“Witness the Specimens of Lava and Pummicestone”

The North Dakota “Burnt Hills” of Lewis and Clark
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Hilltop exposures of pinkish-red clinker on the northwestern edge of Hofflund Flats, North Dakota.
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President’s Message

Making Lewis and Clark Proud

People really love the Lewis and Clark Trail Heritage Foundation. For those of us in the administration of our organization who feel the responsibility, we are absolutely dedicated.

Our Board meetings continue to be very productive. The board members live all over the country and we have many telephone conferences (using a free call-in service). As to in-person board meetings, we started our administrative year by meeting in Kansas City on October 27, 2012; we then met in Troutdale, Oregon, on April 20, 2013; also the Annual Meeting in Bismarck on July 26–27, 2013.

I really like this group. Our board members respect and like one another. We work toward fulfilling our objective, which I would describe as—making Lewis and Clark proud of us.

We Proceeded On, our terrific quarterly journal, took a new step forward at our board meeting on April 20 when the Lewis and Clark Trail Heritage Foundation signed a contract with the Washington State University Press, located in Pullman, Washington, to assume editorial and production duties for the journal. Our new editor is Robert Clark, editor-in-chief at WSU Press. We are so pleased to work with WSU Press staff and Mr. Clark, who attended our Troutdale, Oregon, board meeting.

In 1979, at an early moment in a distinguished career in books and publishing, young Bob Clark worked with his father Arthur H. Clark, Jr., in the editing and publication of Only One Man Died by one of our founders, Dr. E. G. Chuinard. This medical perspective on the expedition (for

Tri-State Chapter Meeting—May, 2013—Garden Creek Ranch, Hells Canyon, Idaho
(front, kneeling): Ellen Miyasato; Kevin Peters; John Fisher; Garry Bush; Bonnie Chew; Allen Pinkham.
(front, standing): Steve Lee, Ken Jutzi, Margaret Gorski, Steve and Deborah Wagener, Melanie and Rob Heacock, Eileen Starr, Laurie Brown, Carie Barndt, Philippa Newfield and Phillip Gordon, Katie Bump.
(back): Dave Blakely, Larry and Ellie McClure, Mrs. and Mr. LeMoine (partially hidden), Jon Townsend, Margaret and Allen Nelson, JoAnn Townsend, Rennie and Barb Kubik, Sandy Sheppard, John Benjes, Holly and Bob Crawley, John Douglas, Kris Townsend, Bob Bump, John Pontarolo, Steve Evans.
(Missing): Pat and Dan Rathmann; Chuck and Penny Raddon.
which the Trail Heritage Foundation owns the copyright) was published that year by The Arthur H. Clark Company. In addition to his publishing career, Mr. Clark has also served as editor of Overland Journal, quarterly journal of the Oregon-California Trails Association, for the last decade. We are delighted to have Mr. Clark and WSU Press on board, as we proceed on.

One of the attractions in our organization is visiting various Lewis and Clark sites around the United States. However, an issue for most of us is remembering the names of people we meet, sometimes once a year. So at regional meetings and at the annual meeting, I propose that a person in the organizing committee of that meeting have responsibility to make a group photograph, including names of each of the persons photographed. This photo with names could be distributed by email to all of the attendees. Also, if the meeting person would please email that photo with names to our Great Falls office, we can keep a (limited, please!) photo record in our national office of each meeting. See the regional meeting group photo for the New Orleans Regional of February 2013 and the WA/ID/OR Regional in May 2013.

Finally, I’m happy to share a photo of my dear wife Mary Lee and me at Kaw Point, the confluence of the Missouri River and the Kansas (or Kaw) River in Kansas City. It’s a wonderful thing to have a supportive and loving spouse.

—Dan Sturdevant
President, LCTHF

New Orleans Regional Meeting attendees from twenty-three states are pictured in front of the Battle of New Orleans monument in Chalmette, Louisiana, in February 2013.

Left to right by row (rows are approximate):

**Front row:** Susan Ritten, Jon Ritten, Peter Ritten, Mary Ritten, Lorna Hainesworth, Ann Bear, Janice Wilson, Jerry Wilson, and Lindy Hatcher.

**Second row:** Doug Davis, Fern Harmon (with sunglasses, partially hidden), Beverly Lewis, Mark Bear, Mary Langhorst, Liz Tidwell, Philip Gordon, Philippa Newfield, Matt Grundy (partially hidden with sunglasses), Paige Cruz, and Dan Sturdevant.

**Third row:** Lou Ritten, Della Bauer, Rob Barg, Jerry Garrett, Jim Koss, Herb Gordon, Joan Stockmel, Jim Fazio, Dawn Fazio, Skip Kowalski, and Margaret Gorski.

**Fourth row:** Mark Nelezen, Mike Loesch, Barbara Galtey, Loraine Loesch (tan jacket), Lynn Davis (pink jacket), Ginny Koss, Cathy Corley, Bruce Jones, and Jay Elder.

**Fifth row:** Ellie McClure, Larry McClure, Doug Dillard, Bonnie Dillard, Jerry Robertson, and Linda Robertson.
Scott Tucker Named Superintendent of Lewis and Clark NHP

Scott Tucker has been selected as the new superintendent of Lewis and Clark National Historical Park, located around the mouth of the Columbia River in Washington and Oregon. He replaces David Szymanski, who was recently selected as superintendent of Santa Monica Mountains National Recreation Area.

“Scott has proven experience working with tribes, leading programs to engage diverse youth in national parks and telling the Lewis and Clark story,” said NPS Pacific West Regional Director Chris Lehmanetz. “I expect that Scott will not just maintain, but continue to build and grow the park’s work with the wide array of partners within the community.”

Tucker has over fifteen years of federal government experience. He is transferring from his present post as manager of President’s Park in Washington, DC, where he had responsibility for the National Park Service property immediately outside the White House complex.

In this position, he has navigated complex public and private partnerships and fostered relationships with multiple federal agencies. For the last five years he has participated in the planning and implementation of nationally significant events such as the National Christmas Tree Lighting, the White House Easter Egg Roll, and Presidential Inaugurations. Additionally, he had oversight of the White House Visitor Center, care and preservation for several monuments, memorials, statues, and gardens, and the monitoring of First Amendment demonstrations that frequently occurred in Lafayette Park and on the White House sidewalk on Pennsylvania Avenue.

Tucker spent five years at the Smithsonian Institution’s National Museum of the American Indian. In this position he created the visitor services program for the museum, planned for the grand opening of the museum in 2004, and contributed to ensuring the Native American voice was incorporated into all public interactions and services.

An avid fan of history and the great outdoors, Scott also has experience interpreting the story of Lewis and Clark’s epic journey across America. He helped launch the Corps of Discovery II Project, serving as the deputy chief of interpretation in 2003 for the Lewis and Clark National Historic Trail’s traveling exhibit that followed the footsteps of the original Corps of Discovery during the Lewis and Clark Bicentennial Commemoration. In this position, Scott traveled the Eastern Legacy of the trail telling the story of Lewis and Clark.

Scott was contacted at his office in Washington, DC, and he asked to share this message: “I am honored and humbled to be able to once again work with amazingly dedicated groups such as the Lewis and Clark Trail Heritage Foundation. When I first participated in the Bicentennial Commemoration in 2003, I quickly realized every community, group, and organization has a little piece of the puzzle that makes up the Lewis and Clark Story. I look forward to continued communication and idea sharing as we all work to preserve and interpret the legacy of the Corps of Discovery.”

Scott will begin his new assignment in late June 2013.
New Lewis and Clark Exhibit Opens

A new exhibit at the Lewis and Clark Interpretive Center in Washburn, North Dakota, is open to the public and thousands of school children have already come by to see it in the month it has been in place. The Maximilian and Bodmer galleries showcase what the German prince and Swiss artist did in North Dakota.

The whole center tells the story of an exciting time in the state's history, and the gallery also features interactive displays.

“...This gallery continues the Jeffersonian age of enlightenment theme that we started with our Lewis and Clark exhibits which were installed a year ago,” said David Borlaug, president of the Lewis and Clark Fort Mandan Foundation.

The whole center was recently remodeled and renovated, and the building is also set to be expanded.

Erosion Fix Sought at Lewis and Clark Site

Southern Indiana preservationists are trying to line up federal money to stop severe erosion at the Ohio River site where Clark joined Lewis on his journey down the river in 1803.

They say the nearly 300-acre site at Clarksville is being damaged by torrents of water from the McAlpine Dam downstream to Louisville.

Clarksville historian Jane Sarles tells The Courier-Journal (Louisville, KY) that a structure is needed to deflect the current away from the shore, rather than piling more rocks as the Army Corps of Engineers has done before.

Officials estimate it will cost $17 million to solve the erosion problem and complete an archaeological park planned at the site, but they’ve been told by the Corps of Engineers that it doesn’t have the money for the project.

New Lewis and Clark Exhibit Opens

Stuart Edward Knapp

Stuart Edward Knapp died in Bozeman, Montana, on May 25, 2013, at age eighty-four. His enthusiasm for the Lewis and Clark story found an outlet through the Lewis and Clark Trail Heritage Foundation. He served as a member of the Bicentennial Committee and Board of Directors, as Vice President and then President of the Foundation (1993-94). He was one of three Foundation members who incorporated the National Council of the Lewis and Clark Bicentennial in 1993. In addition to his work with the LCTHF, Stuart was a member of the Yellowstone Association Board of Trustees and Director of the Montana Committee for the Humanities.

Born the youngest of three brothers to Samuel and Sarah Knapp on August 23, 1928, in Monroe, Washington, Stuart grew up in Snohomish, Washington. He graduated from Snohomish High School in 1946, where he played varsity football and was an Eagle Scout. He received bachelor’s and master’s degrees in biology from Pacific University in Forest Grove, Oregon, where he graduated in 1951. Stuart also received a second master’s degree in biology from the University of Idaho in 1953, and a Ph.D. in veterinary medicine from Kansas State University in 1958. In 1951 Stuart married Beverly Henson, who preceded him in death in 2010.

After graduation from KSU, Stuart spent nearly twenty years at Oregon State University in Corvallis, where he was an associate and full professor in the School of Veterinary Medicine. In 1978, he moved to Montana State University in Bozeman, first as Vice-President for Academic Affairs and then in several capacities until his retirement in 1999, including Acting President of the University. In addition, he was a professor of Veterinary Molecular Biology, Interim Dean for the College of Agriculture, and Director of the Montana Agricultural Experimentation Station. Stuart also served as the Deputy Commissioner for Academic Affairs for the Montana State University System from 1996 to 1998.

Stuart's contributions to scholarship and the academic community were recognized by his receipt of the Pacific University Distinguished Alumni Award, the Montana State University Blue-and-Gold Award, and the University Honors Program at Montana State University Distinguished Service Award.

An avid reader and collector of rare books, especially writers of the American West, he also traveled extensively and loved skiing, birding, and fly-fishing. Stuart will be remembered as a devoted husband, father, and grandfather, as well as a scholar and an educator with an enormous passion for teaching and learning. He is survived by his two sons, Karl (Luisa) of New York, N.Y., and Paul of Greensboro, N.C.; and five grandchildren: Haley, Reid, Hugh, Honor, and Scarlett.

Memorial contributions may be sent to the University Honors Program at Montana State University, P.O. Box 172140, Bozeman, MT, 59717.
Letters

The Death of Lewis Redux

Like the coal fires found in North Dakota and discussed in the feature article of this issue, the discussions of malaria, hypochondria, and the death of Meriwether Lewis that intermittently burst into flame are difficult, if not impossible, to extinguish. In preparing this issue, my first as editor of *We Proceeded On*, I admit to some trepidation about including these letters revisiting the issue of Lewis’s controversial last days. After all, the topic has been hashed and rehashed for two hundred years without resolution. As the latest greenhorn editor, long-time readers of this journal might assume that I thought the topic new. Though the debate isn’t fresh, it is engaging.

The recent articles in *We Proceeded On* by Thomas Danisi and Tony Turnbow, as well as other commentary, prompted these reader responses, and because of their length and focus on a single issue I felt it appropriate to treat them in a unique manner, rather like an article, instead of at the front of the issue as is the usual practice. I hope you will forgive the impertinence.

As always, *We Proceeded On* welcomes letters; however, they may be edited for length, accuracy, clarity, and civility. Send them to c/o Editor, *WPO*, Box 645910, Pullman, WA 99164-5910.

Bob Clark
WSU Press

Tony Turnbow & Major James Neelly

Tony Turnbow’s article in the May 2012 issue of *We Proceeded On* (vol. 38, no. 2) discusses what may be the most significant discovery regarding the death of Lewis since the Monument Committee of the Tennessee Legislature in 1848 reported that Lewis was the victim of an unknown assailant. The implications of the indisputable evidence uncovered by Turnbow that Major James Neelly could not have been at Grinder’s Stand on the date that he reported to Thomas Jefferson are numerous. Court records indicate that it is virtually impossible for Neelly to have confused the date that he was in court. So why did he write Jefferson that he was at Grinder’s Stand the day that Lewis died? Historians may never know, but sooner or later research on Neelly’s career may provide sufficient information for reasonable speculation.

Before listing some of the implications of Turnbow’s discovery, I hasten to point out that it vindicates Vardis Fisher whom Donald Jackson and others harshly criticized for his suggestion that Neelly was not trustworthy. Fisher immersed himself sufficiently in the sources to warrant this opinion. This new information also supports biographer Richard Dillon’s view. In phone conversations with me, Dillon insisted that additional information eventually would be uncovered in Tennessee, including evidence of a Coroner’s Inquest right after Lewis’s death. Dillon complained that suicide proponents generally begin with the assumption that Lewis killed himself and then list information that supports their position. In addition, many of the advocates of suicide have little knowledge of the Natchez Trace, its environs, and the people who lived there. Some day, it is likely that more information will surface that sheds light on what happened at Grinder’s Stand. We historians should admit that seldom do we have sufficient facts to justify the certainty of our interpretations. One of my friends likes to say: “The more a person knows, the less he/she knows FOR SURE.”

Now to a list of a few queries prompted by Turnbow’s research. First, what would Jefferson have thought had Neelly NOT reported suicide? Or had he known that Neelly had not told the truth about his whereabouts? (After all, one of the most compelling arguments in support of suicide is that Jefferson believed Neelly’s report.) What would William Clark have thought? What would Alexander Wilson have thought? And what implications does this new information have in regard to Mrs. Grinder and her reports of events at her homestead? To what extent does this new evidence vindicate others who have questioned the character of Neelly, including some of his contemporaries such as Captain Gilbert C. Russell, commander of Fort Pickering. The longer one ponders possible implications, the longer the list grows. I am certain that many *WPO* readers have a list of their own.

In a large sense, Turnbow’s findings alter the whole dynamics of the debate over the cause of Lewis’s death. Consequently, it will be interesting to see whether or not those who are certain that Lewis killed himself will attempt to discredit Turnbow’s scholarship. At this point it appears that it will be difficult to discredit his findings.

Finally, the Turnbow article substantiates my insistence that historians need more evidence before they declare that Lewis’s death was in fact a suicide. As I have written for years, I first became interested in the question of Lewis’s death because I was astounded that some historians, with so little evidence, declared unequivocally that Lewis killed himself. Hopefully, the Turnbow discoveries might cause the U.S. Park Service to reconsider its refusal to allow a forensic examination of the Lewis’s remains. Its policy leaves room for the assumption that these guardians of our history do not want the truth uncovered.

John D. W. Guice
Hattiesburg, Mississippi
After reading Thomas Danisi’s book, *Uncovering the Truth About Meriwether Lewis*, in which he states in reference to Lewis’s death, “In sum, the ague made him do it,”¹ a thought presented itself that was not in complete congruence with Mr. Danisi’s conclusion. Mr. Danisi claims that Meriwether Lewis suffered from the symptoms of ague, or malaria as it is known today, from 1795 until his death in 1809, a period of fourteen years.² Another way to think about Mr. Danisi’s claim is that Lewis suffered from degradation of malaria for forty percent of his entire life. This claim is supported by numerous contemporary documents in the book, and even Lewis’s own words are given as evidence.³

There seems to be no way to rationally deny that Meriwether Lewis was suffering in some way from malaria when his life ended on October 11, 1809, based on Mr. Danisi’s work.

There is an important aspect of Meriwether Lewis’s character that Mr. Danisi does not seem to consider when providing his theory about Lewis’s death. This aspect of Lewis’s character comes through very passionately in the court-martial proceedings that are provided in full in one of the appendices.⁴ The one thing that Meriwether Lewis seems to have valued above all else and even more than his own life: his public reputation. There are two specific statements made by Meriwether Lewis during his court-martial that demonstrate this. First, he said “…to add the greatest of misfortunes, to deprive me of my reputation—I had much rather he had of indulged his favorite, experience with an attempt on my life an object better calculated to serve the experience of a military man….”⁵ Second, he stated “…now as it is very disagreeable to hobble through life with a broken reputation, I conceive the duty of every man to connect intimately, their life and reputation by all possible ties, to the end. that when the one makes its exit the other may also.”⁶

I really enjoyed reading Mr Danisi’s book and would certainly recommend it to all those who are intrigued by Meriwether Lewis. The amount of original research that Mr. Danisi has done and the documents he includes in the appendices of his book are a very gracious gift to his readers. It certainly does seem though that there was more to Lewis’s death than ague or malaria. Clay Jenkinson writes, “…the proximate cause of Lewis’s suicide was the affair of honor forced upon his sensitive soul by William Eustis, James Madison, and the War Department; coupled with a toxic mix of physical, mental, and spiritual illness; exacerbated by excessive use of alcohol; and deepened by a sense that he had failed to meet the expectations that Jefferson and his own ambition had set for himself.”⁷ Meriwether Lewis was a complex man and so was his death.

Dan Bartley
Richland, Michigan

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“[A] must-read for anyone interested in the Corps of Discovery and its pivotal role in the exploration of the American West.”

—Herman J. Viola
Curator Emeritus, Smithsonian Institution

“[Danisi] has discovered more new sources about the life and times of Meriwether Lewis than any researcher alive…. Even readers who think they know Lewis will find surprises in this book.”

—Carolyn Gilman
Author of Lewis and Clark: Across the Divide

“History buffs will find this book invaluable for its impeccable research, attention to detail, and readability.”

— Publishers Weekly starred review

“Passionately argued and painstakingly researched… brings new insights into the life of one of America’s most misunderstood heroes.”

—Landon Jones
Author of William Clark and the Shaping of the West

“[A] gem!…The scholarship is backed with additional new evidence and supported with never-before published documentation. A must-read….”

— R. Mark Buller, PhD
Professor of virology, Saint Louis University

“Danisi has emerged as the Meriwether Lewis expert of this generation.”

—Jay H. Buckley
Author of William Clark: Indian Diplomat
Notes
2. Ibid., 194-195.
3. Ibid., 178.
4. Ibid., 251-269.
5. Ibid., 267
6. Ibid., 268

Hypochondriac Affections

HYPOCHONDRIASIS: “Hypochondriac affections. A genus of diseases of the class Neuroses...characterized by dyspepsia; languor and want of energy; dejection of mind and apprehension of evil, more especially respecting health, without sufficient cause, with a melancholic temperament.”—John Mason Goode, et al. Pantologia: A New Cyclopaedia (London, 1813)

On October 11, 1809, Governor Meriwether Lewis’s valet John Pernier, Major James Neelly, and Neelly’s servant buried Lewis near the Grinder house on the Natchez Trace in Tennessee. The three men then rode to Nashville, the destination of Neelly and his servant, who had accompanied Lewis and Pernier to the Grinder place from Fort Pickering on the Mississippi River. When Pernier, in Neelly’s words, “expressed a desire to go to the governors Mothers & to Monticello,” Neelly gave the grieving servant travel funds and a letter he had written to Thomas Jefferson with an account of Lewis’s death. Pernier reached Monticello on November 21. It is most likely that Jefferson had already heard or read reports of Lewis’s death, but they could now be set aside for Pernier’s heartbreaking personal narrative.1 If either Jefferson or Pernier took notes or wrote a summary of their discussion, such documents remain undiscovered. But at the close of a letter Jefferson gave Pernier to deliver to President James Madison, there is a glimpse into the bond that shared grief nurtures. “He [Pernier] is the bearer of this letter & of my assurances of constant and affectionate esteem.”2

By the middle of April 1810 Jefferson had received two letters from Captain Gilbert C. Russell, the commander of Fort Pickering. Russell had detained Lewis at the fort when Lewis arrived there on a boat from St. Louis on September 15 in ill health. Russell attributed Lewis’s illness “solely to the free use of liquor which he acknowledged to me after his recovery & expressed a firm determination never to drink any more spirits…”3 Jefferson replied to Russell on April 18, 1810: “He [Lewis] was much afflicted and habitually so with hypochondria.”4

Jefferson used a related term in an 1813 biographical essay of Lewis he wrote for the Biddle and Allen edition of the Expedition journals:

Governor Lewis had from early life been subject to hypochondriac affections. It was a constitutional disposition in all the nearer branches of the family of his name, and was more immediately inherited by him from his father. They had not however been so strong as to give uneasiness to his family. While he lived with me in Washington, I observed at times sensible depressions of mind, but knowing their constitutional source, I estimated their course by what I had seen in the family. During his Western expedition the constant exertion which that required of all the faculties of body and mind suspended these distressing affections; but after his establishment in St. Louis in sedentary occupations they returned upon him with redoubled vigor, and began seriously to alarm. He was in a para- ysm of one of these when his affairs rendered it necessary for him to go Washington...5

“Hypochondriac affections” is an odd term at this time, but the context, and the phrase “sensible depressions of mind” indicate that Jefferson had seen Lewis suffering from what today might be called clinical depression. Two writers, Thomas Danisi and John Jackson, have challenged the standard interpretation of Jefferson’s statements in WPO and in their biography Meriwether Lewis. They believe that Lewis shot himself not to commit suicide but in a delirious response to the sufferings of malaria. Common sense invalidates this “malaria hypothesis” from the start because it requires Jefferson to believe in the absurd idea that Lewis had somehow managed to inherit malaria from his father. Besides, none of the existing eyewitness accounts of Lewis’s final weeks mention malaria: neither Neelly, nor Russell, nor Mrs. Grinder, nor William Clark, nor Lewis himself. What does that suggest?

When authors propose a theory that is not supported by the best historical evidence, they must either abandon or modify the thesis. Or you can ignore the evidence, misrepresent it, and/or invent one’s own evidence, which is precisely what Danisi and Jackson do, on a grand scale, in their feverish efforts to discern malaria where it did, and did not, exist. Two examples involving William Clark illustrate the pattern. For example, they claim that Clark had malaria during the 1803 voyage of the Corps of Discovery to St. Louis: “Other studies have passed this off as a recurring bowel problem. But there is a similarity to malarial symptoms that Clark seemed to have shaken off at Kaskasia.”6 This is how Clark himself “passed this off” in a letter to his brother Jonathan:

a few days after I parted with you on the river bank, I was taken Violent ill by a Contraction of the muskelur Sistem, this indisposition Continued Several days and was ultimately removed by the exertions & Close attention of Capt Lewis, after a few days of tolerable health, I was again attacked with a violent Pain in the Sumock & bowels, with great Obstruction in those parts, which Could not be removed until I arrived at Kaskaskees, which was Eleven
Days, at that place I procured Some Allow which gave me relief.7

Clark, at least, knew the difference between malaria and constipation.

Danisi and Jackson quote the passage below from the letter that Clark wrote to Jonathan upon hearing of Lewis's death:

when at Shelbyville to day I Saw in a Frankfort paper called the Argus a report published which gives me much Concern, it Says that Govr. Lewis killed himself by Cutting his Throat with a Knife on his way between the Chickaw Saw Bluffs and Nashville, I fear this report has too much truth. Tho’ hope it may have no foundation—my reasons for thinking it possible is founded on the letter which I recved from him at your house.8

But Danisi and Jackson withhold from their readers the following statement from the same letter, for obvious reasons:

I fear O! I fear the weight of his mind has over come him, what will be the Consequence?9

Clark was concerned about his friend’s troubled mind, not malaria, but you wouldn’t know that from reading Meriwether Lewis.

Danisi and Jackson impugn Thomas Jefferson’s credibility regarding both Lewis’s health and his own. They claim that Jefferson also suffered from malaria, but “refused to admit it.”10 That’s an extraordinary assertion, one that demands extraordinary evidence, perhaps multiple independent attestations from Jefferson’s family and friends. Such evidence does not exist. The authors refer to Jefferson’s headaches, apparently under the rationale that if Jefferson had them, malaria can cause them; therefore, Jefferson had malaria. Jefferson’s headaches, which were perhaps migraines, are among the better known presidential maladies.11 There is no historical or medical evidence they were related to malaria.

The endnote in Meriwether Lewis for the authors’ claim that Jefferson “refused to admit” that he had malaria lists, but does not quote, two letters Jefferson wrote during his Presidency.12 The relevant passages:

We shall all absent ourselves from this place [Washington, D.C.] during the sickly season; say from about the 22d of July to the last of September.13

Just on my departure from this place [Monticello], where I habitually pass the sickly months of Aug. & Sep.14

The meaning is clear. Jefferson did not contract malaria every summer while he was President. He wisely escaped from the fetid bottomlands of the Potomac River to Monticello during the season when the District of Columbia was an excellent place to acquire malaria if one were so inclined.

How do we know that Jefferson did not suffer from “chronic” malaria? Because he said so:

[1803] I retain myself perfect health, having not had 20 hours of fever in 42 years past. I have sometimes had a troublesome headache, and some slight rheumatic pains; but now sixty years old nearly, I have had as little to complain of in point of health as most people.15

[1819] A fever of more than twenty-four hours I have not had above two or three times in my life. A periodical headache has afflicted me occasionally, once, perhaps, in six or eight years, for two or three weeks at a time, which now seems to have left me…16

There is no evidence that Jefferson suffered from chronic malaria, was in denial about it, or that either of these fictitious states influenced his understanding of Lewis’s death.

The focus of the controversy regarding Jefferson’s statements is the definition of the terms hypochondria, hypochondriasis, and hypochondriacal affections, which were used interchangeably during his lifetime. More to the point, how would Thomas Jefferson have understood and used the terms? According to Danisi and Jackson:

…hypochondria, in the usage of the time, described a set of physical symptoms. Medical understanding of that day made no attempt to identify an emotional condition as the term is used today.

The term hypochondriac referred to the anatomical region seated in the abdominal area and hypochondriac affections actually referred to the disease known as hypochondriasis, a complex physical sickness. Ailments ascribed to the hypochondrium meant a cluster of illnesses manifested by a fever stemming from an unknown cause…

Far from being the melancholic disposition that gave rise to imaginary illnesses, as American doctors have latterly considered it, the hypochondriasis that afflicted Meriwether was a debilitating complication of untreated chronic malaria.17

It is true that there were physical symptoms associated with hypochondria, and that term does indeed refer to the upper abdomen. Hypochondriasis, in Hippocratic medicine, “black bile,” or “melancholy” was one of the four bodily fluids or “humours” which characterize a person’s temperament. A person with an excess of black bile—a melancholic—was a sad, fearful person. Rufus described three types of melancholia: one involved the head only, a second the entire body, and the third the hypochondrium, or upper abdomen.18 To Rufus, “hypochondriac melancholy” was a disease of the mind that had its origins in the stomach.19 It involved an abnormal rise of temperature in the liver and stomach.20 Black bile ascends from the hypochondria to the brain, producing the mental and emotional symptoms of the disease.21 From that beginning, writes Susan Baur:
Hypochondria’s other attributes—preoccupation with disease, inexplicable periods of anxiety, nightmares, and the rest—were gradually added over the next four hundred years, after which the clinical picture, or ‘presenting symptoms,’ as doctors would say, changed very little.22

In 1621 the Oxford scholar Robert Burton published The Anatomy of Melancholy, which distilled the essence of ancient and medieval works on “hypochondriac melancholy” and formed a foundation for future scholars and physicians. Jefferson, whose intellectual interests were eclectic, may have possessed a copy. If not, the writers whose works with which he was familiar were influenced by it. The following is a survey of the medical and popular literature available to Jefferson that would have informed his understanding and usage of “hypochondriac affections.”

In 1661, the English naturalist Robert Lovell listed the symptoms of “Hypochondriack melancholy” as “crudity of the ventricle, pain, syrupcity of the belly, flatulence, anxiety, palpitations of the heart, pulsation in the left hypochondrium, dryness of the tongue, difficulty of respiration, and perturbation of the brain, &c.”23

Jean Baptiste Molière's 1673 comedy Le Malade Imaginaire (The Imaginary Illness):

…our patient here present is unhappily attacked, affected, possessed, and disordered by that kind of madness which we properly name hypochondriac melancholy…you need only consider that great seriousness, that sadness, accompanied by signs of fearfulness and suspicion…24

The Universal English Dictionary of 1696: “Hypochondriasis Affection…a Disease proceeding from windy Humours, bred in the hypochondres; whence a black phlegm arising infects the Animal Spirits and disturbs the Mind.”25

Dr. Sir Richard Blackmore in 1726: “Hypochondriac Affections…in my Judgment, evidently consist of the irreg-ular and disturbed Motions of the Spirit, and the irritable Disposition of the Nerves…”26

The humorist Thomas d’Urfey in 1729: “What martyr to hypochondriasis has not consulted Thomas (vulgo Tom!) D’urfe, whose Pills to Purge Melancholy relaxed the rigid, frigid muscles of sat-urnine King William and cast out the Blue Devils from her querulous majesty Queen Anne.”27

Notably absent in the literature is any equation of malaria with hypochondriac affections. In fact, Dr. Gideon Harvey in 1689 cautioned against treating hypochondriasis with Peruvian or Jesuit’s bark, the “sovereign” remedy for malaria: “…nothing will more certainly kill an Hypochondriac man, or Hysteric woman, in the violence of their returning fits, than the course of bleeding, vomiting, purging, and Jesuiting…”28

In 1780 Dr. Thomas Frewen added to the list of symptoms several which relate hypochondriac affections more closely with what is presently understood as clinical depression: “a constriction of the breast, difficulty of breathing, palpitation of the heart, faintings, vigiliae, inquietudes, swimming of the head, fear, suspicions, melancholy, delirium, etc.”29

How can hypochondriasis be equated with, or be a complication of, malaria as asserted by Danisi and Jackson?

Can “hitting the books” cause malaria? James Fordyce, D.D., in 1791: “…too intense an application to study…often embitters life by oppressing the body with disease and the mind with melancholy…not seldom it has produced hypochondriac affections bordering on madness, if not ending in absolute lunacy.”30

Can malaria prevent malaria? According to Dr. Alexander Philips Wilson, writing in 1803, malaria could relieve or prevent hypochondriasis: “But it is not to be denied that agues supervening on other diseases, sometimes relieve them…”31

The waters of the English hot springs at Bath, James Playfair cautioned in 1809, were beneficial for “hypochondriacal complaints” but “the use of the waters is hurtful in all cases attended with fever…”32

In the first decade of the nineteenth century, and the last decade of Lewis’s life, the definition of hypochondriac affections continued a trend toward mental depression and/or hypochondria, as those terms are presently understood.

Dr. William Perfect, 1800: “…he was suddenly seized with an hypochondriacal affection, attended with vehement motions of the body, fear, suspicion, impatience, and violent perturbations of mind; which at length settled into a deep melancholy…”33

In 1800 The Monthly Magazine in London published an article about a Captain of Marines who had shot himself in the head with a pistol. The unfortunate officer suffered from a: “nervous irritability and depression, in so violent a degree, as to alarm the most intimate of his friends…The Coroner’s Inquest were fully justified in their verdict of insanity, as it was obvious that he had for some time labored under an hypochondriacal affection.”34

Dr. William Heberden in 1802 defined “hypochondriac affection” as a languor and dispiritedness, without any manifest cause, which has cast a cloud over all [the patients’] pursuits, and has afforded only gloomy prospects, wherever they turned their thoughts…a mist will seem to obscure the sight. A giddiness, confusion, stupidity, inattention, forgetfulness, and irresolution, all show that the animal functions are no longer under proper command, and that the mind is controlled by some foreign power…”35

Can a sermon cause malaria? Dr. Joseph M. Cox, 1806: “…many an unhappy instance has occurred in my practice, where the ignorant or injudicious zeal of Preachers has induced hypochondriasis, insanity of the most incurable species, and moping melancholy, often terminated by suicide.”36

Johann Georg Zimmerman in 1808: “The state into which the soul is plunged...
by hypochondria, is an inexhaustible source of pain…Tortured with continual depression, racked with the most painful apprehensions…All the joys of life are poisoned, all the energies of the soul are paralysed…”37

Never mind the bark: nothing like a nice nap to shake off malaria. The Medical and Agricultural Register of 1806 and 1807: “…a fit of the hypochondriasis, cannot be more effectually relieved, than by a short sleep…we awake refreshed, we can reflect on our difficulties with a calm mind, and again reconcile ourselves to the troubles of life.”38

Poet Robert Burns in 1808: “There was a certain period of my life that my spirit was broken by repeated losses and disasters, which threatened, and indeed effected, the utter ruin of my fortune. My body, too, was attacked by that most dreadful distemper, a hypochondria or confirmed melancholy.”39

Dr. Benjamin Rush is justly famous for his insight and compassion in the treatment of mental illness. A passage from Rush’s Medical Inquiries and Observations Upon the Diseases of the Mind, which Rush could not have written nor Jefferson read without Lewis in mind:

But the most awful symptom of this disease remains yet to be mentioned, and that is despair…It sometimes creates such a disgust of life, as to make the subjects of it wish to die. How un describable, and even incomprehensible, must be that state of mind, which thus extinguishes the deep seated principle of the love of life! But there is a symptom of despair which places its horrors beyond a mere wish to die. It often drives the distracted subject of it to precipitate the slow approaches of death with his own hand. A pistol, a razor, a river, a mill-dam, a halter, or laudanum, are the means usually resorted to for this purpose.40

Concerning hypochondriac affections as the term was understood in the early nineteenth century:
- It was a “nervous disease” characterized by depression, anxiety, and/or unreasonable fears.
- It was in some patients attended by physical symptoms, usually gastro-intestinal in nature.
- It was unrelated to malaria. That’s how Jefferson understood the term and used it, as the examples below illustrate.

Danisi and Jackson used a partial quotation from a letter Jefferson wrote in 1787. Jefferson, they assert, not only refused to admit he had malaria, he simply did not understand it: “Even the enlightened president of the nation did not grasp what was dragging them down. Exercise was Thomas Jefferson’s answer because ‘idleness begets ennui, ennui the hypochondria, and that a diseased body.'”41

The document containing this passage is an oft-quoted epistle of fatherly advice from Jefferson to his daughter Martha. What Danisi and Jackson chose to omit reveals its true meaning. It has nothing to do with malaria, unless lassitude can cause it:

Of all the cankers of human happiness, none corrodes it with so silent, yet so baneful a tooth, as indolence. Body and mind both unemployed, our being becomes a burden and these make us precious to our friends.42

More quotations from Jefferson letters:

At first I hesitated, recollecting to have heard Ternant represented in America as an hypochondriac, discontented man…43

I now have a constant correspondence with him and find him a little hypochondriac and discontented.44

The gentlemen must surely be hypochondriac. He compared their case to the conceit of Don Quixotte about the windmills.45

The stocking weavers and silk spinners around it [Maison quaree], consider me as a hypochondriac Englishman, about to write with his pistol, the last chapter of his history.46

He had understanding enough to post up his ledger from his journal, but not enough to bear up against hypochondriac affections; and the gloomy forebodings they inspire.47

No reference at all to malaria.

Jefferson’s statement regarding the inherited, constitutional nature of hypochondriac affections not only rules malaria out; it anticipates the modern understanding of the genetic nature of clinical depression. This view, also, was supported in the contemporary medical literature.

Dr. William Heberden, 1802: “Some derive it from their parents; and the seeds of it, brought with them into the world, are sure to make their appearance at the proper time…”48

Thomas Arnold, 1806: “Hence it is, that the son may receive from his father a predisposition to insanity, by receiving something faulty in the mechanical structure of the brain, tending to disturb the operation of the mental functions; some weakness in the alimentary canal favourable to the generation of hypochondriacal melancholy…”49

The New and Complete American Encyclopedia of 1808 listed “heredity disposition” as one of the causes of hypochondriac affections.50

Dr. Thomas Jameson, 1811: “The Melancholic Disease occurs for the most part in the second epoch of manhood; but when it is hereditary, we can discover a tendency to its appearance before thirty years of age.”51

Dr. Benjamin Rush, 1812: “There are several peculiarities which attend this disease, where the predisposition to it is hereditary, which deserve our notice…It generally attacks in those stages of life in which it has appeared in the patient’s ancestors.”52

The final word to consider in Jefferson’s statement is “paroxysm.” Danisi and Jackson write:
The term paroxygen may seem to describe a mental condition, but in the usage of the seventeenth and eighteenth centuries it denoted a fit or rigor (tremors induced by chills).53

The London Medical Dictionary 1809 edition also employed the term paroxysm regarding epilepsy, hysteria, mania, unspecified fever, ophthalmia, heart palpitations, pertussis, gout, and heartburn.54

Dr. Benjamin Rush, 1812: “The hypochondriasis…has paroxysms, and remissions or intermissions, all of which are influenced by many circumstances, particularly by company, wine, exercise, and, above all, the weather. A pleasant season, a fine day, and even the morning sun, often suspend the disease. Its paroxysms are sometimes denominated "low spirits." They continue from a day, a week, a month, a season, to a year, and sometimes longer.”55

Samuel Johnson: “Melancholy has had in me its paroxysms and remissions…”56

Ann Ward Radcliffe, 1806: “…after the first paroxysms of despair were passed, a heavy and silent melancholy had settled upon her spirits…”57

Dr. Robert Thomas, 1809: “When the furious state is succeeded by melancholy, and the violent paroxysm that returns after this shall have continued a short time, the hope of recovery is but small.”58

It could not be plainer. Then and now, “paroxysm” was not limited to malaria. Therefore, it is no more proof of malaria than it is of anything else.

Eleven days after John Pernier left Monticello for the District of Columbia, Jefferson encountered William Clark in Charlottesville and invited him to spend the night with him. The two men “spoke much on the affairs of Gov. Lewis,” Clark wrote in his journal.59 Through a long, late autumn evening the two men who mattered most in Lewis’s life shared the grief they felt for the loss of a man who was another brother to him who had several and a surrogate son to a man who had none. They did what we all do at such times: examined a tragic death from every angle to find a path to understanding and consolation, and the means to cope with guilt. “Could I have said or done something to prevent this?”

Together, John Pernier and William Clark were a “chain of care” during the last weeks of Lewis’s life. The letters Jefferson received from Neelly and Russell are of great importance to historians, but to Jefferson they were only supplementary perspective or interpretation. The hours he spent with Pernier and Clark are what mattered. They knew the facts. From them Jefferson learned that when Lewis finally arrived in St. Louis to assume his responsibilities as territorial governor, his episodes of “sensible depression of mind…returned upon him with redoubled vigor, and began seriously to alarm. He was in a paroxysm of one of these when his affairs rendered it necessary for him to go Washington…” (see note 5).

Lewis was suffering from depression well before he began his journey east to clear his name. Although most scholars believe that his depression was severe enough to lead to suicide, an analysis of the suicide or murder controversy is beyond the scope of this letter.

In summary:
Since ancient times no one thought of or used the terms hypochondria and, later, hypochondriac affections as having anything to do with malaria. That includes Thomas Jefferson.

Jefferson did not suffer from chronic malaria and had considerable expertise regarding Meriwether Lewis’s physical and mental health, including an insight into the hereditary nature of Lewis’s depression.

There is no eyewitness evidence that Lewis was suffering from malaria when he died.

One final point; it involves Lewis’s stressful relationship with Territorial Secretary Frederick Bates. When the news of Lewis’s death reached St. Louis, land commissioner Clement B. Penrose publicly accused Bates of responsibility for Lewis’s “mental derangement,” blaming it on the “barbarous conduct of the Secretary.”60 Penrose’s accusation can be read in Thomas Marshall’s The Life and Papers of Frederick Bates, a source that Danisi and Jackson cite dozens of times in Meriwether Lewis. Penrose is mentioned several times, but his accusation against Bates is not found in Meriwether Lewis. Apparently Danisi and Jackson could not find a way to blame Bates for Lewis’s malaria, which, according to the contemporary belief of the cause of the disease, would have required Bates to abduct Lewis and leave him bound and gagged in a swamp.

The Danisi–Jackson malaria hypothesis rests upon extensive misrepresentation of historical evidence. Unless and until its proponents can provide real evidence, it belongs on the same shelf as Grace Hebard’s Sacajawea fantasy.

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Notes
2. Ibid., 475-6. Lewis himself had written to Madison on October 16 from Ft. Pickering. That letter’s “lack of fluency,” wrote Donald Jackson, “is often cited as evidence that [Lewis] was not quite himself…” (Jackson, 464-5).
4. Jackson, 728.
5. Ibid., 591-2.
8. Ibid., 216-18. In their narrative of Lewis’s final journey, Danisi and Jackson note his arrival at Fort Pickering following a river passage during which Lewis was reported to have made two attempts at suicide. The
authors acknowledge that Lewis “could have been imbibing enough alcohol to make him drunk,” but then proclaim, “But inebriation does not explain the reported suicide attempts.” (Meriwether Lewis, 318) How can anyone be unaware of the tragic relationship of alcohol, depression, and suicide? Immediately after this unjustified remark, Danisi and Jackson continue to make their case for malaria.

Among the examples of their misrepresentation of evidence are citations from two books used to support their malaria hypothesis. The first is Sir John Pringle’s Observations on the Diseases of the Army, which was first published in 1752 in London. Pringle served as physician to the British forces in the Netherlands in the 1740s. The quotes below are from the 1764 edition.

On page 318 of Meriwether Lewis, the authors quote the following passage from Observations, preceded by the remark, “The English physician John Pringle described soldiers who succumbed to the first stage of the ague:”

There were some instances of the head being so suddenly and violently affected, that without any previous complaint the men ran about in a wild manner, and were believed to be mad, till the solution of the fit by a sweat, and its periodic returns, discovered the true nature of their delirium. [missing sentences, see below] That a few returns of the paroxysms reduced their strongest men to so low a condition as to disable them from standing. That some became at once delirious [missing phrase, see below] and would have thrown themselves out of the window, or into the water, if not prevented.

Danisi and Jackson falsified Pringle’s text at least four times. First, Pringle’s theme in this chapter on camp fevers is that he and his colleagues were treating soldiers whose symptoms presented so many permutations of chills, fever, and sweats that they were not certain what disease they were treating. Contrary to Danisi and Jackson’s claim that it was malaria, Pringle specifically ruled out malaria [an ague or intermittent].

Altho’ this fever, in many particulars, resembles an intermittent... yet it is somewhat of a different nature... In the camp we seldom meet with a regular intermittent, either in a tertian or quartan form; unless the person has been ill of one before he took the field (Pringle, 176).

Second, Pringle wrote “There were several instances...” Danisi and Jackson altered it to some, which gives the impression there were more instances than there actually were.

Third, Danisi and Jackson deleted, without using an ellipsis, several sentences [two hundred words] between “delirium” and “That a few...” Here are the missing sentences, restored, from a 1764 edition available on Google Books:

Some time after, Dr. Stedman, then surgeon to the Greys [a British regiment], acquainted me: “That two of the men who were first taken ill, were seized at once with the symptoms of an ardent fever; and though they were speedily and plentifully blooded, yet, in an hour thereafter, both were in a high delirium, which were continued for some hours (page 181) and went off with a profuse sweat, under which all other symptoms either abated or vanished. That, next day, about the same hour, the paroxysm returned, and in six or seven hours ran the same course. In this manner the fever affected many of that regiment: but others had not the paroxysms so distinct, as the hot fits were long, and followed by imperfect sweats affording little relief. Sometimes the fever had daily intermissions, but generally it only remitted, and the remissions were often so imperceptible, that the disease appeared almost in a continued form. That, the nearer it approached to this last state, it was the more irremovable; but when the paroxysms were distinct, with an intermission of some hours between them, the patients for the most part did well, however great the delirium was during the fever (page 182).

Nor were those the only symptoms. The following sentence from Observation, page 187, is not found in Meriwether Lewis: “When the sickness was at the worst, many voided round worms; which were not the cause of the fevers, but, as observed before, concurred with other circumstances to retard the cure.”

Some intestinal worm infections have symptoms similar to malaria. Fourth, the phrase that Danisi & Jackson omitted in the page 318 quotation with an ellipsis between “delirious” and “would have” is: “without any previous complaint.” The complete sentence on page 182 reads: “That some became at once delirious without any previous complaint and would have thrown themselves out of the window, or into the water, if not prevented.”

The missing phrase may also seem to rule out malaria because there were no prior symptoms. Danisi and Jackson misrepresented Pringle’s text to give the impression that he was writing specifically about malaria patients when that wasn’t the case at all.

The second source is Dr. John Macculloch, “Physician in Ordinary to his Royal Highness Prince Leopold of Saxe Coburg,” who published An Essay on the Remittent and Intermittent Diseases in 1828, fifteen years after Jefferson wrote about Lewis’s hypochondriac affections.

Danisi and Jackson wrote that “Macculloch was the first to connect the symptoms of the ague to the hypochondrium, wherein both the liver and the spleen become enlarged due to the constant strain of the malarial parasites upon those organs.” (Meriwether Lewis, 318.) But the word hypochondrium does not appear in Macculloch’s book. There are half a dozen references to hypochondriasis. Each time it is used with the same meaning as the other references in the present article. For example, Macculloch wrote, “Nor need I repeat, how, as in remittent fever, such a disorder of mind, ill observed, is mistaken for hypochondriasis, as is also a very common case.” His meaning is clear: victims of febrile diseases such as malaria sometimes exhibit symptoms that could be mistaken for hypochondriac affections. That does not make hypochondriac affections a synonym for malaria. Bacterial food poisoning shares symptoms with gastroenteritis, but they’re not the same illness.

9. Ibid., 218. In a letter to Jonathan written from St. Louis on August 26, Clark mentioned the protested bills and pressure of creditors which had “distressed [Lewis] much, which he expressed to me in such terms as to Cause a Cempothfy which is not yet off.” The following sentence from the same letter does not appear in Meriwether Lewis, perhaps because once again it might throw the reader off the scent of malaria: “... if his mind had been at ease I Should have parted Cherefully.” Ibid., 210. Danisi and Jackson ignored or corrupted actual evidence and crafted a narrative of Lewis’s final journey in Meriwether Lewis that is a melodramatic fantasy featuring sentences such as: “Weakened and desperate, the chronic sufferer was close to exhausting his tolerance of the monster.” Danisi and Jackson, 291.

10. Danisi and Jackson, 89. Ironically, it is their credibility that is at stake on the
issue of malaria. Because they try to identify every possible illness as malaria, the disease becomes unrecognizable in their hands. The contradictions and inconsistencies in their writing reveal that they did not adequately understand the science of malaria. Nor, apparently, do they comprehend Lewis's role on the Expedition. "Sometimes taken as a fault," they write, "Meriwether's journalistic lapses on the expedition may have reflected times when malaria immobilized him." Ibid., 311. Lewis immobilized by malaria from May 1804 to April 1805? Yet two pages later, they claim that "the ague [malaria] was periodic, presented itself with violent paroxysms, and usually ended within a day or two." Ibid., 313. Regarding the "journalistic lapses," they contradict themselves yet again on page 338 by acknowledging that "Lewis performed other necessary tasks."


12. Danisi and Jackson, 102.


20. Ibid., 31.

21. Ibid., 84.


40. Benjamin Rush, M.D., Medical Inquiries and Observations Upon the Diseases of the Mind (Philadelphia: Kimber and Richardson, 1812), 95-6.

41. Danisi and Jackson, 141.


43. Thomas Jefferson to John Jay, February 4, 1789. Ibid., 512.


52. Rush, 17, 52.

53. Danisi and Jackson, 308.


55. Rush, 34.

56. Samuel Johnson and George Strahan, Prayers and Meditations (London: Hood and Sharpe, 1806), 121.
“Facts are stubborn things”

Over the past few years Thomas Danisi’s theory concerning the death of Meriwether Lewis has been a matter of discussion within the Lewis and Clark community. Mr. Danisi’s latest article in *We Proceeded On* (vol. 38, no. 4, November 2012), raises the issue once again. After reading the article, I have concerns about the academic/historical credibility of this theory. The author misstates facts of both modern medicine as well as medical history and is guilty of errors in reasoning. In addition, Mr. Danisi has chosen to disregard abundant evidence that shows the error of his theory.

In the November 2012 article, Mr. Danisi writes that the numerous reports of Lewis’s death by various historical figures, “have led most Lewis historians to attribute Lewis’s death to suicide as a result of lifelong depression” (p.19). It is a nuance of my argument, but significant to note that I have never stated that Lewis suffered from “lifelong depression.” In short, what I have stated in the past is that the genetic predisposition for depression was likely present in Lewis at birth. But it took some environmental factors to initiate the manifestation of the depression later in his life. Those environmental factors in my opinion were his job/social situation upon return to society in 1806, and his alcohol and opium abuse. Many disease predispositions are inherited. DNA, comprising genes that may predispose to an illness, “loads the gun,” and environmental factors when present often “pull the trigger” in initiating the symptoms of the disease. It should also be noted that infectious diseases, or in the medical terminology of 1805, those caused by “contagion” (e.g., malaria), generally do not fall within this category.

In the same paragraph Mr. Danisi wrote, “They conclude that these suicidal actions by Lewis were exclusively the result of mental disease—of some derangement or severe depression.” Again, this statement does not accurately reflect what I have stated. I believe that Lewis’s mental disease (depression) was brought about not only by his genetic predisposition, but by his social/work situation, and his alcohol and drug abuse. The latter two are very much physical factors that would greatly exacerbate or initiate Lewis’s mental (depressive) illness. Understanding the inherent difficulty and inaccuracy of making a postmortem diagnosis on someone that a physician has never interviewed or examined, my friend Fred Griffin, M.D., board certified psychiatrist and a training adult psychoanalyst at the Dallas Institute of Psychoanalysis, offered this analysis of Lewis’s clinical picture:

“…looks impressively like some form of (likely rapid-cycling variety) bipolar illness—perhaps more likely Type II (depression being more prominent) than Type I (more classical “manic-depressive” illness): Its periodicity/recurrence; the tendency not only to depressed mood, but also to paranoia; and the not infrequent somatization found with many of these patients who have a kind of narcissistic vulnerability and/or who possess a regression in psychological/cognitive processing during severe bouts…bipolar illness is notoriously responsive to certain emotional triggers (loss of a person or a situation leading to loss of self-esteem or at times feelings of triumph/victory/excitement). Even sleep deprivation in itself or another physical condition or treatment for it can trigger an episode.

And if someone is able to ‘defend against’ or counter depressive feelings through work or a large project (like the expedition), the depression would likely assert itself with full force only after the project is completed—and the person slips more fully into a depressive state without other goals or efforts ‘out there’ to pursue.”

Mr. Danisi then supports his case by citing Stephen Ambrose, Gary Moulton, and me, stating that “for these historians, symptoms of a purely mental disorder of psychoneurotic or psychotic proportions, which is rooted in the early formation of his personality or of his thought processes and characterized by feelings of sadness and hopelessness, confusion or derangement, and sometime accompanied by suicidal desire and suicide attempts.” The quote is attributed to a number of different Lewis and Clark authors but the footnote does not specify which author in particular is being quoted. Thus the reader is led to believe that this is the shared viewpoint of all three authors, which is not the case. The assertion that Lewis’s depression “is pathological” is true by definition.

In a following paragraph that cites Jefferson’s intimate knowledge of Lewis’s character, Danisi writes that “Jefferson’s comments seem key to our understanding of Lewis’s death, and one would expect Lewis’s contemporaries and historians to follow the observations that he set forth in his letters.” I can’t speak for Lewis’s contemporaries, but personally, I would put great confidence in Jefferson’s thoughts about Lewis’s death. He continues: “Surprisingly, however Jefferson’s letters to and from Russell and Paul Allen reveal a fresh and suggestive perspective on Lewis’s death that diametrically opposes the view of House, Neelly, and Russell,” and by logical extension, Ambrose, Moulton, Peck, et al. Any of Mr. Danisi’s “fresh and suggestive perspective” on Jefferson’s writing must be viewed within the context of what we know of history/medical history. If it deviates from established facts or worse yet, ignores them, it is not “fresh
and suggestive.” It is simply wrong and deceptive.

At this point, the Danisi article quotes Jefferson’s letters to Allen and Russell, citing Lewis’s “hypocondriac affections” and “hypochondria,” stating that the modern group of historians “attempt” to address the “first question using the categories and logic appropriate to modern psychology. But they failed to address the second question in an appropriate way.” His implication in using the word “attempt” is that our efforts using the terms of modern psychology do not accurately or adequately define “hypochondriac affections.” Again, this is incorrect. Several of the authors he cites in his footnotes have done exactly what Mr. Danisi states they have not. I covered the historical use of the word “hypochondria” in letters I wrote in WPO (vol. 36, #2/3, May/August 2010), historical medical facts that Mr. Danisi chose to not address in his latest article. In short, “hypochondria” meant in 1805 exactly what it means today. It is easy to illustrate this fact by looking at the writings of Benjamin Rush, M.D., which I will summarize later. (The term “hypochondria” derived from the ancient Greek belief that the seat of the emotions lay in the anatomical area of the hypochondrium, or just below [hypo], the cartilaginous portion of the anterior rib cage [chondrium]).

Mr. Danisi then states that due to Jefferson’s knowledge of Greek, Latin, and French, he chose his words carefully. Then in a stunning leap of logic, he concludes that, “clearly, the phrase ‘hypochondriac affection’ is not to be understood from its modern usage, which is derived from later nineteenth and twentieth century psychology.” This statement is certainly not supported by the preceding argument that because Jefferson was a polyglot, that somehow he clearly didn’t mean what I, with many other authors on Lewis, state as reality. How does an argument about Jefferson’s language abilities support Mr. Danisi’s assertion that it is “clear” that hypochondria cannot be understood in the “modern” way? Additionally, it is an easy task to show that Jefferson meant exactly what the “modern term” means by not only reading his statement, but by implication from Benjamin Rush’s medical writings dealing with hypochondriasis.

Mr. Danisi’s quotation of Dr. Robert Hooper’s treatise on hypochondria is then misinterpreted. Dr. Hooper’s comments are consistent with the ancient Greek belief of the hypochondrium being the seat of the emotions when he wrote: “The seat of the hypochondriac affections is in the stomach and the bowels.” He notes the medical observation that upon autopsy, “the liver and spleen are usually found considerably enlarged.” He is not assigning a causative association between the two, but simply making observations that physicians made about a myriad of things during those times. Since they did not understand very much about human physiology/pathology, physicians of long ago made copious observations about associations of various physical disease and post-mortem findings. If you read the writings of Rush and other historical medical figures, they record nearly endless associations between diseases and environmental and physical findings without assigning causation to any of them. Hooper is not stating that the “hypochondriac affections” were specifically caused by splenomegaly (enlargement of the spleen), or hepatomegaly (enlargement of the liver), but that the two conditions were noted to at times occur together. This again is an important nuance of this argument, and Hooper’s statement when interpreted correctly reflects the belief of the ancient Greek physicians.

The Danisi article then states that Jefferson believed that “Lewis was prey to hypochondriac affections, a disease that did not have a mental source, but, in Jefferson’s words, a ‘constitutional source.’” I completely agree that this was Jefferson’s belief. The ancient Greeks erroneously believed this, too, as well as believing that the seat of a person’s emotions lay in the abdominal region of the body. Jefferson believed that the inherited mental disorder from which Lewis suffered was “constitutionally” passed on to him from his father, as well as to other members of the Lewis family.

At this point I must raise another question about Mr. Danisi’s theory. If Lewis’s “hypocondriac affections” were not depression and/or a fixation on an imaginary medical condition, but abdominal pain associated with a “chronic” malarial infection, are we to believe that Jefferson believed that Lewis’s malaria was inherited from his father? This logical extension of Mr. Danisi’s theory is ridiculous and not even Benjamin Rush believed such a thing, but attributed malaria to a “contagion” or other environmental factors. Jefferson noted that Lewis had probably inherited the disease of hypochondria from his father. Did Jefferson mean that Lewis’s father suffered from abdominal pain, brought on by a chronic case of malaria, or from some other source? If other members of the Lewis family suffered from this disease as well, then they all must have suffered from abdominal pain. This logical extension of the Danisi theory would once again seem rather unlikely.

The author continues in his attempt to establish that both Lewis and Jefferson suffered from a specific disease called “severe intermittent paroxysm,” citing that both had “severe indisposition” and “headache” at points in time—symptoms that I believe every reader of this article has suffered at some time. “Severe intermittent paroxysm” is not a designation of a specific disease. Rather, it is a very nonspecific term that simply means a perceived “severe recurring problem with a sudden onset.” Mr. Danisi then incorrectly and arbitrarily equates his defined “intermittent disease” with “intermittent fever,” attempting to associate Lewis’s health problem with malaria, which also causes “intermittent fevers.” “Severe Indisposition” and “headaches” are present in innumerable disease processes, and by no means refer specifically, or exclu-
sively to malaria. Notice that Jefferson only stated that the severity of Lewis’s symptoms of hypochondria waxed and waned. The Danisi article’s leap in logic has now incorrectly equated Lewis’s problem with an “intermittent fever.” The link between the two diseases does not rest in medical history, but in the creative pen of the author.

Mr. Danisi also mistakes the state of medicine during this era in the following statement on page 25. “He (Lewis) had medical and personal knowledge of the ailments and intermittent diseases because of the treatments that he received from Doctors Benjamin Rush and Antoine Saugrain. He also most likely knew that these sovereign treatments dealt only with the symptoms, not the causes, of such diseases.” None of the men listed here had any realistic understanding of any disease process. There was no germ theory; no understanding of modern pathology or pharmaceuticals. There was no thorough understanding of the actual cause of malaria until the early twentieth century. Since neither Rush nor Lewis understood what caused malaria, they certainly had no understanding of the mechanisms of Cinchona bark (containing quinine), that could successfully treat the fevers caused by the malarial parasite. It was a completely “cookbook” type of medicine during that era. If a person had a fever that occurred during the summer or fall, came and went every few days, and was accompanied by a headache and some nausea, then he was diagnosed with “ague” or an “intermittent fever.” Their medical cookbook designated Cinchona bark as a treatment. Lewis and Rush had no understanding whatsoever of what caused the fever nor how the “barks” pharmaceutical mechanism of action did its work. Again, there is no logical connection between the knowledge of a treatment and the knowledge of the disease attributed to Lewis. Since Lewis had no true knowledge of either, it is incorrect for Mr. Danisi to make the statement he has about Lewis’s familiarity with these issues.

In summary, the sequence of Mr. Danisi’s logic is: severe intermittent paroxysm=intermittent fever=malaria=hypochondriac affections.

Mr. Danisi now states that “Historians in the past have attributed Lewis’s death to suicide as a result of lifelong depression. Unfortunately, this view conceals more than it reveals.” What does this mean? How does the conclusion of Lewis’s suicide conceal anything? And what exactly does it conceal?

Mr. Danisi then states without justification, and once again in a leap of logic, that with “documentary evidence… Lewis’s untimely death cannot be understood exclusively by the categories of modern psychology.” To be clear, I have never stated that the entire answer to Lewis’s death lies in modern psychology, but rather by combining it with an understanding of medical history and knowledge of modern medicine. Mr. Danisi also makes an incorrect implication in his statement that modern psychology is inadequate in its ability to explain Lewis’s mental problems and suicide. He adds that, “his death must be scrutinized by the biological categories of medicine of his day,” then goes on to equate the hypothetical disease equation I’ve listed previously. In this “equation,” Mr. Danisi suggests that the “biological categories of medicine of his day,” contain a more accurate assessment of Lewis’s medical condition than modern-day medicine, a very debatable suggestion! He also misinterprets “intermittent disease” to equal “intermittent fever” that, in his mind at least, equals malaria. However there were numerous infectious diseases unknown to the physicians of the day that would have had symptoms of “intermittent fevers” (fevers occurring every few days, with intermittent days free of fever). Fevers were classified as “malignant,” “remittent,” “intermittent,” “bilious,” “jail,” “putrid,” along with other colorful terminology, sometimes describing the source of the fever; sometimes descriptive of the other symptoms associated with the fever. “Fever” at that time were to be distinct diseases, not a manifestation of a disease.

Since the heart of Mr. Danisi’s argument lies within the disease of malaria, it is of eminent value to note that the organism that generally causes the most severe form of malaria, that was undoubtedly present in America during the time of Lewis and Clark, is Plasmodium falciparum. The species falciparum can create its lethal effects by way of parasitizing all ages of red blood cells, rather than just “old” or “young” red blood cells as occurs with the other human malaria-causing organisms likely present in early America; P. vivax and P. ovale. (The latter two organisms although classified separately, cause nearly identical clinical manifestations in human malaria.) The increased parasitization by the genus falciparum, and the changes it produces on the surface of the red blood cells it parasitizes, result in the clogging of capillaries in various organs, possibly leading to the death or severe illness of the victim. Unlike the generally less severe forms of malaria, the form of malaria caused by P. falciparum does not produce latent liver stages of the parasite (like P. ovale/vivax), thus not producing years of recurrent illness with this most lethal form of the disease.2 In order for Lewis to suffer from an ongoing form of this severe type of malaria, he would have to have been reinfected again and again by a mosquito bearing the P. falciparum parasite. The odds of this happening become increasingly problematic over time. An immunologically normal host, which Lewis most likely was, would probably develop some partial immunity to the effects of reinfestation after the initial case of malaria. Malaria victims in present day Africa who survive initial infections with falciparum-caused malaria will often have more mild symptoms if subsequently reinfected by another parasite-laden Anopheles mosquito. The lack of any latent liver stages for falciparum-caused malaria makes a “chronic” infection, lasting years with this most severe form of malaria, virtually impossible, as the falciparum plasmo-
that the disease he has is much more serious than it actually is. So Rush’s writings of the early nineteenth century show Mr. Danisi’s conclusions regarding the meaning of “hypochondriasis” to be utterly false. Rush’s use of “hypochondriasis” in this sentence matches Mr. Danisi’s so-called “modern” term exactly.

In another area of the same lecture, Rush wrote; “Are there certain grades in the convulsions of the nervous system, as appears in the hydrophobia, tetanus, epilepsy, hysteria, and hypocondriasis?” It is abundantly clear that Rush assigns hypochondriasis in this list of exclusively nervous system disorders. He is not using the term in any possible way to describe abdominal pain associated with any disease process. His use in this case also matches the “modern” meaning that associates hypochondriasis with a mental problem/nervous system disorder.

Rush again directly associates “hypochondriasis” with “hysteria” in writing about bilious fevers: “The hypochondriasis and the hysteria seldom fail to exchange their symptoms twice in the four and twenty hours.” I will not bore the reader with a further study on the word “hysteria.” It is a mental disorder.

In my inspection of hundreds of pages of Rush’s medical lectures, he never uses “hypochondriasis” in relation to anything other than its so-called “modern” meaning. In fact, there is no “modern” meaning of hypochondriasis that was formulated in the late nineteenth and twentieth centuries as is asserted by Mr. Danisi. In the early 1800s “hypochondriasis” meant exactly what it means today. Rush understood its meaning. His writings make his meaning perfectly clear and his writings occurred at the time of Lewis and Clark and Jefferson—not in the late nineteenth or early twentieth century. Only the selective ignoring of these facts by Mr. Danisi produces any different interpretation.

Mr. Danisi has chastised both Ms. Kira Gale and, more recently, Mr. Tony Turn-
The bicentennial celebration of the renowned Academy of Natural Sciences (ANS) that commenced in March 2012 in Philadelphia, Pennsylvania, incorporated a new and informative exhibit, *The Academy at 200: The Nature of Discovery*. It showcased the ANS’s most extraordinary holdings, including all of the surviving Lewis and Clark rock and mineral specimens.1 Just prior to the opening of the exhibit, I had the rare opportunity, courtesy of Dr. Ted Daeschler, Vice President for Collections and Associate Curator of Vertebrate Zoology, and Volunteer Curator for Mineralogy Douglas Klieger, to closely examine the “pummicestone” and “Lava” samples that were sent back east from Fort Mandan in April 1805.2 These two specimens, referred to as Fort Mandan mineralogical specimen 62 and 67, respectively, have long been identified by such experts as John W. Hoganson and Edward C. Murphy of the North Dakota Geological Survey as forms of “clinker.”3 This term is now commonly accepted to describe the array of rocks that have been thermally metamorphosed (altered by heating) from coal bed fires.4

The familiar “top” view of the Fort Mandan mineralogical specimen 67, which has been reproduced in numerous Lewis and Clark references that discuss their scientific endeavors,5 is quite reminiscent of pahoehoe6 lava and recognizable to anyone who has ventured along the slopes of the active Kilauea Volcano in Hawai‘i. Certainly this superficial appearance compelled Meriwether Lewis to identify the specimen as “Lava.” Adam Seybert, physician, gentleman-scientist, and Philadelphia’s leading mineralogy expert, concurred with this interpretation after the Fort Mandan mineralogical collection arrived at the American Philosophical Society (APS) in November 1805. Seybert added supplemental mineralogical comments into the Donation Book of the APS to augment Lewis’s original descriptions.7 I was particularly intrigued by the noteworthy vesicles (cavities) on the edges of the Fort Mandan mineralogical specimen 67 “Lava,” a feature not as evident on the “top” view. Such a unique opportunity to closely examine the “pummicestone” and “Lava” rocks provided an impetus to re-explore segments of the expedition’s route in North Dakota where Lewis and Clark collected these specimens, and encouraged my attempt to find similar samples. In addition, time could be devoted to an examination of the sequence...
The accumulation of different types of plants and their parts, along with differential coalification, in a coal deposit is expressed by an extreme vertical and lateral variability. A whole science of descriptive analyses has been developed to distinguish between different macroscopically identifiable layers. I suspect that Clark made a close inspection of certain coal exposures upriver because he would conduct an experimental burn of lignite samples just five days after the initial exposure of coal-bearing rocks was immediately to the north of the Fort Mandan site. In reconnoitering this area, I came across a fairly contiguous line of bluffs, including a prominent exposure of Bullion Creek Formation channel sandstones, which stand above a narrow, upper terrace of the Missouri River, accessible via 10th Street SW. Climbing along the upper section of these bluffs about 4,800 feet southeast of the Fort Mandan State Historic Site, I traced a 1.5-foot thick bed of lignite to a location suitable for closer examination. The surface of the lignite outcrop was blanketed with a clay film that had washed down from the overlying claystone bed so it was essential to shave off this detrital film to get a close look at the lignite’s compositional features. The basal coal layer was comprised of distinct, well-lithified tabular sheets of black lignite with a dull, matte-like luster with no recognizable plant structures (as opposed to the brownish-black lignites of the Sentinel Butte Formation I was to examine later at Beulah Bay). However, the upper part of the exposure had a noticeably bright, vitreous luster, particularly where the lignite was conchoidally fractured. This was somewhat suggestive of the higher rank coals that Lewis and Clark had encountered in the East.

The place of cogent observations that led to one of the captains’ most widely cited discoveries regarding how these thermally metamorphosed rocks were formed. This investigation would lead to disproving the belief that active volcanoes existed in the Louisiana Territory.

Today’s carboniferous Williston Basin landscape, including the area just west of Washburn, North Dakota, and westward past Williston, is radically different than it was when these rocks were deposited in the Paleocene era, roughly 65.5 to 56 million years ago. The paleoenvironment at that time was comprised of rivers and streams delivering sediments from the emerging Rocky Mountains into a low relief landscape interspersed with vast lakes and swamps where immense quantities of plant material accumulated. These organic deposits subsequently underwent physical, chemical, and biological alteration to become today’s lignite coal reserves. The thick accumulations of claystone, siltstone, sandstone, lignite coal, and sporadic occurrences of volcanic ash and limestone are now grouped into several different geologic formations, the most important of which for our discussions are the Bullion Creek and Sentinel Butte Formations. In the Bullion Creek Formation, lignite beds comprise about 10 percent of the overall formation thickness; Sentinel Butte Formation lignites tend to be less continuous. Individual beds can attain a thickness of greater than twenty feet, but are typically three to five feet thick and occur at several different stratigraphic positions within the formation.

An important consideration for the forthcoming discussion is recognizing where North Dakota lignites are situated in the continuum of transformation (technically called coalification or progressive alteration) from the original plant material deposit into the various forms of coal. The continuum begins with peat (partly decomposed vegetable matter) and progresses to lignite; under the right physical, chemical, and biological conditions, the process can continue through subbituminous, bituminous, semi-anthracite to anthracite coal. Lignite deposits are referred to as a low rank coal because of their relative low degree of coalification. Because the coalification process increases the fixed carbon content while decreasing the hydrogen and oxygen content, coal becomes less volatile with increasing coal rank. As we shall see, the relatively high volatile content of lignite (as compared to higher rank coal deposits) plays a key role in its propensity to ignite and burn.

**First Encounters: Coal and Clinker in the Vicinity of Fort Mandan**

Hoganson and Murphy have surmised that although William Clark had noted coal deposits downriver, these occurrences were probably reworked lignite deposits. The first true exposure of coal-bearing rocks was immediately to the north of the Fort Mandan site. In reconnoitering this area, I came across a fairly contiguous line of bluffs, including a prominent exposure of Bullion Creek Formation channel sandstones, which stand above a narrow, upper terrace of the Missouri River, accessible via 10th Street SW. Climbing along the upper section of these bluffs about 4,800 feet southeast of the Fort Mandan State Historic Site, I traced a 1.5-foot thick bed of lignite to a location suitable for closer examination. The surface of the lignite outcrop was blanketed with a clay film that had washed down from the overlying claystone bed so it was essential to shave off this detrital film to get a close look at the lignite’s compositional features. The basal coal layer was comprised of distinct, well-lithified tabular sheets of black lignite with a dull, matte-like luster with no recognizable plant structures (as opposed to the brownish-black lignites of the Sentinel Butte Formation I was to examine later at Beulah Bay). However, the upper part of the exposure had a noticeably bright, vitreous luster, particularly where the lignite was conchoidally fractured. This was somewhat suggestive of the higher rank coals that Lewis and Clark had encountered in the East.

The accumulation of different types of plants and their parts, along with differential coalification, in a coal deposit is expressed by an extreme vertical and lateral variability. A whole science of descriptive analyses has been developed to distinguish between different macroscopically identifiable layers. I suspect that Clark made a close inspection of certain coal exposures upriver because he would conduct an experimental burn of lignite samples just five days after the
We proceeded on expedition departed Fort Mandan and remark in his April 11, 1805 journal entry that “Some of the pieces appear to be excellent Coal,” suggesting he may have selected various lithotypes of coal to test. Performing my own test burns of samples from this outcrop and others, I found, just as Clark did, that the lignite “resists the fire for Some[time], and consumes without emitting much flame.”

Hoganson and Murphy have suggested the expedition’s first encounter with an exposure of clinker was also in the vicinity of Fort Mandan, specifically a twenty- to thirty-foot thick unit present in the upper part of the ridge northeast of the Fort Mandan Historical Monument. Somewhere in this general vicinity was the locale noted by Clark in his March 21, 1805, Notebook Journal entry and the source of the material he used in his notable furnace experiment:

...on my return to day to the Fort I came on the points of the high hills, Saw an emence quantity of Pumice Stone on the Sides & foot of the hills & emence beds of Pumice Stone near the Tops of the [hills] with evident marks of the Hill having once been on fire, I collected Some [of] the different i e Stone Pumice Stone & a hard earth and put them into a furnace the hard earth melted and glazed the other two and the hard Clay became a pumice Stone Glazed.

In his Field Notes for this day, Clark recorded that the “Stone” he listed first in this entry was a “burnt Stone,” suggesting it had already undergone some thermal alteration. Therefore, it would appear Clark placed some clinker (the “Pumice Stone” and the “burnt Stone”) with some unaltered “hard earth” into a “furnace.” Clark is definitive that the “hard earth melted and glazed the other two” samples of clinker he placed in the fire (again, meaning the “Pumice Stone” and the “burnt Stone”). In addition, a “Hard Clay” metamorphosed into a “Pumice-Stone.” Clark’s notes make no mention of collecting a hard clay separately, so it is reasonable to conclude the “Hard Clay” was the same or a significant portion of the “hard earth” he collected. The claystones in this region are well lithified and hard enough to fracture conchoidally, so they could easily merit the appellation “hard earth.” As such, it was the clayey portion of the hard earth Clark was referring to on March 21, 1805, when he wrote “a part of which i, e, the Hard Clay became a Pumice-Stone.”

It seems most likely Clark placed his experimental samples in the blacksmith forge fire, because he refers to it as a “furnace.” He makes no mention of using one of the Fort Mandan fireplaces or a bonfire outside. This is important because for Clark to conduct a successful experiment, the temperature of the fire had to exceed the minimum alteration temperature of the various constituent minerals that composed the “Hard Clay.” According to mineralogical studies of these same type of rocks, early-stage alterations of clay minerals occur at a range of different temperatures, for example, 500 °C (932 °F) for kaolinite, 550-600 °C (1022-1112 °F) for illite, and 600 °C (1112 °F) for muscovite, but it takes temperatures of at least 1000 °C (1832 °F) for certain minerals to noticeably change their structure and to begin to melt. So, was Clark’s experimental furnace fire that hot?
It is generally agreed that for small fires less than 3-feet in base diameter, the continuous flame region temperatures (slightly above the base of the fire) can reach 900 °C (1652 °F); for larger pool fires, peak flame temperatures can rise to 1100-1200 °C (2012-2192 °F). Based on the abundant evidence from Clark’s journals that the blacksmiths John Shields and Alexander Willard were busily utilizing a small forge complete with a bellows to make “Sundry articles of Iron,” it can be assumed the Fort Mandan forge fire was easily reaching a temperature range of 850-1200 °C (1562-2192 °F). That is the point at which scale falls freely off iron and the metal reaches an optimal malleable working temperature. As such, Clark would have been able to produce enough of a noticeable structural change in the claystone for him to conclude it was recognizable as the same type of “pumice” clinker he was observing in and around the nearby hills. This crucial experiment conducted by Clark was definitive confirmation that the captains’ definition of pumice was not the technically restricted, volcanically-derived vesicular rock, but rather any baked or fused rock, and why the terms “pumice” or “pummicestone” (or the other variants of Clark’s adventurous spellings for pumice) would be used whenever Lewis and Clark noted this lithology upriver.

ON THE VERGE OF DISCOVERY: DESCRIBING THE FORT MAN丹AN MINERALOGICAL SPECIMENS

Although William Clark clearly understood the effects of heating in the formation of his “Pumice-Stone,” it is problematic to definitively conclude the captains had deduced that ignited coal beds were the source of the heat by the time Corporal Richard Warfington’s party set off downriver on April 7, 1805, with the Fort Mandan mineralogical specimens. In the specimen descriptions of “pummicestone” and “Lava” sent back from Fort Mandan, there is nothing definitive indicating that the captains had specifically identified coal bed fires as the agent of metamorphism:

Specimen 62: “Specimen of the pummicestone found amongst the piles of drift wood on the Missouri. Sometimes found as low down as the mouth of the osage river. I can hear of no burning mountain in the neighborhood of the Missouri or its Branches, but the bluffs of the River are now on fire at Several places, particularly that part named in our chart of the Missouri The Burning Bluffs. The plains in many places, throughout this great extent of open country, exhibit abundant proofs of having been once on fire—Witness the Specimens of Lava and Pummicestone found in the Hills near fort mandon” [a reference to Fort Mandan mineralogical specimen No. 67].

Specimen 67: “A Specimen of Lava & Pummicestone found in great abundance on the Sides of the Hills in the Neighborhood of Fort Mandan 1609 miles above the mouth of the Missouri—exposed by the washing of the Hills from the rains & melting Snow…The tract of Country which furnishes the Pummicestone seen floating down the Missouri, is rather burning or burnt plains than burning mountains.”

Lewis’s comment under Fort Mandan mineralogical specimen 62 referring to “The Burning Bluffs” is not a reference to North Dakota coal bed fires. It is a reference to the rock exposures in northeastern Nebraska, specifically the bluffs southeast of present-day Ponca State Park leading northwestward to the Calumet Bluffs, and the phenomena of “pseudo-volcanoes” driven largely by iron sulfide reactions. These are mechanistically unrelated to coal bed fires.

“PUMICESTONE FLOATING”: OBSERVATIONS ALONG THE LITTLE MISSOURI RIVER

One of the most notable differences between the Fort Mandan mineralogical “Lava” and “pummicestone” specimens housed at the ANS are their comparative weights. The “Lava” (specimen 67) was heavy and dense for its small size, but the “pummicestone” (specimen 62) had a light frothiness indicative of a rock that could easily be buoyant in water. With the Missouri River drowned by Garrison Dam throughout much of the region where Lewis and Clark had observed these types of rocks, I was interested in investigating a free-flowing, natural river system to search for floating “pumice stone.” Lewis provided an intriguing lead regarding the Little Missouri River:

April 14, 1805: while we remained at the entrance of the little Missouri, we saw several pieces of pumice stone floating down that stream.

It was also suggested to me by Doug Klieger that it could be potentially productive to seek out some “pumice stone” along the Little Missouri River. I thought it would be particularly advantageous to examine some of the more accessible stretches of the river in the North Unit of Theodore Roosevelt National Park where the Little Missouri still flows freely above its submerged confluence with the Missouri. The floating clinkers the Corps observed in the Missouri and Little Missouri rivers is a consequence of thousands of years
of clinker formation and continual erosional forces delivering and spreading uncounted amounts of thermally metamorphosed rock into the tributaries, terraces and river bed alluvium of these watersheds. In particular, the Little Missouri River incises through thick sections of Bullion Creek and Sentinel Butte formations in the South Unit of the park. The river then flows through the North Unit of the park where the Sentinel Butte formation is exposed. The prospects for finding clinker deposits in the river or its alluvial deposits appeared promising.

The Little Missouri River was running fairly low in the late summer days during my reconnaissance. The conditions were ideal because earlier, higher flows had left long lines of strand gravels higher up on the gently sloping river banks and point bars. Carried to these positions by more energetic river flows, the pebbly and cobble-sized deposits had literally been stranded when the water receded back to the principal river channel. Crawling along these strand lines, I observed a rich array of baked clinker, lava-like, and frothy pumice-like rocks. Scattered among the prevalent subangular and gently rounded fragments of pink baked clinker were subrounded to rounded black, gray, and deeply reddish vesicular lava-like pebbles up to 2.5-inches in diameter. There were also pockets of much larger baseball-size cobbles, looking like miniature asteroids. Some lava-like rocks strongly resembled the rounded, darkly colored and highly vesicular true lava cobbles I have observed along the banks of the lower reaches of the Snake River, both above and below the confluence of the Clearwater River.

While it was not as common as the baked clinker fragments and lava-like rocks along the stretches of river bank I examined, there were sporadic occurrences of well-rounded, frothy clinker up to three-inches long, distinguishable by their color (almost uniformly pink and red), comparative lightness, and by their smaller and more homogeneously-sized vesicles. When I placed a handful of the most promising frothy samples in the waters of the Little Missouri River, several of them easily remained buoyant. Like an iceberg, most of the mass of the more oblong samples remained below the surface of the water. I noticed the banks of the river were coated with encrusted salt crystals and the river water itself was brackish, an observation the captains also noted. Thinking that perhaps the greater density of the slightly saline water was providing an assist to the floating frothy clinker, I tested the same samples in a container of fresh water. A select subset of the samples still floated, although all the other rocks were still buoyant enough to stand upright while resting on the bottom of the container. Placing these samples back in the Little Missouri River, I felt a deeply gratifying connection to the captains and their pioneering scientific observations as I watched my “pumice Stone” specimens “floating down that stream.”

Coal, Fire and “Pumice”: The Captains Make the Connection

Only three days after departing Fort Mandan, Lewis recorded all the components of clinker formation (coal, fire, and “pumice”), but he had not yet ascribed clinker formation to burning coal beds:

April 9, 1805: the Bluffs of the river which we passed today were upwards of a hundred feet high, formed of a mixture of yellow clay and sand- many horizontal stratas of carbonated wood, having every appearance of pitcoal
connection in their subsequent observations: Lewis and Clark could confidently describe the burnt appearance of the hills and bluffs. With the causal beds baked, welded, or melted the overlying strata, causing the captains had determined the burning coal illustrates, the captains had determined the burning coal beds. This observation was recorded in Lewis's April 16, 1805, journal entry and signifies the expedition members were taking closer notice of bluff fires, which Lewis first did on April 10, 1805. Clark was first to describe the hills as “burnt” and to document the predominant color of the clinker hills:

April 11, 1805: the hills on either side are from 5 to 7 miles asunder and in many places have been burnt, appearing at a distance of a reddish brown color, containing Pumic Stone & lava, Some of which roll down to the base of those hills.32

Finally, the captains made the connection. Lewis wrote on April 16:

I believe it to be the strata of Coal seen in those hills which causes the fire and burnt appearances frequently met with in this quarter. Where those burnt appearances are to be seen in the face of the river bluffs, the coal is seldom seen, and when you meet with it in the neighborhood of the strata of burnt earth, the coal appears to be precisely at the same height, and is nearly of the same thickness.

As Lewis's April 16 (and April 29, as well) journal entry illustrates, the captains had determined the burning coal beds baked, welded, or melted the overlying strata, causing the burnt appearance of the hills and bluffs. With the causal link established, Lewis and Clark could confidently describe this connection in their subsequent observations:

April 17, 1805: there was more appearance of burnt hills, furnishing large quantities of lava and pumice stone, of the latter some pieces were seen floating down the river.

Undated, Circa 1806: The Pumice Stone which is found as low as the Illinois Country is formed by the banks or Strata of Coal taking fire and burning the earth immediately above it into either pumice Stone or Lava, this Coal Country is principally above the Mandans. Clarke appears to have been the first who gave any intelligible account of these interesting phenomena. They not only described in considerable detail the appearance of these metamorphic materials…but correctly ascribed their origin to the combustion of the coal beds of this region, being guided in part to this decision, doubtless, by finding some of them actually on fire.36

The credit due to Lewis and Clark for this key scientific discovery was recognized by early scientist-explorers who followed portions of the captains’ route in the mid-1800s using the 1814 History of the Expedition under the Command of Captains Lewis and Clark as their guide. These scientists included Ferdinand Vandiveer Hayden, a trailblazing American geologist and head of the U.S. Geological Survey of the Territories, who made multiple geologic explorations along the Missouri and Yellowstone Rivers. Hayden never failed to acknowledge the captains’ original observations in his published works. His description of the phenomena in the vicinity of the “Great Bend” of the Missouri above the confluence of the Little Missouri River some 50 years after the expedition first passed through this region recapitulates the sum of the captains’ most informed observations almost exactly:

The bluffs here afford fine examples of the spontaneous ignition of the lignite beds, by which the superincumbent strata are fused or heated to various degrees of compactness, sometimes giving the hills the appearance of an accumulation of fragments of burnt bricks. Oftentimes the clays and sands contiguous to the lignite beds are fused, so as to exhibit every variety of character, from a nearly vitreous mass to a light vesicular lava with a specific gravity less than water. Many of these light vesicular masses fall down to the edge of the river, and the current in high water carries them down, scattering them on the sandbars and bottoms, even below St. Louis, and thus the origin of the opinion that there were volcanic products somewhere near the sources of the Missouri.37

Perhaps Joel A. Allen, a renowned ornithologist and lead naturalist on a Northern Pacific Railroad Survey in 1873, summed up the captains’ contributions most succinctly:

Of the explorers who have visited this region, Lewis and Clarke appear to have been the first who gave any intelligible account of these interesting phenomena. They not only described in considerable detail the appearance of these metamorphic materials… but correctly ascribed their origin to the combustion of the coal beds of this region, being guided in part to this decision, doubtless, by finding some of them actually on fire.36

Coal Bed Fires: The Phenomenon of Spontaneous Combustion

Coal bed fires have two principal origins: ignition from wildfires or spontaneous combustion. Lightning strikes that trigger grass fires seem an obvious cause, but it is worth examining the intriguing phenomenon of spontaneous combustion in some detail. This occurs when an organic material oxidizes (i.e., becomes combined chemically with oxygen) and creates an exothermic reaction, releasing energy, in this case in the...
form of heat.\textsuperscript{38} This is a very complex chemical process, consisting of parallel and interacting reactions driven by many different internal and external factors. Put simply, when the carbon content of coal comes into contact with oxygen, it reacts to form carbon dioxide (in addition to carbon monoxide and new coal-oxygen complexes). Most importantly for our discussion, all these reactions generate heat.\textsuperscript{39} Moreover, the type of coal plays a major role. Low rank coal deposits like North Dakota lignite have a higher volatile content and are also far more porous and permeable than higher rank, more consolidated coal deposits. This allows more of the lignite to be in direct contact with the ambient atmosphere and humid conditions (which abets the reaction—see below). Thus, there is a greater tendency for high volatile content lignite coals to self-heat than there is for higher rank coals such as anthracite.

The early stages of low temperature oxidation is the same process that produces those warm, smoldering mulch piles we have all seen in landscape supply centers, particularly when the aforementioned low-temperature oxidation is abetted by heat of wetting (i.e., dry coal generates heat when water or water vapor is adsorbed). In the semi-arid conditions of North Dakota and Montana, the humidity rises in the spring from rains and melting snow, thus improving the overall conditions for spontaneous combustion. In April 1805, the expedition was traversing this region at a potentially seasonally active period, perhaps facilitating observations of coal fires on days such as April 10, 1805. The lightning documented by the captains on April 1, 1805, was a heedful reminder that prairie fires were certainly an important trigger of coal bed fires.\textsuperscript{40}

Whether this relatively low temperature oxidation reaction becomes self-sustaining (after reaching a temperature of about 50 °C or 122 °F) and proceeds to combustion is dependent on several critical factors, including: (1) whether there is sufficient air flow and ventilation (which supplies oxygen), (2) size of the coal particles (the smaller the size, the greater the surface area for reaction), (3) sulfide mineral content (oxidation of iron sulfide minerals such pyrite and marcasite create secondary exothermic reactions), (4) changes in moisture content (heat is liberated when coal absorbs moisture), (5) temperature (increasing temperatures enhance the overall rate of oxidation).

Intuitively, if the heat of oxidation exceeds the rate of heat dissipation, the coal will continue to heat up exponentially. Once it reaches the temperature of ignition (about 350 °C or 660 °F), it will spontaneously combust.\textsuperscript{41} The key to understanding the nature of this self-sustaining reaction is that it involves more than just the original lignite-fixed carbon compounds. Those coal-oxygen complexes mentioned earlier that are formed during the initial oxidation process will subsequently begin to degrade and release even greater amounts of heat as temperatures cross the threshold of 70-80 °C (158-176 °F).\textsuperscript{42} The increasing temperatures generated from the contributing reactions are exacerbated by the fact that the rate of organic chemical reactions double with every temperature increase of 10 °C (18 °F).\textsuperscript{43} Additionally, the emissions of flammable hydrocarbons such as methane, ethylene, and propylene are linked to increases in temperature. Consequently, it becomes readily apparent why this self-heating phenomenon is often referred to as a thermal runaway reaction.

\textbf{Lewis succinctly noted the connection between the coal beds and layers of burnt earth.}

\textbf{Clinker and Paralava: The Products of Pyrometamorphism}

Some of the best places to closely examine extensive exposures of clinker are in quarries where vertical cut faces of entire rock sequences have been revealed. One such quarry is in close proximity to the expedition’s encampment of April 16, 1805, the day Lewis succinctly noted the connection between the coal beds and layers of burnt earth. In this fresh quarry face exposure, the baked clinker occurrences had notable color gradations ranging from pink, orange, red, and dark red to purple. It has been well established that clinker colors are governed by the rock’s mineralogical composition and many researchers have noted the presence of iron oxide minerals such as hematite in the rocks.\textsuperscript{44} It is essential to recognize, however, that it is not the occurrence of iron per se, but the oxidation of iron upon heating (akin to rusting) that gives clinker its distinctive reddish coloration. This quarry exposure also revealed noteworthy textural differences in the rocks. These features were consistently noted by the scientists who accompanied the pre- and post-Civil War era topographic/geologic surveys and numerous railroad route reconnaissance expeditions throughout this carboniferous basin. One of the keenest observers of clinker characteristics, Joel A. Allen, documented that “the texture varies from a glazed, vitreous or porcellanic, compact outer surface, and a dense, jaspery inner structure, with conchoidal fracture, to that so porous and vesicular as to float on water.”\textsuperscript{45}

This quarry was an excellent location to consider the marked differences between Fort Mandan mineralogical...
We Proceeded On August 2013

specimens 62 and 67 and the differentiation between baked clinker and a melt-rock, more accurately termed a “paralava” based on its remarkable physical similarity to true volcanic rocks like pahoehoe. Recognizing such distinctions yields important information about the proximity of thermally altered rocks to burning coal beds. This process governs the temperature the rocks experienced during the alteration process and the length of time the high temperatures prevailed. A complete thermally metamorphosed or “pyrometamorphism” sequence would contain an upward gradation from a residual combusted coal layer to a white ash layer, directly overlain by paralava of a basaltic appearance (where the most intense heating/melting occurred) upward to the less intensely baked and reddened clinker. An interesting question for Lewis and Clark scholars would then be whether Fort Mandan mineralogical specimen 67 should be henceforth termed a “paralava” in the scientific literature as opposed to the oft-used, more general description of clinker. Some interesting mineralogical research has indicated paralava can differ from adjacent clinker derived from the same source rock by noteworthy depletions of silicon, aluminum, and potassium, and enrichment in calcium, iron, magnesium, and manganese. It is not essential for such a historically valuable Lewis and Clark specimen to undergo such an analyses or have thin sections collected to look for phenocryst mineral assemblages representative of post-melting crystallization; the ropy pahoehoe-like flow textures and presence of vesicles I noted on the edges of the specimen are our best evidence this rock experienced melting conditions more indicative of paralava than baked clinker.

The Burnt Hills History:
A Clinker-Controlled Landscape

Of course, Lewis and Clark were not examining pyrometamorphosed rocks in quarry outcrops, but observing them capping the bluffs adjacent to their course up the Missouri River. Clinker beds are erosion-resistant because they have been hardened by heating (the analogy often used in geological literature is the manner in which clay is hardened when it is fired into brick). These durable beds stand out in relief and are responsible for much of the topographic character of the region the expedition traversed between present-day Charlson and Williston, including the area in the vicinity of Lewis and Clark State Park, the sole area labeled as the “Burning Hill” in Clark’s mapping of the expedition’s route.
We proceeded on through this region (but referred to as the “Burnt Hills” on the later Clark-Maximilian Sheet map). Particularly when viewed at a distance from the opposite bank of the river, the clinker-capped terraces, described by Sgt. John Ordway as the “red hills…rough barron broken & Steep,” roughly form a rumpled, stepwise progression of hills and ridges from the river receding back to the distant uplands, comprising hundreds of feet of relief.

Despite an outward appearance of having a regional distribution akin to a typical geologic unit, clinker is a very surficial occurrence that does not extend deep into the landscape. The distance a coal fire can penetrate into a hillside is dependent on the thickness of the coal bed and the thickness of the overlying rock between the top of the coal and the ground surface. The maximum thickness of overlying rock that will permit a sustainable coal bed fire appears to range from 100 feet to 180 feet, with the usual burn depth being less than 120 feet, which explains why these thermally metamorphosed deposits are only found capping the ridges and bluffs throughout this region. Thus, we can read Clark’s March 21, 1805, journal entry yet again and admire his characteristic accuracy as he observed “emence beds of Pumice Stone near the Tops of the [hills].”

The “Burnt Hills” Today: The North Dakota Prairie Oil Boom

During my previous visits to this region, evidence of oil and gas exploration were fairly inconspicuous—just a few pump jacks dutifully bobbing in the back country, and storage lots in Williston filled with all manner of drilling equipment waiting for the next boom. But in 2012, that next oil boom was in full swing. Oil and gas are being produced at much older and deeper horizons than the lignite beds noted by Lewis and Clark, including those from the Late Devonian to Early Mississippian-age Bakken Formation, deposited 416 to 360 million years ago. This is the largest continuous-type oil accumulation the United States Geological Survey has ever assessed. During one of my geology reconnaissance visits in July 2006, there were just over 250 wells in the Bakken producing some 6,000 barrels (252,000 gallons) of oil a day. Revisiting this region of North Dakota in September 2012, the Corps’ “Burnt Hills” were burning anew, this time lit by the natural gas flares of closely spaced production wells. There are now more than 4,600 wells state-wide in the Bakken Formation producing an astonishing 663,000 barrels (27,846,000 gallons) of oil a day—about 10% of total U.S. production. In Williams County alone, comprising the

Typical hill-top exposures of pinkish-red clinker just north of Route 1804 on the northwestern edge of Hofflund Flats. It was exposures like these that were described by Sgt. John Ordway as the “red hills…rough barron broken & Steep.”
area north of Missouri River from the Montana state line just west of Williston to Tioga near Clark’s “Burning Hill” on his finished map, there are more than 1,160 operating wells.59

Although this oil was first discovered in 1951 and initially described in 1953,60 not until around 2008 (after horizontal drilling coupled with rock fracturing completion technology, a process called “fracking,” was applied to free the oil from this low porosity, low permeability formation) did the Bakken start producing one of largest oil discoveries in the U.S. outside of Alaska. The expansion of oil well drilling and pipeline construction is particularly noticeable in this region because hundreds of miles of unimproved roads leading back to the drilling and production sites have been constructed and graded with uncounted tons of distinctive pinkish-red clinker. More significant impacts may be on the horizon: the state would need some 30,000 miles of pipeline installed to economically convey the crude oil and natural gas to market, and to transport the salt water and the chemically-tainted flowback-produced water generated from the fracking process. In addition, a typical well requires two million gallons of fresh water over the course of its productive life, a heavy demand in an area already striving to preserve its aquifers. Furthermore, there is the ever-present risk of pipeline discharges and unforeseen leakage from hundreds of waste-disposal injection wells. Having worked in petroleum contamination remediation over the last twenty-five years, and having experienced first-hand the long-lasting adverse effects to soil, groundwater, and surface waters should environmental vigilance falter, it is my hope that this unique area will be spared the deleterious impacts that have marred other oil producing regions across the country. With care the “Burnt Hills” can remain one of the most uniquely scenic, scientific, and sublime highlights of the Lewis and Clark Trail.

John W. Jengo, a member of the Philadelphia Chapter, is a Professional Geologist and licensed Site Remediation Professional who works for an environmental consulting firm in Pennsylvania, specializing in hydrocarbon remediation and dam removals to restore migratory fish passage. He has published numerous articles in WPO since 2002 on the subject of Lewis and Clark’s mineral collection and the significance and scientific influence of their geological discoveries. He was a presenter at the 2003 annual meeting in Philadelphia.

Notes


4. Although the term “clinker” sensu stricto was used to define either a coal that had been altered by igneous intrusion or a rough, jagged pyroclastic (volcanic) rock that resembles a clinker or slag in a furnace. See Robert L. Bates and Julia A. Jackson, eds., Glossary of Geology, 2nd edition (Falls Church, VA: American Geological Institute, 1980), 118. In this article, I am going to distinguish between different types of clinker to mirror the captains’ descriptions: a relatively dense and heavy, dark colored (e.g., black or dark gray) rock with large, variable sized vesicles that will be referred to as “lava-like” or as “paralava”; a noticeably light, frothy, reddish or pinkish rock with small, uniformly
sized vesicles referred to as “pumice-like.” The term “baked clinker” represents those rocks that were only lightly metamorphosed, retaining much of their original structural appearance (and often having an enhanced pink or reddish color), and lacks vesicles altogether.


6. Pahoehoe is a Hawaiian term for a type of basaltic lava flow distinguished by a smooth, billowy orropy surface; Bates and Jackson, Glossary of Geology, 449.

7. For details on the important role Adam Seybert played in the subsequent fate of the entire Lewis and Clark mineral collection, see Jengo, “Specimine of the Stone,” 21-23. Per Spamer et al., “A National Treasure,” 50, descriptive notes in Seybert’s mineral collection catalogue state the “pummacie Stone” specimen was “found floating on the Missouri.” I have correlated that surviving specimen with Fort Mandan mineralogical specimen 62 (originally described as being “found amongst the piles of drift wood on the Missouri”) rather than the “pummacie Stone” mentioned under Lewis’s original description of Fort Mandan mineralogical specimen 67 (originally described as being found “on the Sides of the Hills in the Neighborhood of Fort Mandan”).


9. Hoganson and Murphy, Geology, 28 and 37.


11. James G. Speight, The Chemistry and Technology of Coal, second edition (New York: Marcel Dekker, Inc., 1994), 10 and 43. There are multiple classification schemes to describe coal deposits besides rank (e.g., heating value, lithotype, chemical composition, and grade), but for the purposes of this article, coal rank as an indicator of a coal bed’s degree of metamorphism and potential for spontaneous combustion will suffice.

12. Hoganson and Murphy, Geology, 82 and 118. Over the next 13.5 river miles of travel upriver from the site of Fort Mandan completed on October 27 and October 30, 1804 (the latter taking Clark on a reconnaissance in the white pirogue past the Knife River villages), Patrick Gass (October 27), John Ordway (October 27) and Clark (October 27 and 30) all noted coal beds in bluffs on both sides of the river (although Ordway’s starboard side observation appears to be in error as both Gass and Clark have that occurrence on the larboard side). Hoganson and Murphy have suggested the men were observing dark-colored ancient soil horizons (paleosols); this certainly seems likely for at least the reported coal occurrences in the vicinity of the Knife River confluence westward of the Missouri River.

13. Per Richard D. LeFever, “The Bullion Creek Formation (Paleocene) of North Dakota,” in E.N. Clausen and A.J. Kihm, eds., Tertiary and Upper Cretaceous of South-Central and Western North Dakota Field Trip Guidebook, (Bismarck, ND: North Dakota Geological Society, 1986), 27-28, “claystones and siltstones are the most abundant lithotypes in the Bullion Creek [Formation].”

14. Coals have a wide range of lithotypes. According to a combination of two commonly-used classification systems, these lithotypes include: brilliant to vitreous, nearly mineral-free deposits that conchoidally fracture (called vitrain), fusain coal (silky, soft friable layers composed of fragments that resemble charcoal), and atrittal coal (finely disseminated or grounded masses of coal). For example, the Beulah-Zap lignite seam in the Sentinel Butte Formation is roughly comprised of 35% vitrain, 5% fusain, and 60% attritus, by volume; see David R. Keesattel, “Distribution, Abundance, and Mineral Content of the Lithotypes in the Beulah-Zap Bed of North Dakota,” in R.L. Houghton and E.N. Clausen, eds., 1984 Symposium on the Geology of Rocky Mountain Coal: Proceedings of a Symposium held in Bismarck, North Dakota, October 2-4, 1984; North Dakota Geological Society, Publication 84-1, 28-40.


16. Ibid.

17. Hoganson and Murphy, Geology, 120. I did not observe this outcrop; however, I have noted clinker exposures roughly 3,200 feet directly north and 5,200 feet north-northwest of the Fort Mandan historical monument that Clark may also have encountered.


19. Ibid., 317.


23. Dr. Robert N. Bergantino, a major contributor of the geology footnotes in the Moulton Journals, has suggested the captains may have used Owen’s Dictionary of the Arts and Sciences for their definition of pumice, listed therein as “a flag or cinder of some fossil, originally bearing another form, and only reduced to this state by the action of the fire.” See Jengo, “Mineral Productions,” 208, n. 71 for the lengthy full title of this Society of Gentlemen reference published in 1754-1755.

24. And presumably earlier in the expedition when Clark noted “Pumey” or “Pamey” stone accumulations along the shoreline of the Missouri River east of present-day Blair, Nebraska, north of Omaha. Moulton, ed., Journals, 2:445.

25. Iron sulfide (FeS₂), particularly in the form of the mineral marcasite, reacts readily with oxygen (O₂) and water (H₂O) to produce a hydrated iron sulfate (FeSO₄·7H₂O) and sulfuric acid (H₂SO₄). This reaction is “exothermic,” meaning that it releases energy in the form of heat. See John W. Jengo, “‘Blue Earth, ‘Cliff of White’ and ‘Burning Bluffs’; Lewis and Clark’s Extraordinary Mineral Encounters in Northeastern Nebraska,” We Proceeded On, 37:1 (2011):6-18.


28. The salt is comprised of sodium chloride, sodium bicarbonate, and magnesium sulfate; Moulton, ed., Journals, 4:23, n. 1.

29. On April 9, 1805, Clark states that the coal beds were “1 inch to 5 feet thick” [emphasis added]; Moulton, ed., Journals, 4: 17. Was this just an error or did Clark carefully note the thickness of individual coal bands? Also, the captains’ use of the term “pit coal” could indicate they sought to differentiate between firm, unweathered coal deposits (called “pit coal” back East because it was typically encountered in excavated pits), and the softer, weathered coal exposed at the surface.

30. The captains could not have known just how long ago that “former period” was. Geochronology studies in the Powder River Basin (north-east Wyoming and southeast Montana) have yielded a wide range of in situ clinker ages, from 5,000 to approximately 1.1 million years ago, with even older clinker found entrained in detrital sediments; see Peter W. Reiners, Catherine A. Rihimaki, and Edward L. Heffern, “Clinker Geochronology, the First Glacial Maximum, and Landscape Evolution in the Northern Rockies,” GSA Today, 21:7 (2011):4-9. These age dates indicate coal deposits have been burning over hundreds of thousands of years in stream beds, ravines, and along hillsides in the carboniferous basins of North Dakota, Montana, and Wyoming.


32. Clark also mentions a “red knob,” in the course and distances for this day, presumably regarding a clinker-capped rounded hill he observed; see Moulton, ed., Journals, 4:23.


38. One of the seminal works on this phenomenon, referenced by many workers in the field at the time, was Vivian Byam Lewes, The Chemistry of the Upper Missouri, being the Substance of a Report Made to Lieut. G.K. Warren, T.E.U.S.A.” Transactions of the American Philosophical Society, (Philadelphia, PA: C. Sherman & Son, 1862), 95.


44. Rogers, “Baked Shale,” p. 8; more recently, see John P. Blumele, “North Dakota’s Clinker,” North Dakota Notes No. 13 found at https://www.dmr.nd.gov/ndgs/ndnotes/ndn13_h.htm. Per Rogers (p. 6), “although the prevailing colors are pink, red, or purplish red, the rocks may be mottled in red and bright yellow, green, or black” as well as gray. Rogers also recognized the non-red color variations were due to reducing rather than oxidizing conditions.

45. Allen, “Metamorphism,” 249. The ceramic-like texture has been termed porcellanite by geologists. Also clearly evident in these quarry exposures was the highly fractured nature of the entire rock sequence; such extensive splitting of clinker deposits is a result of the heating process, which causes both contraction and expansion of the mineral matrix and the loss of water from the rock.


47. Michael A. Cosca, Eric J. Essene, John W. Geissman, William B. Simmons, and Donald A. Coates, “Pyrometamorphic Rocks Associated with Naturally Burned Coal Beds, Powder River Basin, Wyoming,” American Mineralogist, 74 (1989):87. Estimates vary considerably on the minimum melting temperature to form a paralava because of wide variability in mineralogical composition of the subject rock. Other factors include the presence of water and off gases like methane that could catalyze the reaction, but melting generally appears to require a minimum temperature greater than 1020 °C (1868 °F) and perhaps in excess of 1350 °C (2462 °F); see Cosca et al., “Pyrometamorphic Rocks,” 93.

48. Cosca et al., “Pyrometamorphic Rocks,” 94; Clark and Peacor, “Pyrometamorphism,” 559. These are mineralogical analyses specific to paralava in the Powder River Basin. Such mineralogical changes in North Dakota paralava would be dependent on many factors, including the original mineralogy of the rock, the composition of gases produced during coal combustion, the degree of melting, the magnitude of vapor
phase transport of minerals into the paralava from adjacent strata, and the state of oxidation (or reduction) that the rock experiences.

49. In fact, Rogers, in describing vitrified shale in the field, could have been referencing Fort Mandan mineralogical specimen 67 when he states the rocks have “been rendered pasty or molten and has flowed slightly. In some places the material has been rendered sufficiently fluid to develop aropy surface on cooling, closely resembling that characteristic of certain lavas…The rock is not smooth like ordinary baked shale but is rough and very finely vesicular like some kinds of brick.” See Rogers, “Baked Shale,” 6.


51. As succinctly noted by Allen, “Metamorphism,” 262, “Not only do the baked, indurated clays and sands give their own prevalent bright red tint to the landscape, but they arrest or greatly retard the erosion of the buttes and ridges whose summits they compose. Over areas of thousands of square miles in extent they thus in great measure determine the surface contours.”

52. On Clark’s recopied finished map of this route, this locale was identified as the “Burning Hill,” whereas the Clark-Maximilian Sheet 20 route map for about April 14-28, 1805, which Clark’s nephew Benjamin O’Fallon copied for Prince Maximilian of Wied-Neuwied in 1833, had the same locale labeled as the “Burnt Hills.” Gary E. Moulton, ed., Atlas of the Lewis and Clark Expedition, (Lincoln: University of Nebraska Press, 1983), 1: Map 47 (Clark’s finished map) and Map 56 (Clark-Maximilian Sheet 20).


54. Thicker coal beds, particularly in instances where the coal has been reduced to ash at a ratio to 10:1, cause a greater degree of collapse of the overlying rock into the void space. With the more significant collapses, there is a greater likelihood multiple fractures will be created that will reach the surface, allowing airflow to circulate underground to feed the fire. Thus the fire continues to burn deeper into the hillside. Eventually though, the overburden becomes so thick that attendant fractures do not reach the surface, cutting off exchange of gas and heat (because the fractures were crucially acting like chimneys), or the fire encounters groundwater and is unable to progress; Heffern et al., “Geochronology of Clinker,” 158. With regards to the chimney effect, and as described by Rogers, “Baked Shale,” p. 4-6, it had been long recognized that extremely hot gases escaping through fractures also thermally metamorphose rock “along their paths of escape” to form “a core of molten material”; such chimneys are one of the major sites of paralava formation, and are characteristically “fractured and brecciated.”


58. Although the economic benefits have been a boon to North Dakota, delivering a $1.6B surplus and positioning the state second only to Texas in oil production (see “Exxon Spends $1.6B on North Dakota Field,” Williston Herald, September 21, 2012 and “Responding to Oil, Step by Step,” Bismarck Tribune, September 23, 2012), some 30% of the natural gas produced from the wells is not being captured because there are no pipelines to bring it to market (see www.eia.gov/todayinenergy/detail.cfm?id=4030>). The flaring of billions of cubic feet of gas is considered by many to be wasteful and a contributor of greenhouse gases to the atmosphere; in fact, there is so much gas flaring that it is visible from space, making this remote region appear to be densely populated.

59. Ninety percent of the drilling activity in North Dakota is within a seventy-mile radius of Williston; James MacPherson, “In 18 Years, Koeser leads Williston from Bust to Boom,” Williston Herald, September 21, 2012.

Publishing a journal like *We Proceeded On* is challenging. Gathering news and articles, locating photos and illustrations, securing advertisements, plus dealing with a seemingly endless list of details makes the job interesting and always engaging. We at WSU Press are honored to have been chosen by the board of the Lewis and Clark Trail Heritage Foundation to edit, design, print, and distribute *We Proceeded On*, and hope we can live up to the fine tradition of historical publishing established by past editors.

With the readers’ indulgence, we would like to offer a bit of personal background. WSU Press has been publishing books and journals since 1928, though there were periods when the publication program took a respite for various reasons. In the mid-eighties the Press was revitalized, and since that time we have issued almost two hundred books. Our focus over the past three decades has been on the history, culture, and politics of the Pacific Northwest, including western Montana and maritime Alaska.

The Press has published scholarly journals since its creation, and we were excited about this opportunity to work with the Lewis and Clark Trail Heritage Foundation when the board announced they were seeking a new editor. Our retired editor-in-chief, Glen Lindeman, continues to be an active member of the Lewis and Clark community, and served as editor for the magnificent three-volume *Lewis and Clark Trail Maps* series prepared by Martin Pla mondon. Being located on the edge of the trail, just a few miles north of the junction of the Snake and Clearwater Rivers, we feel a kinship with the Lewis and Clark story.

Our staff is small, and our work on the journal will be very absorbing. Robert Clark is the new editor-in-chief at the Press, and his connections with the Lewis and Clark story began in the late 1960s when he worked in his father’s publishing company on Charles G. Clarke’s book, *The Men of the Lewis and Clark Expedition* (Glendale, 1970). Soon after college he joined The Arthur H. Clark Company, and served as editor for one of the founders of the Lewis and Clark Trail Heritage Foundation, E.G. Chuinard, whose *Only One Man Died: The Medical Aspects of the Lewis and Clark Expedition* was published in 1979. Bob’s interest in Lewis and Clark and overland trails has guided much of his work in publishing throughout his career, including an extended stint at editor of *Overland Journal* for the Oregon-California Trails Association.

Bob will be assisted in his work by Beth DeWeese, manuscript editor, and Nancy Grunewald, designer. Beth has worked in the university press world for many years, and related that she once reenacted the role of Sacagawea for visitors to Fort Clatsop. Her children, unlike little Pomp, found the experience uncomfortable. Nancy is our long-time book designer, in addition to serving as designer and production coordinator for academic journals.

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One of the nearly 200 active rigs working in North Dakota’s most recent oil boom in September 2012, located in Truax Township, just south of Lewis and Clark State Park in Williams County, North Dakota. Photo by John W. Jengo