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**YELLOWSTONE**  
**FAREWELL**



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Cover graphics by Jesse W. Sutherland from a photograph by  
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# **YELLOWSTONE FAREWELL**

**This is a fictional account** of events that may only be speculated upon, but which are geologically possible. The locations described in this story are real, for the most part, and some groups and organizations mentioned are based on real entities in order to lend authenticity to the account. If any real group, organization, or entity is mentioned, it is used fictitiously and without any intent to describe their actual conduct. All characters and their actions are the invention of the authors and have no basis in reality. Any resemblance between these characters and any persons, living or deceased, is pure coincidence.

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Wayne M. & Judy M. Sutherland

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For  
Jesse

Sample Chapter

# Acknowledgements

**The rock outcrops** of Wyoming, along with the beauty of geology that is so prominently displayed across the state, provided the initial ideas for this story. Our love for geology was first instilled in us during our college years by such people as Don Blackstone, Harold Bliss, Don Boyd, J. David Love, Samuel H. Knight, Brainerd Mears, Jr., and Richard G. Reider. Inspiration also came from a multitude of friends, hams, cavers, dogs, and horses, whose lives have touched us in many ways.

For help with our writing journey over the past two years, we are deeply grateful to those who gave generously of their time to aid us in the development and completion of this story. We especially thank W. Dan Hausel and William H. Wright for plenty of constructive criticism, along with encouragement; to Nancy R. Sutherland for writing valuable directional suggestions in our manuscript; and to Milt and Karen Mydland for devoting considerable time and effort to review, analyze, and provide detailed ideas that pulled our story over the threshold of loose connections into what we hope is a seamless and entertaining flow.

Wayne M. & Judy M. Sutherland

# Table of Contents

<u>Section</u>		<u>Page</u>
Prologue		1
Chapter 1	First Movements	3
Chapter 2	Investigations	29
Chapter 3	Analyses	57
Chapter 4	Data Release and Fallout	79
Chapter 5	Precursors	95
Chapter 6	Yellowstone	121
Chapter 7	Divergent Connections	143
Chapter 8	Food for Thought	163
Chapter 9	Character	181
Chapter 10	Rising Concerns	193
Chapter 11	Controversy	213
Chapter 12	Dance of Destiny	239
Chapter 13	Storm	253
Chapter 14	Canyon Descent	269
Chapter 15	The Ashen Trail	285
Chapter 16	Damages	299
Epilogue		313
Appendix I	Glossary	317
Appendix II	References and Suggested Supplementary Reading Material	323
Appendix III	Suggested Sources of Information	327
About the authors		331

# List of Illustrations

<u>Description</u>	<u>Page</u>
General map of Wyoming	2
Geologic time chart	20
Past calderas	99
Yellowstone calderas and vicinity	127
Ashfall deposits from past eruptions	129
Union Pacific checkerboard and mining claims	171
Ash depths	305

# Prologue

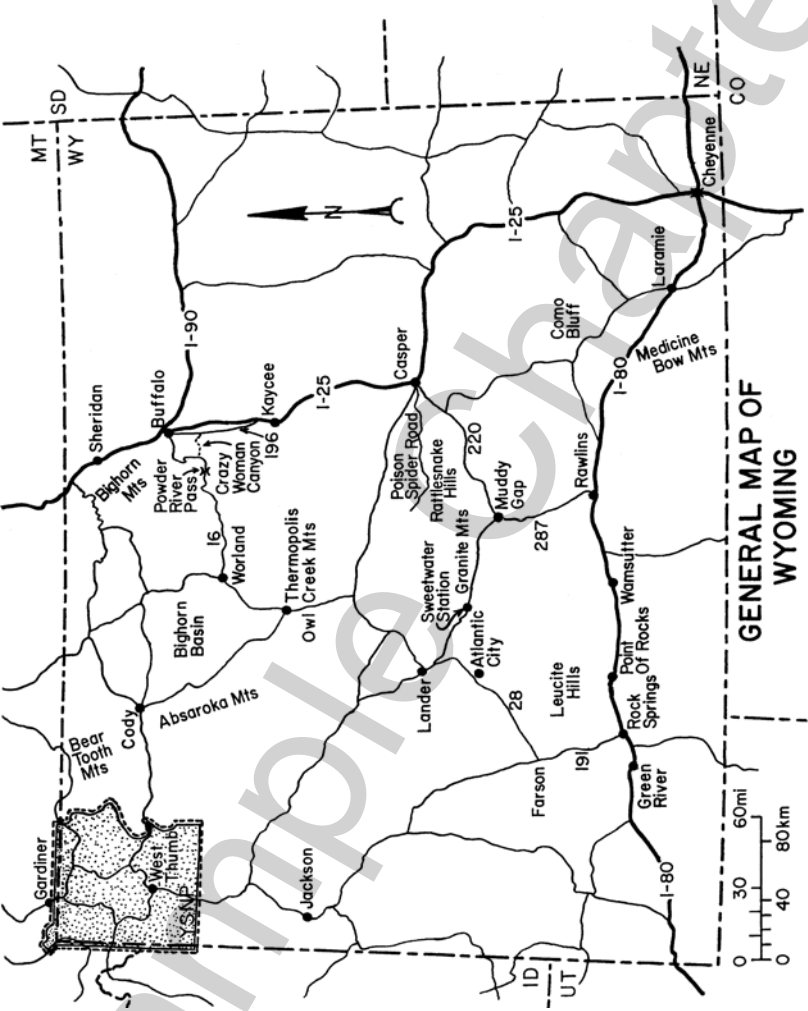


**“In the beginning** God created the heavens and the earth,” (Genesis 1:1). God, in His infinite wisdom, created with logic and purpose. Science, through its evolving wisdom, tries to decipher the order and complexities of that which God created. Science is often successful in bringing to us great understanding of the world in which we live—our world being but a tiny part of the universe. However, where science fails to bring to us clear comprehension of what we call “natural events,” humans then relegate such happenings to the realm of “the whims of God,” or as the insurance companies say... “an unforeseeable act of God.” Humans usually seek to find a scapegoat for large-scale natural catastrophes, such as those caused by severe weather disturbances, or by the sudden and dramatic activities of geologic forces.

*Fact and fiction* can often become so intertwined as to be inseparable. When that occurs, fiction is usually found to be more believable because it is more easily embellished than fact. Yet, fact itself often becomes unbelievable when its scope reaches almost unimaginable proportions.

In this story, the *geology of Wyoming* is the focus of the human characters’ lives, and it is almost a character itself, with which they interact. For readers with little geological background, or for those who would like to learn more, we have included a brief *appendix* at the back of this book, suggesting information sources and supplementary reading material. A *glossary* is also provided in the appendix to assist those who are not familiar with the science of geology.

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**GENERAL MAP OF WYOMING**

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CHAPTER 1

# First Movements



You have made the earth to tremble and have torn it open. Mend its fractures, for it is shaking. - Psalm 60:2

**The frozen high desert** of southwestern Wyoming rested in deep silence as a star-studded sky slowly brightened before sunrise. On this particular Thursday morning in February, a small group of antelope cautiously emerged from a shallow ravine onto the flat, icy surface of a frontage road along Interstate-80. Before crossing, they stopped and stood quietly alert, sensing some vague predatory presence. The distant drone of an approaching semi-truck broke the pervading silence, but the unseen menace lingered, not behind the familiar clumps of sagebrush, but within some indiscernible restlessness beneath the earth. All at once, the tensed-up antelope reeled in retreat and fled back through the hollow of the gully as if sucked into an invisible funnel.

Struggling eastward up the icy grade of I-80, a lone tractor-trailer rig reached the area abandoned minutes before by the wary antelope. Isolated in the confines of the truck's cab, the fatigued driver was unaware of any potential hazard on this lonely stretch of road. He had left San Francisco sixteen hours earlier, and his brain was now locked in a struggle against unconsciousness. Trying to arrest the descent of his drooping

#### 4 YELLOWSTONE FAREWELL

eyelids, he mentally retraced his route, from cluttered California out across the ranges and basins of Nevada and Utah, and on into the emptiness of Wyoming. He liked traversing Wyoming with its un-crowded horizons and easy driving. His only real enemy on the open highway was that lurking rogue *drowsiness*. It was only a few more miles to that rest area east of Point of Rocks; there he would pull over to sleep as the sun rose in the east. A practical man, he often timed his sleep periods to coincide with the rising or setting sun, depending on his direction of travel. This ritual allowed the sun to gain height and substantially reduce his eyestrain. Now he looked forward to that long rest just ahead.

But as the driver's drifting daydreams rode atop the truck's massive rubber wheels, he was oblivious to the dangerous current rising beneath him. Suddenly, the underlying pavement of I-80 cracked with a sharp sound like that of some ultra-modern high explosive, coupled with a long reverberating rumble. Startled for only a brief moment, the driver and his truck, along with its contents, were blasted upward and outward in every direction, shattering and disintegrating, then falling back to earth. The only vehicle remnants found later were a few of the major steel components and some of the wheels that had been scattered over a wide area. Analogous results might be obtained if one placed a toy plastic truck on a pile of mashed potatoes and blasted it with a twelve-gauge shotgun.

This unforeseen virulent rent of the earth's surface, on the west side of a long hill five miles east of Point of Rocks, propagated instantly southeastward and northward, severing both the east- and west-bound lanes of I-80 and the adjacent frontage road. That sharp linear break in the earth's crust also sliced through major power and telephone cables, oil and gas pipelines, and a bundle of high-speed fiber optic data transmission lines.

Simultaneously, a frothy cement-like mixture of rock debris launched skyward to a height of 4200 feet above ground, then fell back down to briefly mix with a still emerging ooze of roughly the same composition. The height attained by the rocky material was limited by its lack of cohesive strength, combined with excessive degassing, fragmentation, and air resistance. However, dust-sized particles swirled upward in turbulence to

as much as 22,000 feet, eventually drifting back to earth as far as 150 miles downwind. This long and narrow eruption, no more than 450 feet wide where it crossed I-80, solidified quickly, leaving a three mile long ridge of new rocky material across lands owned by both the federal government and private interests. The newly formed solid barrier of rock, commonly referred to as a dike, totally stopped all traffic on that part of the interstate for more than a month, jeopardizing Wyoming's allocation of federal highway funds.

People generally assume volcanic eruptions are accompanied by fire. However, this outburst was unique. It differed not only in its composition from any other historical eruption, but in its temperature as well. Even though a major gas line had been severed, the eruption's low temperature, coupled with its high carbon dioxide content, prevented the rapid oxidation known as combustion, or fire, from occurring, at least immediately. The semi-fluid mixture, which extruded from beneath and to the sides of the highway, comprised a material somewhere between lamproite and kimberlite in composition. With an appearance similar to that of concrete, it was highly charged with carbon dioxide gas. The melt rose through the earth at close to twice the speed of sound, churning and accumulating bits of other rock debris as it pushed upward. The carbon dioxide gas expanded in response to rapid pressure reduction as the fluid ascended toward the earth's surface, causing rapid cooling of both the gas and the associated mixture. The rocky fluid breached the surface at a temperature near the freezing point of water, or thirty-two degrees Fahrenheit, which is not a stable condition for such material. The fluid hardened almost immediately, forming a tall but very weak irregular wall that wobbled momentarily, then collapsed, tumbling down into the still rising tail of the eruption and mixing with it until the process ended.

From start to finish, the entire surface eruption lasted only about three minutes—not the very slow geologic processes that go unnoticed by most people—but *catastrophism* in terms of geologic activity. Beneath the surface, however, the eruption began twenty-four hours earlier at a depth of about ninety miles, working its way upward with steadily increasing speed as the over-lying rock pressure decreased. Somewhere near a depth of

## 6 YELLOWSTONE FAREWELL

forty-five miles, minor earthquakes began to accompany the magma movement as the surrounding rocks increased in brittleness. Then, at a depth of about ten miles, substantial fracturing began, and with pressures exerted by the overlying and surrounding rocks decreasing, the upward movement became a race. The eruption increased in speed and intensity until it broke the surface like a rifle shot. Fifteen minutes later, remnants of the new rock wall, none taller than 120 feet, were disintegrating slowly amid the rocky debris and dust. The crumbling continued for the rest of the day, with a relative stability reached about a month later.

The rumbling noise of the eruption and the associated earthquake startled people in surrounding towns as far east as Wamsutter and as far west as Green River. Workers in the Jim Bridger Power Plant and the Black Buttes Coal Mine were brought to waking attention, while train crews on the Union Pacific main line were jarred by the intense blast. At the rest area eleven miles east of Point of Rocks a Wyoming highway patrolman had stopped to recycle his early morning coffee. He was just getting back to his car when the sudden shaking of the ground caused him to flinch and stagger as he grabbed a door handle for support. The ensuing thunderous reverberation that assaulted his eardrums focused his eyes westward toward the direction of the sound. He stared in breathless bewilderment as a part of the earth heaved itself skyward to unknown height, creating a phantom-like wall that was illuminated in the pale gold of the early morning light. The bizarre sight was so unknown and inconceivable to him that it just did not register as a fact.

Startled people to the west of the eruption watched as an ominous, dark spectral shape vaulted upward, was silhouetted against the brightening eastern sky, and then collapsed. One onlooker later described the volcanic dike as “the devil’s long row of jagged teeth, taking one last bite out of heaven before its fire was quenched by the breath of God.”

When the ground finally ceased its shaking, and the showering debris from the sky subsided, the reality of the event gripped the minds of the onlookers. A violent eruption had occurred in their midst, with no warning whatsoever! Wyoming highway patrolmen and rescue units were called to the scene as

a variety of trucks and cars piled up tight against one another on both sides of the dike. The icy pavement of I-80 contributed to a number of rear-end collisions, while causing other vehicles to be deflected into the snow-drifted ditches. Concurrently with the eruption, a series of deep gouges split the pavement of the interstate just west of Rawlins, causing several car wrecks that included three fatalities. Chaos and confusion rode the corridor of I-80 that cold winter day, and word of the fantastic event spread swiftly throughout the state.



A segment of Wyoming's news media hurriedly jumped into action when a recently hired reporter, from Casper's television station KWYN, chartered a helicopter without his station manager's approval. Vance Trounce was a young, overly enthusiastic news zealot who didn't mind breaking a few rules, as long as he created a lively story. Vance had graduated from a Chicago journalism school and had worked for a couple of years in a large eastern city. The novelty of a new job in the western United States had appealed to his sense of adventure. Upon learning of the puzzling disaster from his scanner, set to receive highway patrol and emergency services, Vance hoped to be first on the scene with live television coverage. He ordered a station camera operator, Liddy Hill, to accompany him on the flight.

Liddy was an attractive twenty-eight-year old woman whose gleaming red hair fell in a braid to her waist. She had worked at KWYN for three years as a station engineer and camera technician, and she had been instructed to assist and take orders from the new reporter when her shift required it. Liddy was dedicated and competent, but unlike Vance, she preferred reporting pure *facts* separate from *opinion*, as KWYN was in the process of gaining a reputation for doing. She too had experience in television reporting and she did not like Vance!

As she and Vance strapped themselves into the helicopter, Liddy wondered whether he had actually obtained the *go-ahead* for this endeavor from the station manager, Eric Larson. She hadn't remembered seeing Eric at work this morning.

## 8 YELLOWSTONE FAREWELL

“Well, Vance, are you going to fill me in on what’s going on...where exactly we’re headed and all that?” inquired Liddy as she wiggled into a comfortable position. Liddy hadn’t heard about the eruption before Vance snatched her and her gear a few minutes earlier.

Vance responded, “From what I gathered, some unknown demon popped out of the ground and is eating cars and trucks along I-80, somewhere east of Rock Springs. So that’s where we’re going now, Liddy.”

“Oh, is that all? Doesn’t sound like a story worth the price of this helicopter!” Liddy wondered if this chopper trip would be smooth or not. She recalled her first helicopter ride many years back when her high school boyfriend invited her on a short blue grouse hunting trip into the nearby Bighorn Mountains. “We’ll just take the bird for some birds,” he’d said. Thinking he’d meant his dad’s Ford Thunderbird, she was surprised when a helicopter landed in her parents’ pasture to pick her up. *His father was a pilot*, she’d remembered. They had flown only two miles when she had become so nauseated that she demanded they set her down immediately. She walked back home and swore she’d never set foot in a helicopter again! But now her job required it, and she just hoped for the best.

“So what’s really going on, Vance? I heard the word “*eruption*” flying through the hallway at work. A volcanic eruption or what?”

Vance nodded, “That’s what it appears to be. I’ll need you to get some good cover with your camera. Live coverage, Liddy...don’t make any mistakes! I just hope there’s enough wrecked cars and dead bodies to make a worthy headline!”

Infuriated by Vance’s insensitive remark, Liddy snapped back, “Vance, we need to discuss something! Ever since you started working with us your dark side has been glaringly evident, and you’ve irritated everyone at the station. You distort every story you report...screw up the facts...add your own spin on things. I’ll admit you’re good at what you do, but your *focus* is wrong. You won’t last, and if you want to keep your job, you’ll relay the plain old truth and nothing more. People in Wyoming don’t tolerate fantasy in the news! You’ll be roasted before you know it, Vance!”

Liddy usually didn’t get angry and blow up, but his

attitude that life and death were entertainment to be exploited for the promotion of sensationalism and personal gain had struck a raw nerve! However, she was already regretting the way she had spoken to him, and she was now concerned that their working relationship might suffer for it in the future.

Vance wasn't used to being cut up and insulted by *lowly* camera operators. He knew he was better than these country bumpkins, and maybe he was just *too* good for small town reporting. After all, nothing newsworthy ever happened out here in *no-man's land*—too much peaceful co-existence. If he couldn't jazz up the news a bit, maybe he'd pack up and head for the west coast—they'd appreciate him out there! But meanwhile, a story was waiting for him, and he hoped to be the first reporter on the scene. He might even get *national* attention for his footage. "Get your camera ready, Liddy! I think I see what we came out here for!"



KWYN's station manager, Eric Larson, had been a few minutes late getting to work that morning. He had only learned of the eruption upon entering his office quarters. Eric was considerably upset when he was informed that Vance had taken the initiative to visit the site without prior approval. He particularly expected permission be obtained by employees before incurring a major expense, such as a chartered helicopter. On the other hand, he would accept the scoop on this story and chew Vance out later.

Until Eric heard from Vance and Liddy, he would attempt to locate someone who could possibly explain what this *eruption* thing was all about. Eric had met a few geologists and knew of several who might offer some explanations. He remembered that the Wyoming Office of Mines and Geology (WOMG) in Cheyenne had recently tried to splash the media with press releases for "Geological Awareness Week." This had appeared to be a thinly veiled attempt to save their budget from cuts in the current legislative session. For geological insights, Eric could call the WOMG, or Wyoming State University's geology department in Laramie. But his dedication to the

Casper community suggested that the power of the press could be more skillfully applied through his selection of *local* talent. Eric remembered a fellow from Casper Technical College (CTC) who had recently impressed him with his seemingly extensive geological knowledge and communication skills. He telephoned Sam Westone, a locally known geologist who had begun teaching at CTC a few years earlier.

Eric quickly introduced himself, noting that he had listened to one of Sam's public lectures on diamonds some two months earlier. He informed Sam of the 5.4 earthquake, depicted on a United States Geological Survey (USGS) website, and of the mysterious eruption that had just occurred near Point of Rocks. He asked Sam if he could come by the station at nine-thirty that morning to offer any answers as to why this event had occurred. The USGS website had also shown a smaller 5.2 quake near Rawlins and a 4.8 quake near West Thumb in Yellowstone National Park, both of which Eric had failed to notice.

"That really sounds interesting!" responded Sam. "I hadn't heard the news this morning. The timing conflicts with my morning class, but I think I can get a fill-in. If you could round up as many details as you can, that would really help. I'll be there!"

"Great!" replied Eric. "I'll see you here at nine-thirty sharp. Thanks!" He hung up the phone while thinking that this just could be a *two-way coup*: one for our informative cover of the news, and one for publicity for our college. Eric was locally supportive of many things, although at times he could have been more sympathetic toward his own employees. He had been tight on wages and often required long hours, resulting in a greater staff turnover than would be expected from such a long-established television station.

Sam Westone had acquired a fair amount of field and consulting experience in precious gems and metals exploration. He was also interested in geomorphology, Precambrian geology, and volcanism. Sam cared little for oil and gas or coal, but while consulting, he had gained moderate experience in their exploration and development. Sam was currently concentrating on imparting his knowledge and experience to his students at CTC. He also spent his spare time writing articles and booklets



on prospecting and geology. Sam received some decent remuneration from his writing efforts, but the college teaching job paid the bills, was gratifying to him, and suited his energetic lifestyle. He thoroughly enjoyed bringing an understanding of geology to anyone who showed an interest. Sam lived alone, just a few blocks from campus. Although only thirty-three years old, his dark brown hair and moustache were starting to show some premature graying around the edges. His broad shouldered, but lean, tall frame depicted a man who was physically active, while an easygoing manner attested to his calm disposition.

Sam was anxious to find out more about the eruption. He needed to brush up on the geology of the Point of Rocks region before rushing into his interview. He didn't have much time, and he kept asking himself *why* he had agreed to be interviewed at KWYN on such short notice. He drove to his office at CTC and made arrangements for his brief absence. Sam had never been one to jump into the spotlight for anything, but he usually took the initiative when he perceived that something needed to be done. Besides, he considered that the CTC Geosciences department might benefit from positive public exposure. And who knows? *This could be extremely interesting.* Or was he just rationalizing a poorly thought-out snap decision, made before he had sipped his morning cup of coffee?

The last time he had jumped on some unknown path was just after he began teaching at CTC, when the college's cave exploration club was in danger of being eliminated for lack of a faculty sponsor. Two of his geology students had asked him to sponsor their group, since there was a tie-in with geology. Sam accepted the position at the persuasion of his students. That had turned out to be an enjoyable adventure. He had learned a new perspective on limestone geology and had even accompanied the group on caving trips to Mexico. However, at the moment, he could not rationalize how a KWYN interview could develop into a similar adventure.

Sam found another instructor who would activate a video on gemstones and lead a brief discussion in his absence. Sam had been saving the video just in case he needed to miss a class. And come to think of it, he had not missed a class in two years and had filled-in numerous times for other instructors. Sam's

## 12 YELLOWSTONE FAREWELL

dedication to geology and to teaching was well known among the CTC staff. Geology was not only Sam's occupation, but his greatest *avocation* as well, often provoking remarks that he "get a life outside of geology." Yes, he was dedicated to his chosen science, but he *did* have other interests.

Sam's biographical sketch, placed beneath his picture at the entrance to the CTC Geosciences building, along with those of the rest of the staff, mentioned that he enjoyed a wide variety of outdoor activities, including cross-country skiing, hiking, hunting, and cowboy action shooting. He still enjoyed those activities, although he was less involved in them now. He participated in his church, was active in amateur radio, and occasionally attended random social gatherings of various types. However, maybe the other staff members were right, in part. When CTC was in session, Sam found that he just didn't have enough time for his other interests. In fact, when he thought about it, his other interests almost always took a back seat to geology. He socialized much less now than he had when he first began teaching.

Sam's reflective thoughts faded as he now focused on class preparation and the hasty research he needed to do immediately. Sam really did not like to miss a class because it disrupted his interchange with students. Those interchanges helped him gauge how well they were learning the material he presented. But for some unknown reason, he felt that today's situation just might be important in the long run, or maybe it was CTC's budgetary concerns that caused him to agree to KWYN's request? He went to his empty classroom to write assignments on the chalkboard for his students.

After completing these preparations, Sam walked briskly back to his office and did a rapid scan of several geological references related to southwestern Wyoming. In particular, he looked for references to active faults or landslides, but there was not much detailed or reliable information available on these subjects. A small, but noticeable, earthquake had occurred outside of Green River in the mid 1990s, resulting in one death when part of an underground trona mine collapsed. After the dust had settled, part of that 1600 foot-deep mine was overlain by a surface depression more than one and a quarter mile long by a half mile wide and a couple of feet deep! Debate and

follow-up investigations never fully determined whether the earthquake had caused the mine collapse, or whether the collapse had caused the earthquake.

More in his area of interest were reports published in the late 1900s by Louis Pease on the geology of the Leucite Hills, just north of Point of Rocks. Sam was familiar with Louis, and had even talked with him concerning a few consulting projects. Louis had been a dedicated geologist and prolific writer, working with metals and gemstones for the WOMG, but his interest had waned as the bureaucracy increased. Louis had retired from the WOMG and from geology, shortly after the turn of the twenty-first century, and was now entirely occupied with other interests, although he did occasionally converse on geologic projects that caught his interest. The WOMG no longer had expertise in metals or gemstones, and their current budget emphasized computerized studies related to expanding industrial minerals markets and coal mines.

Sam's brief research brought forth a lot of general information, but nothing that he wasn't already familiar with, although he may not have remembered all of the details from his previous investigations.

The Leucite Hills are a geologically young volcanic field along the east and north sides of the Rock Springs uplift, and they received their name from the potassium-rich mineral *leucite* ( $\text{KAlSi}_2\text{O}_6$ ) found there. The volcanic field consists of several lamproite dikes, necks, plugs, flows, and cinder and pumice cones. Each individual eruptive center is very limited in extent, but conditions at the time of eruption allowed flows to build up to 122 feet thick at South Table Mountain. Although there are many variations in chemical composition and in xenolithic and xenocrystic inclusions, all of the volcanic material is classified as *lamproite*.

*Xenoliths* are rock pieces that have been incorporated into a melt from surrounding rocks and are included in an igneous rock, even though they may have no direct relationship to that particular igneous melt. Similarly, *xenocrysts* are crystals that are genetically foreign to the igneous rock in which they occur.

*Lamproites* are potassium-rich and silica-poor igneous rocks, generally containing many of the dark iron- and magnesium-rich minerals. No known eruptions of lamproites

have occurred during the course of recorded human history. These represent some of the rarest rock types in the world, and act as hosts to extremely rare minerals. In addition to the mineral leucite, lamproites may contain potassium feldspar, diopside, apatite, olivine, and many other minerals. Some of these minerals, such as *armalcolite*, are hardly mentioned, even in mineralogy texts. In fact, armalcolite is so rare that it was first identified in lunar basalts brought back to earth by the Apollo 11 astronauts, before it was identified in lamproites on Earth. The mineral was named for the Apollo 11 crew—ARMstrong, ALdrin and COLlins, as it was thought to have been a unique discovery restricted to the moon.

Sam was familiar with lamproites, which have similarities to *kimberlites*. He had examined many kimberlites—the world's best-known host rock for *diamonds*. He also knew that both rock types originate at great depth and may bring to the surface nodules of rock from the earth's mantle that may include diamonds. Rich diamond deposits were mined from lamproites in Western Australia beginning in the 1980s and mining has continued to the present. Sam had explored for diamonds in the Leucite Hills, but he had never found any. However, some unconfirmed reports of diamonds, a few years earlier, centered near an olivine-rich lamproite that was found buried beneath dune sands near Hatcher Mesa.

The geologically young ages of the Leucite Hills lamproites had always intrigued Sam. The oldest lamproite there was dated at about 3.1 million years before the present, using potassium-argon radiometric dates on grains of the mineral phlogopite. That is the age of the *Boars Tusk*, a well-known, 300-foot high volcanic neck, or pinnacle, at the northwest corner of the volcanic field. The Boars Tusk is about twenty-eight miles north of Rock Springs.

Potassium-argon dates for the volcanics generally decrease toward the southeast with dates of 2.4 million years at Steamboat Mountain, 2.2 million years at Spring Butte, 1.6 million years at Zirkel Mesa, and 1.4 million years at Emmons Mesa. The youngest age was measured at 1.1 million years, plus or minus 0.4 million years. Sam knew that *plus or minus* could put the last eruption as young as 700,000 years before the present, or as old as 1.5 million years. The volcanic field also

had a distant outlier at Pilot Butte about six miles northwest of Rock Springs, suggesting that a neat, orderly progression of the volcanics in both time and space, from the northwest to the southeast, may not be true.

Reviewing the geology of the area put Sam's mind in the right frame to accept and evaluate new information as it was presented to him. He just didn't know which information would prove to be useful, and which would not. Enroute to KWYN, he heard on the radio a brief mention of the blockage and closure of I-80 near Point of Rocks, which is just south of the Leucite Hills. He also learned of the traffic accidents at Rawlins and a report of a minor earthquake near there. Radio station KRAW in Rawlins had been on the ball reporting local happenings, but like many small stations that had been taken over by large broadcasting corporations, their flexibility in local reporting, and their availability of personnel to do so, had been severely reduced.

Casper Technical College, through a grant and cooperative study with Wyoming State University's Department of Geophysics and Geology, was in the process of installing a seismograph that Sam would eventually be able to make use of. Unfortunately, the unit was still at least a week away from being functional. A local earthquake would have been a nice test for that new piece of equipment. And it would have been something to intrigue his students. Earthquakes are uncommon throughout most of Wyoming, except for Yellowstone and the western Wyoming mountain ranges.

Sam had acquired much less knowledge on what had happened than he had hoped, and he was regretting his snap decision to appear on television. He liked to be one step ahead and did not like *winging it* with inadequate information. However, given a few facts, he was quite capable of realistic interpretations. Sam was also able to clearly convey to his audience, no matter what their background, the distinctions between known facts, interpretive projections, and pure speculation. Sam figured that KWYN wanted *interpretive projections*, even though they referred to it as *speculation*. The English language provides marvelous opportunities for the same words to have different meanings to different people. Sam arrived at the KWYN studios just before nine-thirty.



As the helicopter reached the sight of the eruption, Liddy shuffled her gear around and gazed out of the left cockpit window at what appeared to be the shiny double ribbon of I-80, cut in two by a long string of jagged rubble. It reminded Liddy of oppositely flowing tubes of some vital fluid that were suddenly cut and blocked. The tubes, or driving lanes, now slowly dribbled out their contents of vehicles against the sides of what severed them. “Looks like your subterranean monster shoved his rocky knife upwards across the highway. And the pieces of his blade are still stuck there, Vance.” Liddy’s sarcasm had no effect on the preoccupied reporter.

Vance ordered the helicopter pilot to slowly circle the dike several times so that Liddy could record an overall picture of what had occurred. The helicopter, because of its periodic rental by KWYN and by other television stations across Wyoming, sported an external uplink antenna so that Liddy’s digital video and audio signals could be relayed, via satellite, directly back to Casper. The absorbed reporter, with his microphone against his mouth, could offer no clear explanation as to *what* had happened or *why* it had happened. This did not stop him from babbling incessantly with his uninformed ad nauseam opinions, more typical of popular national television talk shows than of the usually concise and informative statements made by KWYN’s veteran reporters. Although not a religious person, Vance actually prayed that he would someday get to be in the spotlight of the national news.



Back at the station, Eric Larson met Sam Westone in the KWYN reception area and led him to one of the smaller studios, used for pretaping interviews. The studio was also occasionally used for splicing in live commentary, particularly during sporting or community-wide events. Here Eric briefed Sam on all that KWYN currently knew about the event, explaining that the interstate was blocked, and that traffic was now being

rerouted either south to I-70 in Colorado, or to the north across South Pass. Eric also showed him the video that was now coming in from Vance and Liddy's airborne camera. The audio was also on, but the commentary, with the volume lowered, served no useful purpose for Sam. As the helicopter moved in for a landing, Sam carefully studied the aerial views with undivided attention, taking in the overall situation and noting some details. Sam was fascinated by what he saw! He realized that this would be of major interest to all geologists. *He would have to see it for himself.* Eric interrupted Sam's train of thought and explained that he would now interview him for the ten o'clock news.



Upon completing aerial views and commentary, Vance ordered the pilot to land near a hillcrest to the east of the eruption. Liddy quickly set up her ground-based satellite uplink and then mounted her camera on a heavy tripod downwind as a light breeze began to blow. The wind in that part of Wyoming is almost always from the west and usually gets stronger as the day progresses. Liddy zipped up her bulky, down-filled, hooded parka while Vance, in his polyester sport coat, attempted to look unaffected by the cold. As Liddy adjusted her audio and video, trying in particular to attenuate the wind noise, Vance wandered over toward the edge of the hill about thirty feet away and began to light a cigarette. This was a very bad move. Although the ruptured gas line had automatically shut down when its computerized sensors detected the break caused by the eruption, the large pressurized line still contained a lot of gas to leak after the shut-off. A substantial pocket of gas, from the ruptured pipe, had accumulated beneath the solidified volcanic debris and was escaping steadily. It was also being carried by the west wind up the slope of the hill to where Vance stood.

As Vance's lighter sparked, flames exploded from where he was standing just west of the hillcrest and flashed down to the new rock ridge, then expanded skyward and outward in a fireball. Vance's clothing ignited instantly and began melting. The force of the blast caused him to lean into the hill, his feet

flying out from under him, due to ice that had built up on the ridge. The video camera recorded him as a ball of flames crashing headfirst into the rocky ground, before sliding backward on the ice and disappearing from view. The incident treated those who were monitoring KWYN's unedited video feed to incendiary activity, reminiscent of Buddhist monks in southeast Asia during the 1960s.

The flames arched up past the edge of the hill where Vance had been, causing a minor singe to the camera, the nose paint on the helicopter, and to Liddy's long red hair. The explosion happened so fast that no reaction or evasion was possible. Intense flames continued for several minutes after the pilot and Liddy had run for their lives. Because of the strong updraft from the fire, the rush of flames arched high above them, so damage to them and their equipment was minor. Vance was lucky only in that when he fell, the blow to his head rendered him unconscious. He felt nothing in what would otherwise have been an agonizing death. The scene recorded by Liddy's camera showed that Vance had fallen out of view below the hillcrest, and his position in the video was replaced by a wall of flames of sufficient intensity and duration as to leave no doubt about his demise.

A highway patrolman was at that time parked on the hillcrest about one hundred yards south of where the helicopter had landed. When the gas ignited near the helicopter, he had felt the heat, but was too far away across the wind to be in any great danger. He saw people running and immediately ran to their aid, bringing them back to his patrol car for treatment. It was ten minutes later before either dazed Liddy or the pilot thought to ask about Vance. The patrolman responded as quickly as before, but upon returning to where Vance was last seen, even a casual glance left no doubt that little remained of the incinerated reporter.



Eric's fifteen-second introduction of Sam was followed with aerial footage of the I-80 blockage. Sam's commentary was superimposed as audio instead of Vance's, with the



exception of Vance's initial exclamation at how thoroughly the interstate had been blocked. Although only a short amount of time had been allocated for Sam's interview, it progressed smoothly with only one brief interruption.

"Dr. Westone, isn't this blockage of the interstate near some coal mines and the Bridger Power Plant?" inquired Eric. "Could you give us some details of the geology of the area?"

"The *Rock Springs uplift*, where this happened," explained Sam, "is an *anticline*...where rocks are bent convex upward, and the structure is of *Laramide* age, which is roughly sixty-five million years old. In the uplift, sedimentary rock layers have been bent and in some places broken. The rocks were then worn down or eroded over time by the actions of water, frost, and wind. This erosion exposed rock units ranging in age from Late Cretaceous to Paleocene. Oil, gas, and coal are found within the rock layers of the Rock Springs uplift. The Bridger Power Plant, just northwest of the recently blocked I-80, burns coal from nearby Paleocene coal beds mined south of the Interstate."

"Sam, could you define some of your terms?" interrupted Eric.

"Oh, sorry," apologized Sam. "*Cretaceous* and *Paleocene* are the names of geologic ages..."

The interview was suddenly interrupted when a studio technician shouted, "*What the blazes!*" Everyone in the studio looked up as Liddy's camera recorded a fireball engulfing Vance, accompanied by a scream from Liddy, and something unintelligible from another voice, probably that of the helicopter pilot. The brief excitement was followed by silence, and a view of the edge of the hill was accentuated for several minutes by intense, but diminishing flames. The video feed continued to run without commentary, causing much worry and frantic attempts by station personnel to communicate with the helicopter pilot and news crew.

Due to quick editing by Eric, the fireball recorded by Liddy's camera was not a part of the morning news. Eric did not believe that violent death, either graphic or strongly suggested, should be brought into his viewers' homes unannounced, even if most details are omitted. It was clear from the video that Vance's lighter had sparked the fire.

Taking a couple of minutes to calm down, Eric continued

## GEOLOGIC TIME CHART

ERA	PERIOD	EPOCH	Millions of Years Ago	Events		
CENOZOIC	Quaternary	Holocene	0.01			
		Pleistocene	0.6	Last Major Yellowstone Eruption		
	Tertiary			2.0	1 <sup>st</sup> Yellowstone Eruption	
		Pliocene	12			
		Miocene	26			
		Oligocene	38			
		Eocene	54			
		Paleocene	65			
					65	Laramide Orogeny
		MESOZOIC	Cretaceous		136	
Jurassic			190			
Triassic			225			
				225		
PALEOZOIC	Permian		280			
	Pennsylvanian		320			
	Mississippian		345			
	Devonian		395			
	Silurian		430			
	Ordovician		500			
	Cambrian		570			
				570		
PRE-CAMBRIAN	Proterozoic Eon		2500			
	Archean Eon					
	Estimated age of Earth		4700			

with the interview. *Interview* may not be the best term, since Eric's questions were cut out, leaving only explanations and interpretive projections by Sam, coupled with a state map showing the location, which then faded into the recorded aerial views.

Sam, too, was shocked by what he had seen in the fireball, but continued from where he had left off. He explained that the Paleocene generally encompassed the time from fifty-five to sixty-five million years ago, and the Cretaceous preceded it, extending back as far as 136 million years ago.

Sam's first look at the aerial views suggested several possibilities to him. His initial thought, which he found intriguing, was that the *first ever* lamproite eruption in recorded human history had just occurred, extending southward the progression of past eruptions through time in the Leucite Hills. Since such an *historical* event had never happened before, this would be unique in geology. Sam carefully explained this concept, but emphasized, "Proof of that would require field examinations coupled with the collecting of samples for analyses."

Sam's second possibility was that over-pressured gas, mud and water, probably from underlying Cretaceous strata, had vented through a fracture creating a *sand dike*. In his explanation of a sand dike, he noted, "The minor earthquake at Rawlins occurred at the same time as the new dike, and both quakes may have been related to a regional stress adjustment. Therefore, the stress adjustments and quakes possibly involved the creation of a new fracture through which a sand dike had been emplaced."

"Just how common are these sand dikes?" questioned Eric.

Sam continued, "Occurrences of sand dike injections are well-documented to accompany earthquakes in soft sediments. The geologic record shows similar dikes in more indurated sedimentary layers as well. Some over-pressured gas layers are known from Wyoming's Cretaceous oil and gas reservoirs, and some were reported in nearby oil and gas fields. As noted from the aerial views, there appears to have been little, if any, heat associated with the eruption; snow adjacent to the new intrusion has not been melted. The presence of flammable gas also

## 22 YELLOWSTONE FAREWELL

supports the possibility of a sand dike, with the gas venting from some underlying reservoir.”

No one thought to check with the regional gas transportation company to see if they had a line crossing that area, or if such a line was present, whether it had ruptured. The disruption of fiber-optic data, although noted in some areas, had not yet been commented on.

Sam found that the eruption, whatever its type, was *terribly* exciting! He knew that within the United States, no volcanic activity had occurred away from the west coast during historic times! The geologic record, however, is filled with volcanic activity across the west over the course of the last few tens of millions of years. If it *is* a sand dike, the structural implications would also be intriguing. Sam was wound up enough that he immediately decided to visit the site over the weekend, dragging any interested students along. This would nicely supplant his previously arranged introductory field trip to Bessemer Mountain and Muddy Mountain, south of Casper.

Summarizing his televised commentary, Sam took the conservative approach and addressed his second possibility first, with the slight hedge of noting, “A lamproite eruption is possible, but not expected.” His final remark was, “On-site investigation is really needed before true causes can be determined.” Hedging on bets and broadening the field of possibilities diminishes the impact of an interpretation, but sometimes it is better than placing all of your eggs in one basket. The Wyoming Office of Mines and Geology later took Sam’s lead, but put all of their eggs in the *sand dike* interpretation basket.



An endless half hour after her camera recorded the fireball, Liddy reestablished audio contact with the studio in Casper. A sigh of relief then flowed throughout the worried staff at KWYN.

Sam’s explanation of the possible geologic causes was picked up by the national news networks and was aired on their afternoon and early evening programs. They edited KWYN’s

five-minute take to less than two minutes, keeping Sam's words about "regional stress adjustment" and "sand dike," but emphasizing, "possible lamproite eruption" and "such a thing had not happened before in recorded history," because it sounded a bit more exciting for the national viewers.

Vance's prayer for the center-stage spotlight was answered when the national news media took an item from a later KWYN feed that afternoon. They noted that "one of our own" had died trying to bring news of this event to the world. It was a nice subject change for their news reports. Besides, it took some of the heat off of the most recent in a barrage of political scandals that had shaken the U.S. Senate for a month and a half.

Sam was not pleased with the national evening news programs that day. He did not like being quoted out of context, particularly when it was made to appear that he was making wild and unproven statements, even *if* a lamproite eruption was a definite possibility. KWYN's local evening news was a repeat of Sam's morning interview, with the addition of Vance's death in a natural gas explosion, the cause of which was under investigation. Liddy's and the helicopter pilot's escape from major injury was also included, along with pictures of them and the singed helicopter nose. In addition, the late newscast mentioned the accidents and fatalities resulting from the cracks in the interstate near Rawlins. It further related that temporary repairs near Rawlins had been made, but no estimate was given as to when the I-80 blockage near Point of Rocks would be cleared.

That afternoon, the pipeline company noted that the ruptured gas line had, indeed, been the source of the explosion. This information was relayed immediately to emergency personnel on the site to allay any fears of additional fire or explosion. But that did not make the news until the late evening program. Other details trickled into the news over the next week.



The Wyoming Office of Mines and Geology had been at a

disadvantage. Their access to the USGS earthquake information had come via a dedicated link through the now severed fiber-optic cable. That link had been set up as part of an earthquake hazards investigation grant for rapid retrieval of data, without the congestion found in typical internet links. The WOMG could access the same information over the internet, but if a large database was being retrieved there could be a substantial delay, hence the dedicated link. However, as with any system that gets relied on too heavily, when it breaks it often takes a while to remember how things were done before the newer system was installed.

Mismanagement for more than a decade, under the direction of half a dozen politically connected but incompetent (and a couple of rogue) office chiefs had pruned the WOMG of the competent staff geologists and mining engineers that had made it the geological force of note in earlier times. The rapid management turnover was perceived by a state government oversight committee as a problem with the existing staff, rather than with their poor choices for office chiefs. Independent thinkers and self-motivated problem solvers just did not mix well with the bureaucracy of the “just smile and say *yes* crowd.” The *yes-men* and *-women* were the ones who remained employed, while the real workhorses generally resigned in frustration or disgust.

The WOMG now retained only one or two experienced geologists and several who, although they were titled “geologists” and “mining engineers,” lacked both field experience and inspiration. However, these specialists were smooth at projecting an air of importance while talking about their chosen fields of expertise. For them, on-the-ground analyses would be a challenge. Other publicly funded agencies and more large private businesses than one would care to believe also suffered under similar *modern* management concepts. The general public, along with several prominent state legislators with their own agendas, noticed a lack of productivity from the agency—there had been no significant WOMG publications in more than four years. With the tighter state budgets caused by declining oil and gas production, the Wyoming Office of Mines and Geology was close to being eliminated entirely.

All other things aside, the geologist whose job it was to keep abreast of happenings such as earthquakes almost always checked the USGS Earthquakes Information Center, before he did anything else when he came to work. Bill Burnhard, fifty-five years old and looking forward to retirement, was in charge of Engineering Geology and Geologic Hazards at the WOMG. *Engineering Geology* encompassed anything that might be related to strengths of geologic material for any construction, outside of mineral production. *Geologic Hazards* addressed all natural movements of geologic materials, outside of groundwater. Groundwater was managed under a separate division of the WOMG. Geologic hazards primarily included landslides, floods, and earthquakes. Bill had been around almost as long as anyone at the WOMG could remember. He was frustrated because he could not access the USGS data link that morning.

Newer satellite links that would make the fiber optic connections as outdated as a Model-T Ford were coming to southeastern Wyoming soon, and they were currently being installed in several state agencies in Cheyenne and in some buildings on the WSU campus in Laramie. Earlier attempts at such a system had not worked well, but new breakthroughs in data transmission, switching, and signal enhancement were making this happen. However, if its budget was cut, the WOMG might not be around long enough to benefit from the technology. Casper Technical College got a good plug for their Geoscience Department with Sam's introduction on KWYN, and the WOMG first heard about the eruption from one staff geologist's wife who saw it on KWYN's mid-morning news.



The Wyoming State University Department of Geophysics and Geology (DGG) received several calls seeking explanations. However, those faculty members capable of providing answers were out of town and would not return until Monday. Several members of the faculty were presenting papers at a meeting of the National Association of Geologists and Geophysicists in Atlanta, Georgia. Although not considered a

black eye for not having the first answers to an unexpected geological question, the department lost its chance to be first on any immediate interpretations. The spotlight was now shining elsewhere—at Casper Technical College.

Several calls were received by the WOMG after KWYN's morning news, and amidst the scramble to prepare a presentation of their endangered budget to the legislature, the WOMG moved rapidly. The current WOMG Chief, Gordon Aughey, made the snap decision that Bill Burnhard would not accompany him to the budget presentation, but would instead take a vehicle immediately to the eruption site to investigate. Bill would have rather sent one of his assistants, but they were all tied up in other important matters. Before eleven o'clock, most WOMG employees had all seen a replay of Sam's presentation, available on KWYN's web site.

Protesting the sudden change of plans made for him, Bill prepared to go to the field. At least he would not have to leave the Interstate, and traffic was certain to be light since the road was closed at Rawlins. Bill even thought to call ahead to the Wyoming Highway Patrol to make sure that they knew he was on official business and would not be stopped at the roadblock.

Not liking to travel alone, Bill persuaded a Computer Mapping Systems II technician, thirty-one-year-old Debby Johnson, to travel with him. They would be late getting back, but she would get overtime. With her low salary and the high cost of apartment rentals in Cheyenne, she could use all the overtime she could get. None of the other staff geologists or engineers were available to accompany Bill; they all seemed to have plausible excuses. Bill and Debby were on the road before eleven-thirty, after grabbing some prepared sandwiches at a convenience store as they left town. Bill very much preferred a leisurely restaurant meal to a sandwich, to which his overweight condition attested. He was, in striking contrast to his assistant, terribly out of shape. Any kind of fieldwork, or physical labor for that matter, was something that Bill avoided as much as possible.

Just before one o'clock, Chief Aughey headed for his budget meetings with the added ammunition that a field team from the WOMG was currently investigating the geologic causes for the blockage of Interstate-80.





Sam Westone found this new geologic conundrum that had jumped into his life terribly interesting, but it also worried him. What caused subsurface pressure to blow out a sand dike at *this* time and in *this* place? Were more of these likely to occur? And what if it really was *magma* instead? That would make things much more complicated to try to understand. What could cause a rupture in the earth clear down to the mantle? Or was new magma forming at a shallow depth because of some unknown geologic activity?

Compared to the historical geologic perspective of slow, but steady, processes shaping the earth over long periods of time, this recent *violent* movement seemed to be only an isolated occurrence. However, that paradigm of geology would soon be called into question.



Sample