, such release indicative of mineral breakdown and generation of mixed oxides and hydroxides, preferentially Fe and Mn. These profiles, either rest mostly on unweathered deposit (D or Cu horizons), with either coarse grained materials or a mix of >2mm and <2mm diameter material; in the case of Viso 8 the substrate granulation merits a Cu horizon (u=unweathered) and a color of 2.5Y 5/2, which is commonly close to the color of unweathered till, moraine or mass wasted debris in the research area and beyond.

Of the sites shown in Fig. 3A, only V8 and V9 have been analyzed beyond field characteristics, and even then granulometry showed only minor differences between profiles with V9 having ~2% rise in clay content from weathering in place since the LG, compared to V8 (in the younger of the two rockfall lobes). The clay mineralogy comprises chlorite and illite-vermiculite in both profiles, and soil chemistry indicates similar organic C and N at the two profiles, which one would expect, because organic C, at least, comes into dynamic equilibrium within a millennium (Mahaney et al., 2016). Within the four profiles in Fig. 3B, only V9 qualifies as a paleosol, given its advanced LG age, and more advanced horizon development relative to V 2, 4 and 8, and the latter (V8) similar to other sites on the younger

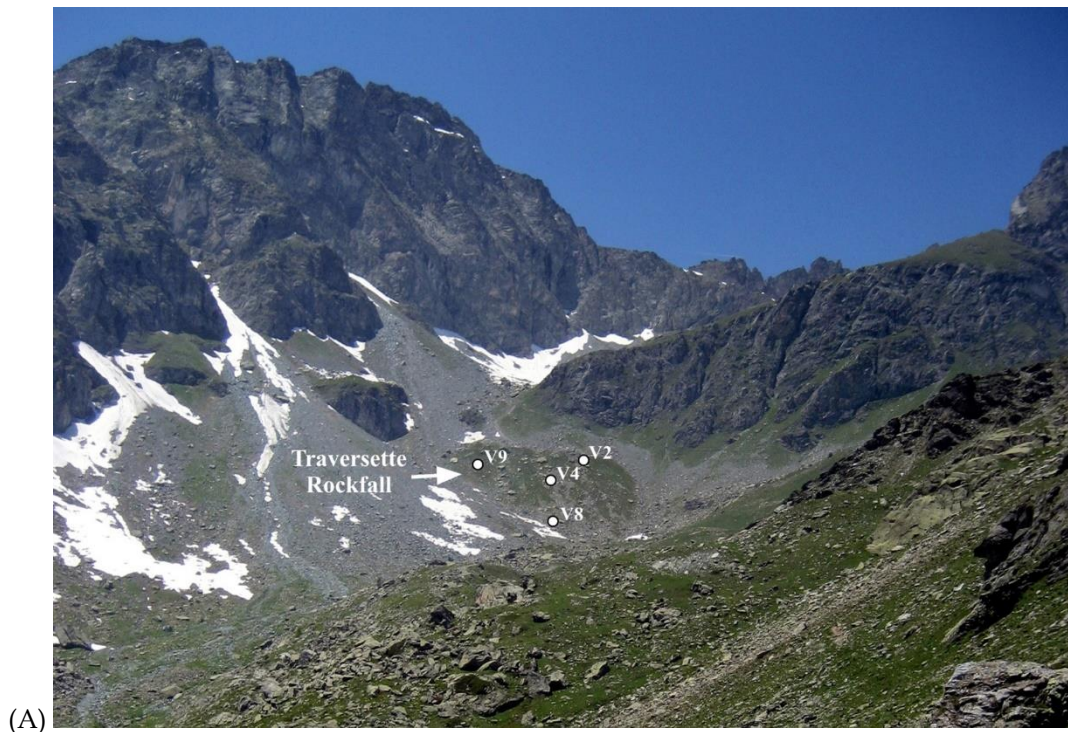
lobe excavated in the rockfall. Thus, the soil stratigraphic differences worked out here, in brief, expands upon Polybius' original weathering assessment. The rockfall is a two-tiered event (Polybius III, 54).

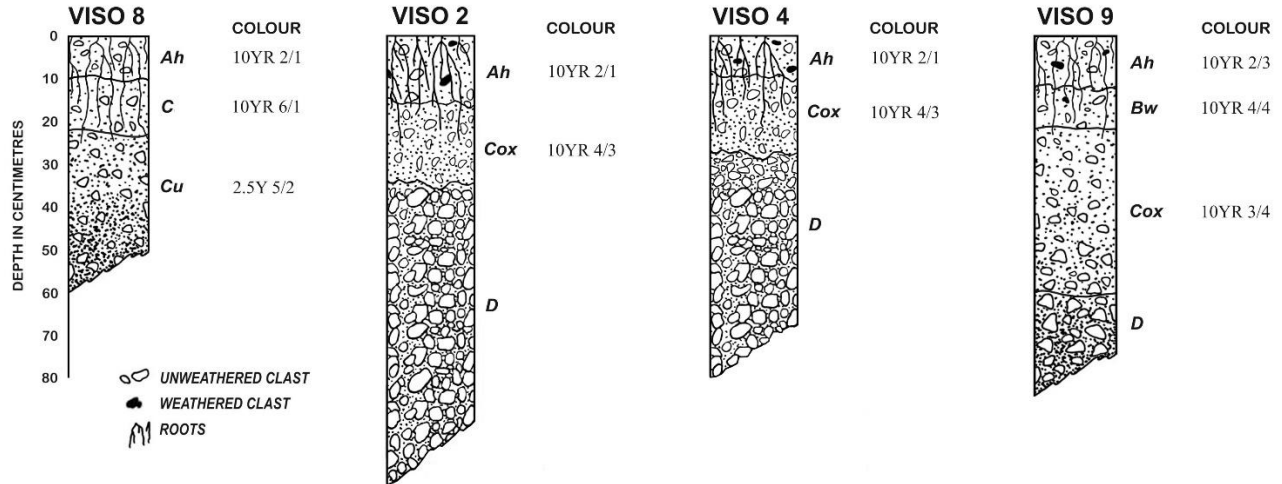
Hannibal's route over the Alps, considered one of the great questions of antiquity, has been argued over and over by historians and archaeologists for centuries. Seven books on the invasion and aftermath were written in Hannibal's time (Proctor, 1971). In all these works the exact route was left unidentified, the possible exception in Silenus' first-hand account, left shelved in the Library of Alexandria which burned, 300 AD. Following on from that, historians and archaeologists have argued over various routes, most without visiting the Alps to test one route against others, even in the face of Polybius' roadmap *History* which is quite definite as to route and target col. While scant, environmental information such as timberline elevations, presence of permafrost, frozen ground, several km-long defile on the approach, large boulder near the defile entrance, and massive blocking landslide allowed exfiltration of the army, the larger beasts—horses and elephants—were held back. These interlocking variables have been used to establish the Col de la Traversette as the most likely route followed by the Punic Army in 218 BC. Of all these environmental parameters, the tundra, high peaks and lack of trees, are summed up by Polybius (III, 55) "The crests of the Alps and the parts near the tops of the passes are completely treeless and bare of vegetation, because of the snow, which lies there continually between winter and summer, but the slopes half-way down on the Italian side are both grassy and well wooded...", which eliminates all low lying passes, those lacking firnpack, that is, snow surviving summer melt. But it is the massive landslide (i.e. rockfall) that defines the route identified by Polybius (III, 54), that proved to be the main geomorphic feature searched for by several expeditions (Mahaney, 2008a, 2008d). Using satellite imagery and ground truthing, the lee flank of all passes, the only landform offering a barrier to exfil off the mountain is the Traversette 250-m wide rockfall (Fig. 2). Scott-Kilvert (1979), translator of Polybius' Greek text, uses the term landslide which is a one-stage movement of earth along a slope of ~10-30 degrees; a rockfall is different with release of rock from high ridges, a mass free-falling in air, such that edges become instantaneously fractured and dislodged. The rockfall in question is composed of a grain-size mix ranging from fine clays and silts to sand, pebbles, cobbles and boulders, with boulders and cobbles dominating, many with dislodged edges. With the trail widened and re-ballasted several times over several centuries, the width estimated at

~250 m; in Hannibal's time the rockfall was likely more robust providing more of a blockade to movement of large creatures such as elephants, horses and mules.

Of all major parameters identifying the route, the rockfall must have centered squarely in Polybius' logged notes along with snow looming in the high pass. Polybius notes the weather, cold and snow distressing Hannibal's soldiers, followed by descent to the rockfall, whereupon depression heightened close to hopelessness; in his words - 'at this point the soldiers lost their nerve and came close to despair' (Polybius III, 54). The landslide, actually a rockfall or rock blockage described thus: 'A previous landslide had already carried away some 300 yards of the face of the mountain, while a recent one had made the situation still worse'. With the

term 'face of the mountain' Polybius indicates a high ridge with steep face which exactly describes the situation at the top of the identified rockfall (Fig. 3A). But it is the differentiation of 'previous landslide' vs. 'recent one' suggesting Polybius used tonal contrasts from variable rock weathering—oxyhydroxide coatings, lichen cover—to distinguish the two masses and their relative ages. Even today, one can decipher a difference in lobe age from tonal contrasts visible even from the Traversette Col itself—older surfaces either side of the fresh mass that is the younger of the two. It is this close observation and insightful remark about the relative ages of the two rockfall masses that mark Polybius as someone with acute and unusual knowledge of the landscape.





(B)

Figure 3. A, View of the rockfall from the east off the trail to the Traversette Col. Sites on the older lobes (V9) contrast with sites on the younger lobes (V2, V4 and V8); B, Schematic profiles on the rockfall depict younger Entisols with A/C profiles in an early stage of soil morphogenesis vs. V9 in an older group in the Inceptisol stage with A/Bw/Cox horization. Appearance of the Bw horizon (w =weathering state), is considered passage from early weathering stage (Regosol, Entisol) to higher grade (Inceptisol, Brunisol) remarked by removal of soluble constituents and release of oxihydroxides with color grades approaching 10YR 4/4 as a standard.

5. CONCLUSIONS

Considering our modern times, misinformation rampant in the media, it is stranger still that Hannibal's boulder firing episode, presumably initiated by Livy, maintained a life of its own for centuries, lasting through the Dark Ages, Medieval times and the Renaissance to today. Livy, who never left Padua, had to have gotten news of the firing, perhaps from Silenus' original report on the invasion that lasted through the Roman Republic and height of empire, to expire in the great fire of the Library in Alexandria (300 AD). Silenus may have referenced the boulder firing event in his history of the invasion to heighten Hannibal's reputation, a possibility that remains unproven. Aside from this, recent research shows conclusively there is no evidence of carbonized rock in the Traversette Rockfall and nothing to indicate cracked boulders beyond the edged chipped clasts normal in rockfall mass wasting deposits. Beyond

this, Polybius' observation of distinct two-stage rockfall events: a much older lobe of probable LG age (15-13 ka) that carries a dark oxidized and lichen covered surface offset against fresh, more massive, middle lobes of recent age, placing the younger sediment of middle Neoglacial age (~2.5 ka). At the time of Polybius' crossing the younger deposit would have been only a few hundred years old, and of considerably fresher appearance, in contrast with the older deposit. Seemingly Polybius' observation, taken a few centuries after deposition of the younger lobe, supports relative low lichen cover on the younger lobes vs. high cover on the older lobes. Polybius' detailed observation proves Hannibal crossed the Traversette, since no other rockfall deposit of similar size exists on any of the exit trails from other cols in the Western Alps. Polybius' two-tier observation marks him not only one keen observer, but most likely the *first stratigrapher in history*.

ACKNOWLEDGEMENTS

This work benefitted from conversations/correspondence with John Lazenby (University of Newcastle), arguably one of the foremost authorities on Hannibal and the Punic Invasion of Italia. Lazenby, one of the few historians to actually visit the various cols, considered the Traversette too difficult for Hannibal and his elephants to negotiate. And while we argued over the emerging scientific evidence, he clung to the notion that Mt. Cenis or Col du Clapier were the favored cols Hannibal passed over. Yet, Sir Gavin de Beer, polymath, classicist, noted biologist and former director of the British Museum of Natural History, contrarily pointed to the Traversette as the most likely col of passage for Hannibal and his army.

The satellite imagery in Figure 1 was provided by Trent Hare, USGS, Flagstaff, Arizona (credit JPL, NASA/USGS). I also gratefully acknowledge field assistance and discussions with Volli Kalm (deceased, University of Tartu,

Estonia); Peeter Somelar (University of Tartu); Chris Allen (Queens University Belfast); Pierre Tricart and Stéphane Schwartz (University of Grenoble); Roelf Beukens, Rana Sodhi and Ernie Seaquist (University of Toronto); Ron Dorn (Arizona State University); Pat Julig and Randy Dirszowsky (Laurentian University, Canada), Rene Barendregt (Lethbridge University, Alberta), Barbara Kapran (York University); David Merrick (London), Michael Milner (York University) and Craig Hanyan, deceased (Brock University, St Catharines, Ontario, Canada). Allen West (Comet Research Group) assisted with Ox Cal AMS C14 dating of the G5 group (upper Guil V) and V21 sample group in the Upper Po R.

I gratefully acknowledge assistance from the License granting authority of the Prefét des Hautes Alpes, to conduct excavations on the French side of the Traversette (Réserve Naturelle Ristolas-Mont Viso), France, with support from Prof. Pierre Tricart (University of Grenoble) and the Upper Po Park, Italia. Marco Rastelli, Chief Park Ranger, Mon Viso Park Authority, was especially helpful to designate research areas free of endangered species. I am also grateful for the hospitality offered over several years by the staff/management at several refuges in Italy and France. In particular, I thank Aldo Perotti (Pian del Re), Laura and Andrea Sorbino (Refugio Giacoletti), and Sarah and Paul Ciselar (former Custodians of the Refuge du Viso). In addition, I thank the National Geographic Society for funds awarded (grant number 9988-16) to carry out the field and dating part of this research; and Lion TV (London) and ZDF (Germany) for filming during July, 2017, and allocation of funds to Quaternary Surveys. This whimsical tribute to Polybius is purely my thanks to one brilliant, enterprising and unusually observant general and historian who had the foresight to include landscape signposts with important geomorphic details in his History of the invasion. Had he not mentioned the landslide viz rockfall details and remained mute about the firing event, we might have remained fixed on Livy's erroneous details of boulders fired to high temperature, cracked after dousing with sour wine. Yet, the fired-rock-doused-with-sour-wine myth persists, with comment by Virgil, Pliny, and Gibbon et al. down through the ages. Even Jonathan Swift's Gulliver satirized the firing.

REFERENCES

- Appian (Appianus), trans. H. White (2002) *Roman History*, Loeb Classical History, Harvard University Press, Vol 1., 647 pp.
- Bagnall N (1999) *The Punic Wars*. Pimlico, London, 347 pp.
- Birkeland PW (1999) *Soils and Geomorphology*, Oxford University Press, Oxford, U.K., 430 pp.
- Brown, JET (1963) *Hannibal's route across the Alps*. Greece and Rome, 2nd Ser. Vol.10 (March), 38-46.
- Cottrell L (1992) *Hannibal Enemy of Rome*. Da Capo Press, N.Y., 257 pp.
- de Beer G (1969), *Hannibal*. The Viking Press, N.Y., 320 pp.
- Dodge TH (1891) *Hannibal*, Houghton Mifflin, NY.
- Fink, W., Vashna, V., Hare, T., Tricart, P., Mahaney, W.C., (2024) Hannibal's misconstrued route across the alps reconstructed with Dijkstra multi-objective optimal path planning, *Nature*, in progress.
- Hart BHL (1967). *Strategy*, Penguin, London, 426 pp.
- Lamb H (1958) *Hannibal-one man against Rome*. Doubleday, NY, 310 pp.
- Lancel S (1999) *Hannibal*, Blackwell, Oxford, 243 pp.
- Lazenby JF (1998) *Hannibal's War*, University of Oklahoma Press, Norman, 340 pp.
- Livy, trans. Aubrey de Sélincourt (1972) *The War with Hannibal*, Penguin, London, U.K, 711 pp.
- Mahaney WC (1990) *Ice on the Equator*. Wm Caxton Ltd., Ellison Bay, Wi., 386 pp.
- Mahaney WC (2008a) *Hannibal's Odyssey: Background to the Alpine Invasion of Italia*. Gorgias Press, Piscataway, N.J., U.S.A, 221 pp.
- Mahaney WC (2008b). *The Warmaker: Hannibal's Invasion of Italia and the Aftermath*. iUniverse, Bloomington, Indiana, U.S., 302 pp.
- Mahaney WC, Kapran B, Tricart P, (2008c) Hannibal and The Alps: unravelling the invasion route. *Geology Today*, 24 (6): 223-230.
- Mahaney WC, Kalm V, Dirszowsky R, Milner MW, Sodhi RNS, Beukens R, Dorn R, Tricart P, Schwartz S, Chamorro-Perez E, Boccia S, Barendregt R, Krinsley DH, Seaquist, ER, & Merrick, D (2008d) Hannibal's trek across the Alps: Identification of sites of geoarchaeological interest. *Mediterranean Archaeology and Archaeometry*, 8 (2): 39-54.
- Mahaney WC, Somelar P, Dirszowsky RW, Kelleher B, Pentlavalli P, McLaughlin S, Kulakova AN, Jordan S, Pulleyblank C, West A, Allen CCR (2016) A microbial link to weathering of postglacial rocks and sediments,

- Mt. Viso area, Western Alps, demonstrated through analysis of a soil/paleosol bio/chronosequence. *J. Geol.*, 124:149–169.
- Mahaney WC, Allen CCR, Pentlavalli P, Kulakova, A, Young, JM, Dirszowsky, RW, West, A, Kelleher B, Jordan S, Pulleyblank C, O'Reilly S, Murphy BT, Lasberg K, Somelar P, Garneau M, Finkelstein SA, Sobol MK, Kalm V, Costa, PJM, Hancock RGV, Hart KM, Tricart P, Barendregt RW, Bunch TE, Milner MW (2017a) Biostratigraphic Evidence relating to the Age-Old Question of Hannibal's Invasion of Italy: I, History and Geological Reconstruction, *Archaeometry* 59: 164-178.
- Mahaney WC, Allen CCR, Pentlavalli P, Kulakova, A, Young, JM, Dirszowsky, RW, West, A, Kelleher B, Jordan S, Pulleyblank C, O'Reilly S, Murphy BT, Lasberg K, Somelar P, Garneau M, Finkelstein SA, Sobol MK, Kalm V, Costa, PJM, Hancock RGV, Hart KM, Tricart P, Barendregt RW, Bunch TE, Milner MW (2017b) Biostratigraphic Evidence relating to the Age-Old Question of Hannibal's Invasion of Italy: II Chemical biomarkers and microbial signatures. *Archaeometry*, 59: 179-190.
- Mahaney WC, Somelar P, West A, Dirszowsky R, Allen CCR, Remmel T, Tricart P (2018) Reconnaissance of the Hannibalic Route in the Upper Po Valley, Italy: Correlation with Biostratigraphic Historical Archaeological Evidence in the Upper Guil Valley of France. *Archaeometry*, <https://doi.org/10.1111/arcm.12405>.
- Mahaney WC, Somelar P, Allen C (2022) Late Pleistocene Glacial- Paleosol-Cosmic Record of the Viso Massif – France and Italia – New Evidence in Support of the Younger Dryas Boundary (12.8 ka). *Int J Earth Sci.* <https://doi.org/10.1007/s00531-022-02243-9>.
- Polybius, trans. Ian Scott-Kilvert, (1979) *The Rise of the Roman Empire*, Penguin, London, UK, 574 pp.
- Proctor, Dennis (1971) *Hannibal's March in History*, Oxford University Press, Oxford, UK., 229 pp.
- Romano M, Palombo MR (2017) When legend, history and science rhyme: Hannibal's war elephants as an explanation to large vertebrate skeletons found in Italy. *Historical Biology*, doi.org/10.1080/08912963.2017.1287178.
- Seibert J (1993) *Hannibal*, Wissenschaftliche Buchgesellschaft, Darmstadt, p. 75-134.
- Sengör, AMC (2020) Revising the Revisions: James Hutton's Reputation among Geologists in the Late Eighteenth and Nineteenth Centuries. *Geological Society of America, Memoir* 216, 167 pp.
- Walbank FW (1990) *Polybius*, University of California Press, Berkeley, Calif., 201 pp.