

# PEG

FALL 2016

## Water Line

How Calgary Geoscientists  
Put Their Expertise to Work  
for Refugees in Kenya





# Seeking Water in a Harsh Land

Amid cable-eating camels and curious children, a team of Calgary geoscientists discovers clean and reliable water sources for 200,000 people in the world's third largest refugee camp

For Paul Bauman, P.Eng., P.Geoph., an intensive, two-week water exploration trip to Kakuma Refugee Camp — in the middle of Kenya's Turkana desert — can be summed up in one word: crazy. How crazy? "Completely, totally crazy," he says. "Most people who have been there would say it's probably one of the most insane places on the planet. When you come back home, life just seems so boring."

Mr. Bauman and a crew of six colleagues from Calgary's Advisian, a division of APEGA Permit Holder WorleyParsons, travelled to the camp in January as part of a humanitarian mission funded by Geoscientists Without Borders. Their objective was to identify potential wellsites to supply fresh water to Kakuma, the world's third

largest refugee camp, with a population nearing 200,000.

"It's pretty cool to be able to use your profession to help people. I've never experienced anything that felt so good," says crew member Erin Ernst, P.Geo. "It was really a unity of heart and mind."

"Seeing the camp was both exhilarating and terrifying," recalls Ms. Ernst. "Kakuma is like a bustling town with shops and restaurants and mud huts behind fences built of thorn bushes. It is amazing how tenacious humans are, eking out an existence in the most inhospitable place I have ever been."

Finding water in the desert is no easy task, though. Add in knife-wielding locals, gunfire, punishing temperatures reaching

**LIFE ON THE LAGGA**  
A Turkana girl scoops water from a hole dug in dry river bed, or lagga. When this lagga dries up, herders will move on to a larger lagga nearby, in search of water for their livestock.  
-photo courtesy Paul Bauman, P.Eng., P.Geoph.

40 C, herds of camels trying to eat your seismic cables — when the school kids aren't playing tug-of-war with the cables — and you've got yourself a real adventure.

"It was the unusual local hazards that made things a little challenging — but interesting," says Mr. Bauman.

### AN NGO COMES CALLING

Despite Kakuma's size, Mr. Bauman — like many — had never heard of the sprawling mishmash of buildings, carved into four compounds and spread over 12 square

## GOOD WORKS

### DATA RECOVERY (below)

Curious children from Kakuma Refugee Camp watch as Landon Wood, P.Geo., analyzes geophysical data.  
-photo courtesy Josie Bauman

### QUIET ON THE LINE? (right)

Refugee and Turkana children tag along on the survey line with Landon Woods, P.Geo. After school, hundreds of children play in the dry river beds and haul water to their homes — or, in this case, watch Mr. Woods spool 1,000 metres of cable across the sand.

-photo courtesy Paul Bauman, P.Eng., P.Geoph.



kilometres. That changed two years ago when he was contacted by IsraAID, an Israel-based non-governmental organization (NGO) involved in international development projects and humanitarian missions.

Would Mr. Bauman be interested in teaching Kakuma refugees and Turkana villagers a two-week groundwater and geophysical exploration course?

"I immediately said yes and looked at the map to figure out where Kakuma was," says Mr. Bauman. The program IsraAID explained, after all, was exactly in his wheelhouse.

The goal of the training: livelihood improvement.

Mr. Bauman is well known in the international aid community for his volunteer work in water-desperate places across Africa, the Middle East, and Southeast Asia. He's volunteered his technical skills on many projects, using geophysics to find solutions to groundwater challenges. This level of commitment is one of the reasons he received APEGA's 2016 Community Service Summit Award.

Refugees in Kenya are technically not allowed to work, but exempted are water

and sanitation jobs with NGOs operating within the camp. Job prospects are also limited for the 120,000 Turkana people who live around the camp, but with the right skills they can find work with Kenyan water utilities.

For the 35 students accepted into the course, this was an incredible opportunity to gain life-changing employment skills. The course covered topics like geophysical water exploration techniques, water well construction and evaluation, environmental hydrochemistry, and groundwater monitoring.



Though Mr. Bauman has over 30 years of experience using geophysics to explore for groundwater, natural resources, tunnels, unexploded bombs, industrial waste, and ancient burial sites — basically anything you might want to find without drilling or digging — he had never taught a class quite like this one. He spent hours putting a course together from scratch, making his first trip to Kakuma in October 2014.

“I went there not really knowing or understanding anything about the camp or the real issues there,” he says. His first impressions were of a dystopian society

reminiscent of Mad Max movies — chaotic, remote, dry, dusty. And desperate. “You can’t believe you’re seeing 200,000 people plopped in the middle of the desert.”

The refugees aren’t allowed permanent housing, so they live in tin or mud huts. They can’t grow their own food, so they’re dependent on daily rations, including water, provided by the United Nations High Commissioner for Refugees (UNHCR). Most ended up in Kakuma after fleeing civil war, famine, or drought. Some have lived at the camp since it was established in 1992. Thousands were born there.

“Every person there is a survivor of some incredible, traumatic experience,” says Mr. Bauman.

For the Turkana, the situation is also bleak. Semi-nomadic herders, they live traditional lives, roving the desert as they hunt for increasingly elusive water sources. They use sticks and pots to dig scoop holes in dry river beds, often drinking the same contaminated water as their livestock. “In the outlying areas, it’s like stepping back in time,” says Mr. Bauman.

While he was in Kenya teaching, he got a firsthand look at the camp’s water system

## GOOD WORKS

when a flash flood swept through, ripping up water lines. Being the only hydrogeologist around, he was asked by UNHCR to do emergency well inspections and check up on water chemistry. He was appalled — both by the small volume of water and its low quality — coming from the camp’s wells.

Those looking for water were using 1D resistivity sounding, which is “not the best option for the complex geology of the east African Rift Valley,” says Mr. Bauman. As a result, a lot of dry or low-yield holes were being drilled. Another problem: many successful wells had to be abandoned because of toxic levels of fluoride, which is common in the volcanic rock of the Rift Valley.

With better technology, including 2D resistivity and seismic refraction, Mr. Bauman thought there was a good chance of locating high-volume water sources with less fluoride. Though more expensive and complicated, this technology provides better results, which can be more easily interpreted.

How would he make that happen? Back home in Calgary, Mr. Bauman filed a grant request with Geoscientists Without Borders, a charitable arm of the Society of Exploration Geophysicists. He proposed a two-week, intensive water exploration program for Kakuma. Funding for the project was quickly approved. Mr. Bauman’s



## BY THE NUMBERS



**200,000** people living at Kenya’s Kakuma Refugee Camp, from more than 20 different nations



**600,000** refugees in Kenya



**120,000** Turkana locals living around the Kakuma Refugee Camp

**60 hours** travel time from Calgary to Kakuma



**3 flat tires, 5 hours, 125 kilometres** — driving stats for the team, as it made its way from Lodwar, the capital of Turkana, to Kakuma, along one of Kenya’s most treacherous highways.

**16 wooden crates, 1,400 kilograms** — geophysics survey equipment

**55%** of Kakuma children don’t go to school



**20 litres** of water, per person, per day, that UNHCR aims to provide Kakuma refugees for drinking, cooking, and hygiene



**225 litres** of water per day, the amount the average Canadian uses

### SURVIVAL (top)

A Turkana man and a goat drink water from the same scoop hole, which is likely contaminated with E. coli. Though the Turkana know this water is unhealthy, many can’t afford to buy clean water. Locals must pay 10 Kenyan shillings — about US 10 cents — to fill a 20-litre jerry can from a hand pump or tap. Water is provided free to Kakuma refugees, though in limited quantities.

### ON TAP (above)

Water taps only run during restricted hours during the day, creating long lineups. At night, pumps fill a small number of storage tanks to supply water for the next day.

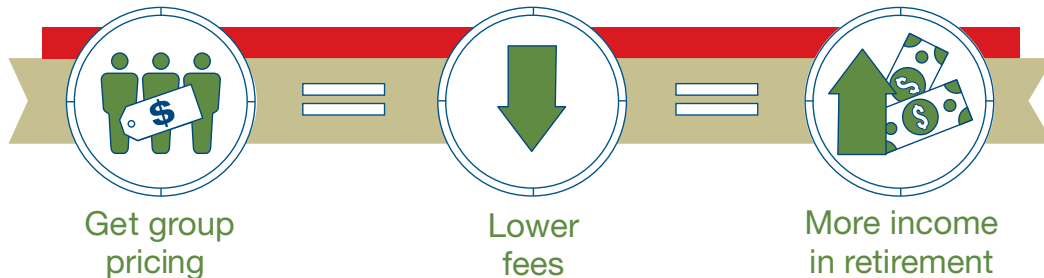
-photos courtesy Paul Bauman, P.Eng., P.Geoph.

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## “Every person there is a survivor of some incredible, traumatic experience”

-PAUL BAUMAN, P.ENG., P.GEOPH.

employer also got on board, providing the necessary geophysics equipment.

Consent from the United Nations and NGOs at the camp took longer. But the project eventually got the go-ahead, shortly after Mr. Bauman returned to Kakuma last November to teach a second course to a new group of students.

Two months later he was back again, this time with a six-member team, 1,400 kilograms of equipment, and a two-person documentary film crew in tow. *See related story, below.*

### PUTTING THINGS INTO PERSPECTIVE

Slashing their machetes through thickets of thorny acacia, team members thought they had a green light to lay cable near a village just outside the camp. But five angry Turkana men wearing wrist knives and waving sticks at them apparently missed the memo. Fortunately, a village elder they had previously negotiated with came to the rescue, calmed things down, and got their survey back on track.

A few days later it was the sound of nearby gunfire — AK-47s, to be specific — that sent hearts racing. Mr. Bauman and the others didn't know it at the time, but police had fired shots into the air to disperse an angry mob at a nearby health clinic, where a child had reportedly died after being given the wrong dose of medication. “I suppose it's not surprising that in a place where one's hold on life is so tenuous, tensions are always ready to be released at any provocation, especially as tragic an incident as this,” Mr. Bauman wrote on his Calgary to Kakuma Facebook page, which tracked the team's progress.

Fortunately, moments like these were few. Indeed, for the Calgary team, the trip was an enriching experience they'll not soon forget.

As well as Erin Ernst, five others joined Mr. Bauman in Kenya. They were colleagues Landon Woods, P.Geo., Colin Miazga, G.I.T., Douglas MacLean, G.I.T., and Randy Shinduke; and University of Calgary geophysics PhD student Franklin Koch. Another colleague, Alastair McClymont, P.Geo., PhD, helped back in Calgary with organizational details and data processing.

“Kakuma was easily the most rewarding field program I've been on because of the humanitarian aspect,” says Mr. Woods. He had previously visited the Turkana region for paleoseismic mapping for a hydrocarbon development, but he never knew about Kakuma until learning about Mr. Bauman's work there.

“To see the camp, smell the smells, feel the heat from the sun, constantly shake the sand out of everything, and see the lineups at the water taps — it really puts things in perspective,” he says. “At times it was hard to grasp the situation

the refugees are in. I am not sure that someone like me, with the privileges and relative safety I have in Canada, can ever fully understand what they've gone through.”

Mr. Woods recalls working one day near a village, collecting survey data by a dry lagga, or riverbed. An elderly Turkana woman was in a scoop hole, almost up to her chest, lifting water into a metal basin for her five donkeys.

“It shows how desperate the water situation is there, and what the Turkana and their livestock have to do to survive. For them, it was business as usual,” he says.

His favourite memory is interacting with local children, who tagged along trying to help out with the survey work, posing for pictures so they could see themselves on an iPad screen. An estimated 55 per cent of Kakuma's residents are children.

All's quiet on the seismic line? Not when school lets out.

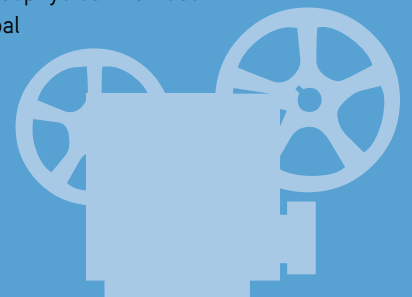
### FINDING WATER — A DOCUMENTARY IN THE MAKING

It's hard to imagine the daily struggles faced by refugees and locals living with chronic water shortages in northwest Kenya. Alberta film maker Brendan O'Brien will bring their story to life in his new documentary, *Finding Water*. He spent two weeks in the desert, recording the work of Calgary geoscientists who travelled to Kenya last January in search of new water sources for the Kakuma Refugee Camp and local tribespeople.

Mr. O'Brien worked as a geophysical field technician with WorleyParsons before resigning his job to start Red Van Studios and pursue his dream of making movies.

*Finding Water* will provide an in-depth look at the geophysical methods geoscientists use to find water. It will also examine global water challenges and the potential for increased water shortages in the future.

The Society of Exploration Geophysicists and a crowdfunding campaign financed the documentary. Funders will get a sneak-peak at the movie at the end of September. It will be released online near the end of the year.





STRAIGHT TALK

University of Calgary student Franklin Koch and Douglas MacLean, G.I.T., discuss how to keep seismic cable straight on a steep river bank.

-photo courtesy Josie Bauman

“There are many curious children running around, which can be an interesting and funny problem when trying to collect seismic data. They would hang around in little groups of friends, laughing and giggling at the silly foreigners in their big wide brimmed hats and sunburned skin, messing about with long cables and wires,” he says. “Some of the most fun I had was hanging around these kids, but the truth is that they likely do not know the reality of their situation yet.”

More than half of Kakuma’s children don’t go to school due to issues like child labour and lack of resources. Many spend long hours waiting in line at water taps, filling up jerry cans and hauling them home to help their families survive.

The team’s efforts to find more dependable water sources for the camp could help alleviate water shortages and wait times — but it wouldn’t be easy.

**MORE TWISTS AND TURNS THAN A SEISMIC CABLE**

Wake at 6:30 a.m. Put on sunblock. Have chai mandazi — milk tea and fried bread — for breakfast. Load equipment. Head out into the desert heat. Complete seismic and electrical surveys. Drink water. Drink more water. Try to avoid sunstroke. Return home (the World Food Program compound for aid workers). Shower. Eat dinner (rice, vegetables, and goat meat). Process survey data. Sleep. Repeat.

Such was the typical day for the Calgary team and 28 Kakuma and Turkana students who joined the crew.

Between January 11 and 25, they collected 12 kilometres of tomography data using 2D electrical resistivity and six kilometres of seismic refraction data, on the hunt for drilling targets in an unforgiving landscape.

“All of the vegetation around Kakuma is trying to kill you,” says Ms. Ernst with a laugh. But perhaps it’s not much of an exaggeration. “Everything has giant thorns on it. Keeping the survey lines straight was a huge challenge.”

The local students, who were paid for their work through grant money, worked closely with Calgary team members, getting hands-on field training. But learning is always a two-way street.

Says Mr. Woods: “The biggest thing that I learned from the students was patience. It seems everyone in Kakuma is patient — because you have to be. I also found out where many of them were from and had a chance to hear some of their stories.”

The opportunity to share technical knowledge was another highlight. Says Ms. Ernst: “They were so keen to learn as much as

**DID YOU KNOW?**

Seismic refraction surveys define the tops of rocks, along with whether rocks are fractured or massive. Electrical surveys identify whether pores in rocks are filled with fresh or saline water.





#### WALK THE LINE

Erin Ernst, P.Ge., and student Peter Kuya lay cable in a dry river bed near the Kakuma camp. For the first few days of the trip, the team surveyed near existing boreholes — where the geology, water levels, and water chemistry were already known — to help them gain confidence in their data interpretations.

-photo courtesy Josie Bauman

possible, and by the end of our time there, they could pretty much run the surveys without any help or direction.”

That included planting geophones, running GPS, laying cable, operating a truck-mounted seismic source, and doing other tasks — like chasing goats off the line and stopping camels from eating cables.

Early on, crews ran their geophysical lines through existing wells, where the geology, water levels, and water chemistry were already known. “Initially, we thought we’d go in and bang, bang, bang, it will all be easy,” says Mr. Bauman. But the local geology proved a real challenge. Kakuma is located at the edge of a basin, or dish, filled with sediment, he explains. That dish is made of a variety of volcanic rocks, which rapidly rise and fall below the surface. The sediment can be sand, clay, volcanic gravels, sand and clay. It can be saturated with fresh water, it can be saturated with salt water. Or all of the above.

Interpretations of geophysical results, therefore, were complicated and uncertain.

Another twist was added by tribal chiefs from nearby villages. They demanded that the crew search for water for the Turkana, in exchange for access to their land. “The relationship between the Turkana and the refugees is very tense. The Turkana view the refugees as usurpers and are bitter that the aid provided to the refugees has not been extended to them,” explains Ms. Ernst.

An agreement was hammered out by UNHCR, IsraAID, and the Turkana chiefs — and the scope of the project quickly expanded. “You definitely have to be able to adjust and have backup plans and deal with things you may not have been able to take into account,” says Mr. Bauman.

After two exhaustive weeks, the team was able to gather and interpret enough data to identify several potential wellsites in zones of thicker gravel — locations that would likely have high volumes of water and minimal fluoride. Its final task was putting together a detailed report outlining the best water well targets.

Now it was up to the UN and NGOs to start drilling.

#### SO FAR, SO GOOD

Good news arrived in June: using data from the Alberta team’s report, three wells had been drilled on the northern edge of the camp. All were successful. For Mr. Bauman and his team, that was a huge relief.

“In any kind of drilling program, there’s some uncertainty. So we’re pleased that we were correct,” says Mr. Bauman. “Not only does it actually give the refugees water, but hopefully it gives them a better understanding of the aquifer and a methodology to move forward for developing new sources.”

The UN's goal in any water drilling program is to supply 20 litres of water per person, per day. Together, the three new wells can supply that and more for up to 140,000 people, including the Turkana, some of the existing Kakuma refugees, and residents of a new 60,000-person camp planned for incoming refugees escaping conflicts in South Sudan.

Mr. Bauman saw the new wells in action when he returned to Kakuma in September to teach a third class in groundwater and geophysical exploration. Like the Calgary to Kakuma Water Project, the course has had great results. More than 60 per cent of students have found employment. Some have even been

repatriated because their new skills are in such high demand in their home countries.

"It's completely transformed their lives," says Mr. Bauman.

He'll continue doing humanitarian work in the region for as long as there's a need. "It's really satisfying to use your skills to do work that people genuinely and immediately appreciate and need. You can see the impact," he says. "The refugee situation in Africa is comparable to Syria, but not in the way it's represented in news media. I've learned so much about a part of the world that a few years ago I'd never even heard of. It's been an eye-opener — a profound experience."

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## APEGA Geoscientist Helps Unearth Holocaust Escape Tunnel — And Says No to Movie Maker James Cameron

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Over the past two decades, Paul Bauman, P.Eng., P.Geoph., has volunteered on about 20 archeological projects around the world. He's been featured in documentaries, including National Geographic's Finding Atlantis and one that's about to be released about finding water wellsites for a Kenyan refugee camp.

Two weeks before heading to Lithuania for other projects, the famous director asked him to work on a sequel to Finding Atlantis.

Mr. Bauman couldn't fit the project into his schedule and had to turn Mr. Cameron down.

And off he went, to be part of a project that ended up having particular personal significance because of his Jewish lineage. Near the end of the Second World War, a group of prisoners held captive in a stone-lined pit dug their way to freedom. Of the 80 prisoners who attempted the daring escape from the Nazis, only 11 survived to tell the tale, becoming known as the Burning Brigade escapees. The exact location of their tunnel had been a mystery.

On the three-week archaeological expedition in Lithuania in June, the APEGA Summit Award recipient and colleague Alastair McClymont, P.Geo., PhD, helped discover the tunnel, using a geophysical imaging technique called electrical resistivity tomography (ERT). Similar to an X-ray or an MRI, the technology provides researchers with a picture of what's going on below the Earth's surface.

The images revealed a narrow tunnel, just 35 metres long and about 60 centimetres in circumference. Its location — the middle of a quiet forest near Lithuania's capital city, Vilnius — is historically significant. More than 70,000 Lithuanian Jews and 30,000 non-Jews were killed there early in the war. They were marched into

the forest, shot by the Nazis, and buried in pits. It's considered one of the first sites of Nazi genocide. As the war came to an end and the Nazis attempted to destroy evidence, prisoners were forced to dig up bodies and burn them.

"It was only after we were there that the historical context started to sink in," says Mr. Bauman. His family is Jewish, with roots in nearby Belarus. "It certainly took on a lot more meaning for me."

Besides finding the tunnel, the researchers were able to determine the exact location of Pit One, the first pit used for the mass executions. They also found the trench leading into the pit, where people were herded to their deaths.

In Vilnius, Mr. Bauman and Dr. McClymont also worked with archaeologists to survey the subterranean floors of the Great Synagogue of Vilna. Built in the 17th century, it was partly destroyed during the war and later demolished. Thanks to the work of the geoscientists, however, archaeologists have already been able to excavate two floors down.

Mr. Bauman and Dr. McClymont were also part of a team exploring Rasu Prison for the burial site of Jacob Gens, a controversial Jewish leader who was appointed by the Germans to run the Vilna Ghetto. He was executed by the Nazis in 1943 and is said to be buried with a metal cigar box containing his memoirs.

The projects in Lithuania were led by the Maurice Greenberg Center for Judaic Studies at the University of Hartford, and the Israel Antiquities Authority. A documentary for the TV series NOVA, set for release next year, will tell the story of the Burning Brigade escapees, the search for the tunnel, and the other archeological work in Lithuania that's underway.

“

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that a few years ago I'd never even heard of.  
It's been an eye-opener — a profound experience.**

”

Paul Bauman, P.Eng., P.Geoph.

*Recipient of the 2016 Community Service Award, APEGA Summit Awards*

