EXCERPT: CHAPTER ONE HELL DAY MINUS TWO

My name is Jack Oswald, and before Hell Day, I was a geology professor at the University of Alaska Fairbanks. Now I'm just like everyone else, merely one more refugee who somehow managed to stay alive these last two years. If you're reading this, you already have a pretty good idea of what has happened since the beginning of Armageddon. But because almost no one survived up north, what you probably don't know is what it was like to have actually been there when all hell broke loose.

For me, it began two days before Hell Day. It was the first week in August, about three weeks before classes were scheduled to start. My wife and colleague, Dr. Angela Martinez, two of my grad students – Mark Starr and his wife Jill – and I were in a classroom in the geology building discussing the role of the greenhouse gas methane in climate change.

A brilliant climatologist, Angela's research focused on the impact of arctic methane on global warming. Just married in June and seemingly as inseparable as Siamese twins, Mark was working on his doctorate researching the climate-related changes to Alaskan glaciers while Jill was studying changes in the permafrost. Me? During the school year, I taught courses and did research in petroleum geology. During the short Alaskan summer, I typically did field work and often consulted with the oil

companies up on the North Slope.

That morning, the four of us were discussing atmospheric methane produced by melting permafrost and undersea deposits of methane hydrate. I should probably explain. Methane is a colorless, odorless, highly flammable gas that's the primary constituent of the natural gas you burn to cook food and heat your homes.

You see, there's a great deal of dead vegetation buried under the tundra in a thick layer of frozen ground called permafrost. As the arctic has warmed, more and more of the ice in the permafrost layer has melted, allowing that vegetation to rot and give off methane.

On the other hand, great deposits of methane hydrate exist in the frigid underwater sediments along the continental margins, especially near the Earth's poles. It's basically just water ice with an amazingly large amount of methane trapped in its crystalline structure. Methane hydrate is actually rather remarkable stuff, and my students used to love it when I'd bring a chunk of it into the geology lab and set it on fire with a match. It looked just like a burning chunk of frozen milk.

Anyway, the four of us were very concerned about the release of this methane from both the permafrost and oceans into the atmosphere because the potential amounts are absolutely staggering. Worse still, even though methane's half-life is only seven years compared to roughly a century for carbon dioxide, it has a global warming potential that's 84 times higher on a pound for pound basis. In other words, although carbon dioxide stayed in the atmosphere far longer than methane, methane absorbed so much sunlight that it was potentially – pound for pound – a far more dangerous greenhouse gas were it to be rapidly released into the atmosphere. Worst of all, we knew that a catastrophic

rapid release of methane was possible because it had already happened before some 55 million years ago. During the Paleocene-Eocene Thermal Maximum, the concentration of atmospheric methane suddenly skyrocketed, and the global temperature jumped at least 7°F and possibly even as much as 15°F. The impact on the planet was horrendous, and the rapid change drove numerous species into extinction.

While the scientific community was in overwhelming agreement regarding the reality and potential magnitude of the danger posed by atmospheric methane, it wasn't clear just where the tipping point was. No one knew how much the temperature of the arctic could be allowed to rise before the melting of the permafrost produced an out-of-control positive feedback loop causing a catastrophic release of methane. Our climate models just weren't able to give us a precise answer. Some models implied that we could safely let the Earth's temperature rise another 7°F while others suggested a maximum safe rise of only 2°F. Most frightening were the models that implied we were already past the point of no return and the tipping point would inevitably be reached in the next four to five years. While I tended to trust the more conservative climate models, Angela was convinced that the pessimistic ones were more accurate. Truth be told, I feared she was right because every time we added missing feedback loops to our climate models, their predictions just got worse and worse.

Anyway, the four of us were debating the latest published research when my phone rang. The call was from Kevin Kowalski, an Exxon Mobil manager for whom I'd often consulted.

"Dr. Oswald," he said when I answered. "Thank God, I got you. We have a big problem, and I need you

up here right away."

"What kind of a problem?" I asked, putting him on speakerphone so the others could hear. "I've got classes about to start and I need to…"

"Forget the classes," Kowalski interrupted. "We have a disaster in the making up here. You know those huge holes that opened last year in norther Siberia?"

"Sure," I replied. "They're probably just big sinkholes caused by the melting of subsurface ice or the melting of very large pingos."

"Huh? What's a pingo?" Kowalski asked. He may have been an experienced oil company manager, but his knowledge of geology was largely restricted to underground oil reserves. To him, surface features were merely something that made life difficult when drilling wells and piping oil.

"Pingos," I replied, "are large conical hills of ice covered with a relatively thin layer of dirt. Anyway, what about the sinkholes? Are you telling me we've got one up on the North Slope?"

"Damned straight," Kowalski answered angrily. "In the last twenty-four hours, we've spotted over two dozen, and several have opened up near our oil wells. There's even one close to the Trans-Alaska Pipeline down by Pump Station 2, and I don't have to tell you the hell there'll be to pay if another one opens up under the pipeline. I need you up here right away, so you can tell me what's causing them and how likely it is that one will open up under our facilities. We're facing a financial and environmental disaster, and I need you up in Deadhorse ASAP. How soon can you put a team together?"

I looked questioningly at my wife and students. Angela nodded enthusiastically. Jill said, "Count me in,"

and Mark added "Me, too."

"Okay, Mr. Kowalski. You can have us for a week, two weeks tops, but then we have to be back here so we can finish preparing for the beginning of classes."

"How soon can you be ready," Kowalski asked, his voice making it clear he would have preferred to have us up there yesterday and stay until the danger was over, regardless of how long it took.

"We can pack our equipment and a few necessities and be ready to leave in about four hours," I answered, looking over at Angela for agreement.

"That works for me too," she said. Mark and Jill briefly looked at each other and then nodded their agreement.

I checked my watch. "The drive from the University to Deadhorse is just under 500 miles, and with luck shouldn't take more than 14 hours or so. If we take turns driving and factor in a few short breaks, we could be up there in about 20 hours."

Now some of you might think that 14 hours is a heck of a long time to drive 500 miles, but you don't know the Dalton "Highway". While they've paved some of it, the Dalton's essentially a bumpy gravel road built to bring heavy duty oil equipment up to the North Slope. It also has many steep grades with no guardrails where it goes over the Brooks Range.

"Excellent. I knew I could count on you," Kowalski said with a chuckle. "But forget about driving. I had one of our aircraft take off about 20 minutes ago to pick you up. It will be waiting for you in front of the western-most hanger on the south side of the Fairbanks Airport when you arrive."

"You're pretty sure of yourself, sending down a plane before you even call me," I observed, not sure whether

to be angry at his presumption that I would drop everything and come or impressed by his efficiency.

"Seemed like a safe bet. What geologist is going to pass up an opportunity to be the first to investigate these new holes? I suspect it could have been finals week and you still would have found some way to come."

"I assume you'll be supplying transportation, provisions, tents, and survival gear as well as a guide and someone to keep an eye on the local wildlife and ensure it keeps its distance," I continued. "I don't want to wake up one morning with a grizzly or polar bear in our tent."

"Don't worry. We'll take care of everything," Kowalski continued. "And while you're getting ready down there, I'll get my stuff together and fly over to Deadhorse and meet you there. My boss has made it crystal clear that this is my one and only priority until we know what we're up against. See you soon." Kowalski hung up, ending the call before I even had a chance to say goodbye.

"Well, I guess we'd better go and get ready," I said putting the phone back in my pocket.

"We've got company," Angela said as she pointed over to the doorway where a strikingly beautiful young woman was standing.

She had long red hair that matched her dress, a small scattering of freckles across her nose, and the greenest eyes I think I've ever seen. Definitely Irish, I thought to myself.

"Well, it seems my timing is just about perfect," she said with a smile.

"Who are you?" I asked, a little thrown off by her sudden appearance and unexpected remark.

"Aileen O'Shannon," she answered, walking up to

me and reaching out to shake my hand. “I’m a reporter for the Fairbanks Daily News-Miner.” She looked at the others in the room and asked, “And your colleagues are?”

As if her looking away had broken some spell, I realized that I was still holding her hand and quickly dropped it. “This is my wife, Dr. Angela Menendez, and these are two of my grad students, Mark and Jill Starr.” I said, feeling somewhat guilty without knowing why. “How can I help you?”

“I’m here to interview you about the holes that were just discovered up on the North Slope,” she answered, once again training her green eyes on mine.

“I’m afraid you actually picked a rather poor time for an interview, Ms. O’Shannon,” I said, instinctively taking a step backwards when I realized how closely she was standing to me. “As you may have overheard, we’re leaving now for the North Slope. Call my department secretary once school has started, and she’ll schedule the interview for you. By then I should have something to tell you. So if you will excuse us, we have to be leaving now.”

“Forget the interview, Dr. Oswald. That won’t be necessary now that I am coming with you as your expedition’s photographer.”

“Now wait a minute, Ms. O’Shannon,” I said, surprised and a little miffed by her presumption that I’d take a stranger with us up to the North Shore. “I already have my team, and we don’t need a photographer.”

“Oh, but of course you do, Dr. Oswald,” she said with wry amusement. “Every expedition needs a professional photographer. Besides, my experience will prove quite useful. For example, have any of you been to Siberia and actually seen the holes there?” she asked,

looking at each of us in turn. “I thought not,” she continued when no one answered. “Well, it just so happens that I have. You’ve probably seen some of my photos of the holes on TV, in various magazines, and they’re naturally all over the Internet.”

She had a point, but I didn’t have time to deal with her. “I’ll think about it,” I said, trying to be as non-committal as I could. I looked at my wife and students. “Angela and Jill, you two go and pack some clothes and essentials for us while Mark and I crate up the equipment. We’ll haul it out to the airport and meet you there.”

“Sure thing, honey,” Angela said, giving me an exaggerated wink. “We women folk would just love to do our womanly chores while our big strong men impress us with their manly muscles.” Jill gave Mark a hug and the reporter a quick look that clearly signaled “hands off – he’s taken”. Then our better halves had a good laugh as they walked arm-in-arm out the door.

Of course, Angela knew I was well aware that she was the athletic one and could probably bench press 20 pounds more than me. And Jill was the outdoor type who wasn’t afraid of getting her hands dirty doing fieldwork. I’d actually volunteered Mark and myself to pick up the geology equipment because I knew what I wanted to take and Mark knew how to pack it properly, having accompanied me on several previous field trips. Besides, Mark was the team’s best engineer when it came to maintaining the equipment. He would know the tools to bring along with us in case anything failed in the field.

Out of habit, I stepped over to the chalkboard and quickly erased the diagrams and notes from our discussion. When I turned around, Aileen O’Shannon was gone.

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We arrived outside the designated hanger on the private charter side of the airport within minutes of each other: Angela and Jill in our cars and Mark and I in a university van carrying the ground-penetrating radar, seismometers, portable drill for taking core samples, and all of the other gear we thought we might need. We pulled up to the open luggage compartment of the executive jet with Exxon Mobil painted on its side. Then our significant others boarded the plane, while Mark and I helped the crew load our luggage and equipment.

Once everything was properly stowed, I followed Mark up the short stairs and through the small door into the lavish interior of the Embraer Legacy 500 business jet. Unlike the typical cramped commuter planes I usually took when flying up to the oil fields, this jet had opulence written all over it. Either the executive funding our expedition was desperate to get us up there, or this was the only aircraft the company had left to send. Either way, I was going to enjoy the unexpected upgrade.

Unlike typical airliners, the jet's eight luxurious leather seats were organized around four small tables, two on either side of the cabin. Each table in turn separated two seats, the front seat facing the back of the airplane and the back one facing the front. Angela and Jill were sitting in the second row facing the front of the plane leaving the first row seats facing backwards for Mark and me. Mark sat down opposite Jill, and I was about to sit down opposite my wife when I noticed her pointing her finger over her shoulder to the rear of the cabin. Following Mark had prevented me from realizing that Angela and Jill had selected this particular seating

arrangement to put us as far as possible away from the unexpected extra person sitting in the back. With flaming red hair and the smile of a cat having just feasted on a canary, there sat Aileen O'Shannon. I marched straight to the rear of the plane and said, "I'm sorry, but I never said you could come along on this trip."

"And I'm not sorry, and you never said I couldn't," she replied, giving me a stunning smile that I'm sure usually got her everything she'd ever asked for. "I naturally took your silence to signify agreement, so I packed my bag and cameras, and here I am. Lucky for you that I did; you wouldn't want to get up there only to realize you needed someone to make a visual record of your discoveries. Besides, I know some of the discoveries the Russians made that they didn't publish."

The co-pilot walked up behind me. "Excuse me, Dr. Oswald. Can you please take your seat now? We're on a very tight schedule and Mr. Kowalski wants you in Deadhorse as soon as possible."

I looked up front and saw that the cabin door was already closed, and the seat belt signs were on. Before I could answer, the plane began slowly taxiing away from the hanger. Realizing it was too late to rid ourselves of the reporter, I turned around and took my seat facing Angela.

"I see we have Ms. O'Shannon with us," Angela said with more than a hint of icy irritation. "I take it you didn't ask her to come along."

"Nope," I answered as the plane sped down the runway. "I'd ditch her in Deadhorse, but I think she'd just rent a car and follow us. Unfortunately, as much as I hate to admit it, I'm beginning to think it may be best if she comes along. We're going to be very busy the next

couple of weeks, and I'd just as soon not be bothered by having to stop and take pictures of what we find. And who knows; maybe she does know something interesting the Russians didn't publish."

"I'm not particularly pleased either," Angela replied. "But I'll put up with her as long as she doesn't get in the way and you keep your eyes on your work. She looks like the kind of woman who enjoys wrapping men around her little finger and doesn't care whether they're married or not. I have no intention of letting her do that with you, and I'm sure Jill feels the same about Mark."

Thankfully, Jill interrupted us by reaching over and handing me a large envelope. "The pilot asked me to give you this."

I opened the envelope, and pulled out a letter from Kowalski with the job description, a standard consulting contract, a short stack of papers, a dozen large pictures of different holes, a map with the position of all the holes labeled on it, initial reports from company geologists, and a thumb drive that I assumed had electronic copies of everything. I spread the pictures out on the table between us so that Angela and I could look at them.

"Look at the size of this hole," she said, pointing to an 8 by 10 photograph that had obviously been taken from a helicopter. "I didn't realize how big it was until I noticed the two caribou standing next to it. It has to be a couple hundred feet across and nearly as deep."

"Where'd all of the earth go?" I asked, completely stumped by the large size and strange shape of the crater. It looked like a giant had taken a huge cookie cutter and dug out a titanic-sized tuna-can-shaped drum of dirt. Also bizarre was the fact that only a tiny amount of loose dirt ringed the perimeter of the pit.

The hole was indeed enormous. Its sides were practically vertical, and various layers of soil and lenses of ice were plainly visible where the sunlight illuminated the top fourth of the hole. The bottom looked like it might be covered by water, but it was too dark to tell for sure. The only thing that was certain was that it wasn't a normal sinkhole or the remains of a melted pingo. In fact, I had no idea what could have caused it.

We looked at the map next. I counted twenty-six holes running from the National Petroleum Reserve to the Arctic National Wildlife Refuge and from the Brooks Range to the coast. Most were close to the coastline, sixteen were in areas with active oil wells, and one hole – a little farther south than the others – was within a few miles of the Trans-Alaska pipeline.

By the time we were done with the photographs and map and had skimmed the initial reports from the company geologists, we were just leaving the Brooks Range and beginning out decent into Deadhorse. During the last ten minutes of the flight, we flew by three holes, though I found it impossible to estimate their size or see the bottoms, which were hidden in shadow.

We touched down on the Deadhorse airport's single short runway and taxied over to the private hangers for the oil company planes. As promised, two Range Rovers and a Ford Raptor pickup truck that was towing a small trailer for our equipment, were parked next to us as we stepped off the plane.

Kowalski and a man I'd never met before stood next to the three vehicles. Rather short, with thinning brown hair, and the belly of a man who spent more time behind a desk than in the field, Kowalski was in his late fifties. Always immaculately dressed, I was only a little surprised to see he wasn't properly dressed for fieldwork. Still, it could have been worse; at least he was

wearing business casual under his jacket rather than his usual three-piece suit and tie.

In contrast, the stranger was perfectly dressed for the wilderness from his weather-beaten hat down to his well-worn boots. He stood maybe six-two and had the rugged build of a former oil roughneck. He was somewhat younger than Kowalski, in his late forties or early fifties, and sported a short black beard and mustache.

"Welcome to Deadhorse, Dr. Oswald," Kowalski said as he and the other man joined us by the airplane. "This is William Henderson. He's one of our wildlife biologists. He'll be protecting us from any polar bears, wolves, or other animals that might delay your research."

"Dr. Henderson," I said, shaking his hand. His grip was firm but not excessive like those of some oilmen I've met; he had the handshake of a man comfortable in his strength with nothing to prove by squeezing harder than necessary.

"Call me Bill," he replied. "Just a masters, I'm afraid. Could never quite justify the time and expense of going for my doctorate. Besides, I'd much rather spend my time outdoors than indoors studying or teaching classes."

"This is my wife, Dr. Angela Menendez," I said, motioning to Angela. "She's our climatologist and will be helping us determine whether the exceptional warming we've been having up here the last couple of years has caused the holes. And this is Mark and Jill Starr, two of my grad students, who will be helping us take measurements and also take care of the equipment we brought."

Having given my full attention during our flight to the information Kowalski had provided, I'd managed to

forget our fifth wheel who'd sat quietly in the back of the plane.

"Hello Mr. Kowalski," she said, stepping forward and extending her hand when she realized I wasn't going to introduce her. "I'm Aileen O'Shannon. I'm here to photograph the holes and make a visual record of our findings while we're in the field." She shook Kowalski's hand, holding it just a few seconds longer than necessary and smiled. "I hope you will find some time to tell me all about the important work you do up here."

I'm pretty sure Kowalski was beginning to blush when Aileen turned to our field biologist. "A pleasure to meet you, Bill," she continued, placing her left hand on top of his right as they shook hands. "I'm sure I speak for everyone when I say we all feel safer knowing you are watching our backs."

"Miss, the pleasure is definitely all mine," Bill replied, his appreciative expression making it clear that he would be more than happy to watch her back or any other part of her.

Angela leaned over. "Care to guess whose back he'll spend the most time watching?" she asked, whispering into my ear.

"Nope," I whispered back. "And the way she just hooked and reeled in Kowalski and Bill pretty much settles the matter of her status. We're just going to have to get used to having her with us for the duration."

"I'm sure we're all anxious to get started," Kowalski said. "Let's load up, shall we?"

Mark and I quickly transferred our equipment from the plane to the trailer that held the tents and other supplies Exxon Mobil had provided, while Angela, Jill, and Aileen loaded our luggage and backpacks into the back of the Range Rovers. Leaving the tiny airport, we

stopped briefly at the Prudhoe Hotel for a late lunch, where Angela and Jill steered us to one table while Aileen happily sat with Bill and Kowalski at another.

Forty-five minutes later, we were caravanning south down the Dalton Highway towards a large hole that had appeared uncomfortably close to the Trans-Alaska Pipeline, which carried North Slope crude to the Valdez Marine Terminal. I led the way with Angela and Kowalski in the first Rover. Mark and Jill followed in the second Rover, and our biologist and reporter brought up the rear in the Raptor.

The fifty-six mile drive was uneventful except for the large trucks that occasionally barreled past us going in the opposite direction on the relatively narrow two-lane highway. Occasionally dotted with ponds and small lakes, the tundra was a beautiful green in late summer. We occasionally saw small herds of caribou in the distance or crossing the road. The Trans-Alaska Pipeline paralleled the highway some distance away on our left. Typically raised eight feet above the ground on its vertical supports to prevent it from melting the permafrost, the pipeline was also high enough to make it easy for the caribou to cross under. Just past the pipeline, the Sagavanirktok River, or the Sag as most people called it, ran north to the Arctic Ocean.

About fifty miles south of Deadhorse, we passed Pump Station 2, an unmanned complex of ten buildings, a microwave communications tower, and a large oil storage tank. One of 11 such stations along the Trans-Alaska Pipeline, it had once helped pump oil south to Valdez before it was put on standby. Kowalski remarked that it had the last indoor toilet along the highway this side of the Brooks Range. Just past it, the road bent to the southwest, away from both the pipeline and the river.

Four miles further down the road, we came to the

spot where the Dalton Highway came closest to the hole that was our first destination.

"We leave the road here," Kowalski said, looking at his GPS receiver. "The hole is about one and three-quarters miles northwest of us."

I put on my turn signal to warn the others, slowed, and carefully drove off the road. Thankfully, our 4-wheel off-road vehicles had no trouble driving over the gently rolling tundra and crossing two tiny streams that flowed north to the Arctic Ocean. Sinking several inches into the soft wet soil of the streambeds, the cars left muddy ruts that marked our passage towards the giant pit.

Ten minutes later, we could see it. I looked for a relatively dry spot at the top of a low gentle rise and parked our car next to where we'd make camp. The hole was about seventy meters away to the northwest: close enough to easily walk to with our equipment but far enough away to avoid the risk of the weight of the cars causing the side of the hole to collapse under us.

Once we'd all stepped out of our cars, Bill started handing out the compulsory cans of insect repellant. "Better put this on," he said. "Although it's mid-August and the mosquitoes don't swarm much after the end of July, there are still more than a few of the little vampires that would happily suck us dry, not to mention all the black flies that love taking little nips out of any exposed skin."

"Bill, would you be a dear and please spray me where I can't reach," Aileen asked. She turned her back to him and used both hands to lift her long fiery hair from her neck.

"It would be my pleasure," he replied. Given how he allocated his time to the task, it seemed clear he believed

the mosquitoes and flies would be particularly attracted to her exquisitely-shaped backside and legs.

Scowling at the pair with a thinly-vailed mixture of irritation and disgust, Angela and Jill handed Mark and me their cans and turned around. “Do us,” Angela ordered. Anxiously hoping to deflect any stray anger away from us, we submissively spray painted our better halves and then made a point of not looking at Aileen while we liberally covered ourselves with the repellant.

Once protected from attack by Alaska’s famed insects, we all walked over to get a better look at the hole. It was much bigger than I expected, easily 80 to 100 meters in diameter and nearly 70 meters deep. That made it roughly the same diameter of the largest of the Siberian holes, but at least two to three times deeper. The exact measurements would have to wait until we unpacked our surveying equipment.

An uneven ring of dirt, maybe a meter high and twice as wide, surrounded the pit. The top two meters of ground had thawed, loosened, and slid into the hole, producing an incline of roughly 45 degrees before angling straight down to the bottom. Whereas the thawed layer above the permafrost was primarily silt saturated with the water from the frequent summer rains, the smooth sides of the pit below clearly remained frozen solid.

“Damn,” Mark said, edging his way closer to the edge for a better look. “That is one big hole.” He was just about to step onto the encircling ring of loose dirt when Jill yelled, “Stop! Mark Starr, don’t you dare get any closer until you’re in a climbing harness that’s properly roped to the winch.”

“Okay, Jill,” he answered somewhat sheepishly. “But Baby, you’ve got to come up here and see this.” He

waved her forward, and she slowly advanced until she stood next to Mark, who put an arm protectively around her waist.

The rest of us carefully crept closer until we all stood in a row parallel to the edge.

"Doc, have you ever seen anything like this?" Jill asked with a slight tremor in her voice due to her proximity to the edge. "The photographs of the Siberian holes don't do it justice."

Our reporter turned photographer grimaced at the unintended slight of her work as she raised her camera and began taking pictures.

"I don't see how global warming could have caused this," Jill continued, pointing to the side of the hole. "Even though the top couple of meters has thawed and that's about four times deeper than it should be this far north, the rest of the hole is clearly frozen all the way down to the bottom."

"Is the permafrost layer usually this deep?" Aileen asked. "I thought it would only be frozen about fifty feet down."

"It varies depending on how far north you are," Jill replied, naturally taking on her role as teaching assistant. "Down in Fairbanks, the ground's actually frozen down to about 150 feet. It's about a fourth of a mile deep where we're standing, and up at Prudhoe Bay it reaches down some 2,000 feet below the surface."

"That's got to be what's keeping the nearly vertical sides of the hole from collapsing," Mark said, clearly impressed by the cylindrical shape of the hole.

"Still in spite of the record temperatures the last couple of summers, it's surprising to find the ground has thawed even six feet down, when it shouldn't be more than a foot and a half. That's got to have a significant

impact on methane production. We're going to have to re-measure the depth of thawing and factor that into our climate models."

"You're right, Jill," I replied. "I'll help you put together a grant proposal once we're back down in Fairbanks."

"Just remember folks that Exxon Mobil is not paying you to study global warming," Kowalski interjected. "You're here to determine the risk posed by these holes to our wells and pipelines, not to work on your climate models. And every minute spent on something else is a minute we don't have to waste."

"But the increasing temperatures may somehow be part of what's causing the holes," Mark said, coming to his wife's defense.

"I fail to see how a little extra melting at the surface could be causing such deep holes or explain where all the ground's gone, for that matter," Kowalski said, his increasing irritation clear in his voice.

"You're right, of course," I told Kowalski before Jill or Mark could say anything more that might unnecessarily upset the man funding our work. "We're here to study the holes and find out what's causing them."

"So what do you think that might be, Dr. Oswald?" Aileen asked. Everyone looked at me.

"I haven't got a clue," I replied, looking around at the gently rolling tundra that I knew extended all the way from the Arctic Sea south to the nearby mountains. "There aren't any pingos anywhere near here, and they sure as heck aren't shaped like this hole. Even if one melted, the resulting decrease in pressure on any buried methane hydrate wouldn't be enough to cause it to blow a hole this big. And even if a sinkhole could have

opened in frozen ground, I don't see how it could possibly have thawed the missing soil and have left such a cylindrical pit." I paused, shaking my head in frustrated bewilderment. "Let's set up camp, grab a quick meal, and decide how we're going to tackle this. We'll need to rappel down the hole and take samples on the way down and at the bottom. It's too late to do much more today other than surveying the hole to get some accurate measurements of its size and shape. We can go down and take samples the first thing tomorrow morning."

About an hour later, we'd set up our six tents: one for Angela and me, one for Jill and Mark, one for Kowalski and Bill, one for Aileen, one for our supply tent, and another for our equipment. Two hours later, we'd unpacked our equipment and had a surprisingly good dinner cooked on a couple of camp stoves.

Leaving Kowalski and Bill to clean up after dinner, Angela, Jill, Mark, and I set off to measure the hole. I set up the tripod and mounted a theodolite for accurately measuring angles and the laser range finder for measuring distances. Jill and Mark then took turns holding the prism poles and measuring the distances from our instruments to the edge of the hole. Meanwhile, our reporter snapped pictures of our camp, the pit, and us taking various measurements.

About an hour later, we had our initial results. The hole was nearly circular, measuring between 79 and 84 meters across, and the depth to its essentially flat bottom averaged 58 meters. The walls of the hole were sloped roughly 3° inwards from vertical, making the bottom roughly 73 across across and the walls – for all practical purposes – straight up and down. A simple calculation gave an estimate of roughly 270 thousand cubic meters of dirt or, as I told Kowalski and Aileen, the volume of a

little over 2,000 railway tank cars. Once more, I wondered where the contents of the hole could have gone. Logic told me it must have sunk into some colossal subterranean cavern. But I could think of no way such a huge cavity could form, how the frozen contents of the hole could have thawed and flowed into the cavern, or why the pit's sides could be so smooth and vertical, especially given the ground was entirely frozen rock solid except for the top few feet. It was as if some giant circular elevator had dropped 200 stories down into the ground. Mark, Jill, and Angela were as stumped as I was. We struggled to find some possible explanation as we walked back to camp, but we easily shot down each suggestion as soon as it was made. Mark had the best suggestion, theft by aliens, but Kowalski was the only one who actually considered it.

With no wood and only tundra as far as the eye could see, there was no way to make a campfire. And so, with the temperature dropping rapidly as the sun dipped below the northern horizon, everyone called it an early 'night'.