THE MAGAZINE OF CANADA'S ENERGY GEOSCIENTISTS

RESERVOIR

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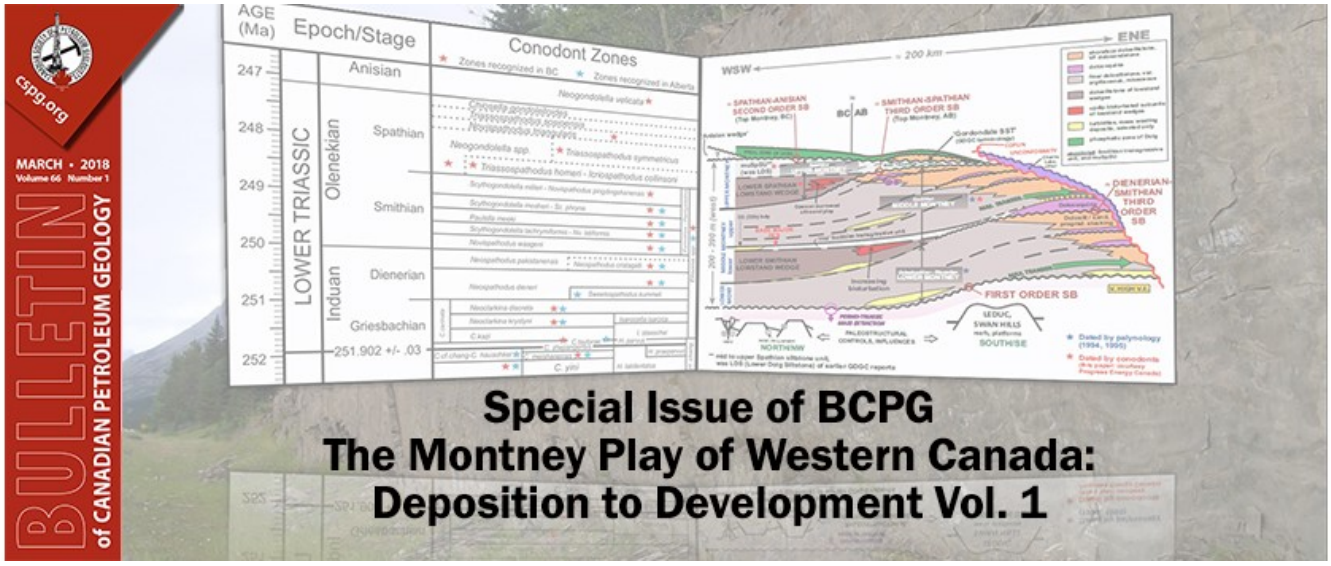

VOLUME EDITORS: TRISTAN EUZEN, THOMAS MOSLOW, & MARK CAPLAN

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Please submit RESERVOIR articles to the CSPG office.
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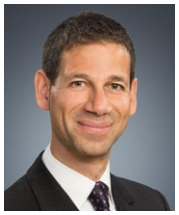

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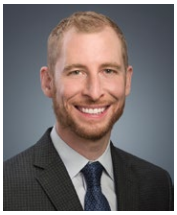

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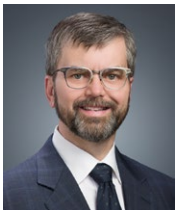

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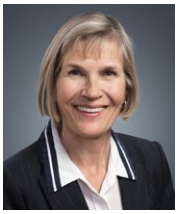

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RESERVOIR

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FRONT COVER

Evaporitic Polygons - Death Valley. Saltpans in Death Valley National Park, California are subject to repeated flooding and desiccation resulting in the formation and reinforcement of these distinctive sedimentary structures. The transition from still-submerged (right), through recently emergent (center) to older (left) is apparent.

Photo: Jerry Osborn

Jason Frank
Technical Editor for the CSPG Reservoir
Sr. Geologist at Athabasca Oil Corporation

Jason Frank is a Professional Geologist who holds a B.Sc. and M.Sc. from the University of Alberta. He has over 16 years of experience in oil and gas including technical and leadership positions in exploration and development both on and offshore. Past experience includes Shell Canada Ltd., Burlington Resources Ltd., ConocoPhillips Canada Ltd., and Talisman Energy Inc. Jason has volunteered for the Society in the past, most recently chairing the Duvernay session at the Society's annual convention (2014) and the Honourary Address Committee.

Travis Hobbs
Technical Editor for the Reservoir
Professional Geologist at Encana

Travis Hobbs is an undergraduate from University of Calgary with a graduates degree from Simon Fraser University in Geology. Professionally he has worked both domestically and internationally for 19 years in the Oil & Gas industry, and is currently celebrating 15 years with Encana. Industry roles have included development, exploration, management and business development. Prior to the Reservoir, Travis has held previous roles on convention committees and six years as the Chair of Continuing Education. As free time permits Travis enjoys cycling, cross-country skiing and teaching his two daughters violin.

SUMMER "GEOFUN" EDITION

Welcome to special "GeoFun" edition of the Reservoir. If you've got school-aged kids, I'm sure you are asking yourself, "Where did that year go?" With the dog days of summer in full force we thought that we would provide some lighter reading that you could enjoy with the summer weather.

We have a special contest in this edition titled "Geology in your Neighbourhood," whereby we are asking readers to submit their answers to 12 field photos that current CSPG President Clinton Tippett has submitted. Please have a crack at answering these, and e-mail your responses. We'll publish the answers in a following edition of the Reservoir. I'm hoping that with some good participation, we can make it a tradition to have every current President submit their favourite rock photos!

Another aspect of summer usually involves family road trips...and if you've got kids the ever present question, "Are we there yet?" Don't fear, your trusted editors of the Reservoir have a solution for you – even if you don't have kids. Try Earthcaching. It's a fun treasure hunt that will take you on countless adventures, and perhaps even open your eyes to Geology that's all around you. At the very least, it will force you to stretch your legs on that next road trip.

Speaking of road trips, while many of us in Western Canada will have vacations plans that will include some time in the Rocky Mountains, Dale Leckie has provided us with a paper describing the landforms and Geology on a journey through our Mountain Parks. Highlights include: Maligne River in Jasper National Park, Mount Norquay lookout and thermal springs in Banff National Park, fossils of the Burgess Shale in Yoho National Park, and thrust faulting at Mount Yamnuska in Bow Valley Provincial Park.

I'm particularly excited about the Talking with Architects article with Geologist Philip Benham. Long known to Reservoir readers as the one behind the 'Go Take a Hike' series, Philip has been a tireless volunteer with the CSPG and the Alberta Paleontological Society. He speaks candidly about his experiences in the field and some of the important work that he is doing to use Geology on his travels to help raise awareness about social issues in the world today.

Finally, Jon Noad has provided us with a great paper reminding us of the ephemeral nature of some of the Geological Wonders of the world. The forces that have produced some of these wonders, are also the forces that will take them away. Perhaps we should all take this as a bit of a warning and make plans to visit our favourites, before they disappear.

We hope that you enjoy this "GeoFun" edition of the Reservoir. It's been entertaining putting it together, and we learned a few things along the way. I guess that's the sweet spot – having fun and learning something at the same time...just don't tell the kids.

Have a great summer!

Your editors,
Jason and Travis

TALKING WITH ARCHITECTS

Interview with Philip Benham

Philip Benham is Geological Advisor on the Integrated Charge Evaluation Team at Shell Canada Limited. He is also Chair of the Paleontology Division for the CSPG and is the past Technical Program Coordinator for the Alberta Palaeontological Society. He is an active board member of the Burgess Shale Geoscience Foundation. He has given numerous talks on his travels in the high Arctic, Indonesia, Madagascar and East Africa. He defines his life by adventure, fulfilling his passion for knowledge and hopefully turning others on to the natural and cultural wonders of the world.

Questions more on a technical background:

1) Who were the influences on your work during your early education/training? Is there a seminal experience you feel every Geologist should have to call themselves a "Geologist?"

There are many I would cite as significant influences early in my career. At UBC my first formal educational encounter with geology was with the late Dr W.R. (Ted) Danner. He confirmed in his lectures (almost always ending with a slide show) that geology was where I was destined to be. Good thing too as my Calculus, Chemistry and Physics marks were not so strong! His passion for the subject came through in his lectures and many students with Geology as an "elective" ended up switching majors because of him.

I was fortunate to have early field experience studying permafrost near Tuktoyaktuk with the late Dr J.R. Mackay. My two summers of fly camp and research of pingos, ice wedge polygons and other permafrost related features reinforced my love of the outdoors but also expanded my interests from rocks to the living world (the amazing flowers of the short Arctic summer, the tremendous herds of caribou and the comical ptarmigan). But what I took most from my experience with "J.R." was discipline, rigorous planning required for surviving and working remote settings and an awareness that the great geoscientists have a passion for things beyond their focused expertise. J.R. Mackay knew the Inuit, English and Latin names of every plant, what was edible and every story about a place. He also had a long term view of experimentation... observing permafrost growth by visiting a lake he had drained for research purposes every summer – for decades. For me this was the start of six field seasons during my student days, an experience that is vital for the development of any geologist.

Later I had the opportunity to work in the field and office with some of the true greats of the Geological Survey of Canada: H.W.Tipper, E.T.Tozer, Bob Thompson and Mike Orchard. From each I took lessons about tenacity, curiosity and humanity. When finally my journey lead me to Shell it was Les Eliuk, Gil Graff, Felix Frey and Clinton Tippett who were my early role models. I also reflect that my journey in Shell would not have gotten far if Bob McMechan had not taken the time to interview me (a second time) one cold and snowy October and Chief Geologist Patricia Lee (who set the standard for caring about staff) saw the potential in me and eventually encouraged me to take on her mantle when she retired.

2) What is your best field memory (hike/field work/looking at rocks)?

I feel very lucky to have started my career in a time when field work was still common. My formative summers were spent in the Mackenzie Delta, the high Arctic and Northern BC. Probably my most important field experience was a summer in 1987 as part of the GSC Frontier Geoscience Project in the Queen Charlottes being run at that time by Bob Thompson. Not only was the geology diverse and challenging but there were perhaps 40 geoscientists mapping intrusives, doing sedimentology on submarine fans, sorting out the stratigraphy with ammonites and conodonts and trying to understand the hydrocarbon potential for the basin. The opportunity to work with a diverse crew in the field and to participate in the endless conversations at the end of the day in camp allowed me to step from being a university student to a "proper" geologist.

(Continued on page 8...)

(Continued from page 7...)

I also spent two seasons on ice covered Bylot Island (north of Baffin) mapping out sparse outcrops of Cretaceous and Tertiary strata in a region so poorly understood the GSC had some of them on their maps as PreCambrian. Two things stand out for me. The first is the remoteness of the place – I suspect some of the places I stepped I was the first man to do so. The second was the discovery of dinosaur remains the summer before- the northernmost in the world at the time – and the reason I chose to do my MSc fieldwork on the island!

While it is harder these days to get extensive field experience my advice to those seeking post graduate studies to try and land a thesis topic that has a field component. You will not regret it.

3) How much have you worked in western Canada vs. other geographic areas? And how has this influenced you as a Scientist? Has it changed your perspective on Geology?

We are all a product of our experiences. I felt I had a sufficient breadth of experience doing field work, exploration and development the West and East Coasts, Canadian Arctic as far north as Bylot Island and of course Western Canada. I since have realized that this was a conceit after expanding my horizon to Malaysia, Russia and Kuwait. Exposure to a diversity of geological settings creates better "pattern recognition" but in particular it opens you up to alternate scenarios and you can perceive the data in new ways as a result. If your role doesn't permit extensive travel, if you are not able to explore a variety of outcrops or view core, you can still read. Even now I try and read at least 5 papers each week looking for differing views and inspiration.

4) Palaeontology has been an interest of yours for some time, what sparked your interest? What aspects do you love the most about Paleontology?

I have been fascinated by fossils and the world around me for as long as I can remember. My parents encouraged me with trips to Drumheller (pre-Tyrrell), Hawaii and England to pursue my curiosity. Geology is as much an art as it is a science, and the ability to create a picture when you communicate is a powerful one. If looking at rocks is like reading a book then the fossils are the colour pictures on those pages.

5) Your passion for travel is evident in the work that you do, and the talks you give. How did this start? Have you always enjoyed exploration? Is there a favourite trip or adventure that you have been on?

A passionate reader in my youth, I was inspired by the stories of adventures by Hillary, Shackleton and Scott. I have always enjoyed exploring and travel, but a key transformative experience in my career was an Earthwatch assignment by Shell in 2005 to Madagascar to study lemurs and understand man's impact on the environment. While in one of the villages near the lemur reserve our group saved a teenage girl's life by providing transport and a mere $25 for medication of a combination of illnesses. From that point on not only did I want to travel but I also wanted have a tangible positive impact on the places I went. In the case of Madagascar I have spoken to several thousand people and raised funds through a charity (Madagascar Ankizy Fund) to get a school built and arrange for medical and dental visits to the village. Subsequently I have done similar things in Rwanda, Solomon Islands and Malaysia. When I give my talks I raise the point that a single person can make a difference.

6) What were the biggest changes/ challenges you personally noticed transitioning from a conventional oil and gas focus to an unconventional one?

I was involved in operations and studies teams in the mid-2000's in the Deep Basin near Hinton, chasing stacked targets in the complex structural geometries of the triangle zone. I had to switch mindset from exploration (where I had just been involved in play generation and the drilling of the first well in 2500m deep waters in Orphan Basin, Offshore Newfoundland) to trying to resolve the question of economic mass production in basin centred gas when we did not yet fully understand the key reservoir mechanisms.

It was an exciting time as the science of unconventionals was young and completions technology was (and still is) evolving rapidly. The evolution of the play lead to tight integration between all the subsurface disciplines. It was all new, and the lack of "old hands" meant that everyone had something to contribute. As our focus moved eastwards out of the structured zones the development approach evolved to horizontals with multi-stage fracs leading to debates on pilot design, optimum horizontal length and frac spacing. Of course, Shell wasn't figuring it out in isolation and the other satisfying aspect was the involvement in research consortia and peers in the industry.

7) With respect to the "Go Take a Hike" series in the CSPG "Reservoir," how did the idea come about? Have you completed most of the hikes? Which ones are your favourites?

I recall that Cindy Riediger and I were approached by someone at the CSPG to see if we wished to contribute some articles the geology of popular hiking areas. In 2009 we hiked Helen Lake with Randle Robertson of the Burgess Shale Geoscience Foundation both to create an article and also to assess whether it was a worthwhile hike for the foundation to deliver. We enjoyed the hike and the experience of the article and planned to do more in 2010. Tragically she passed away that year. As we gathered to remember our friend the discussion turned to how could we pay her tribute. The end result was the series that represented her passion for teaching and the world around her. We now have 83 hike articles (many previously published in the Reservoir) in final edit as we push towards completion of a CSPG Special Publication that will raise funds to a charity in her name. If I have one favourite hike in the book it is the Rockpile at Moraine Lake because I got married there; guests will recall I provided an impromptu geological tour as we made the short ascent to the viewpoint.

Questions focused on career development:

1) What attracted you to the Earth Science discipline, and when did you realize you wanted to focus on the field of Geology?

The attraction for me is in putting together the picture in terms of time and geological processes when often you have but a few pieces of the great puzzle. While I have always had a passion for palaeontology, by the time I got to university I felt I could apply my interests in the broader context of geology and have more employment opportunities.

2) Having worked successfully for an international oil and gas company for (26 years) wondering if you'd like to share some pearls of wisdom on how you have achieved this success (i.e. what skill-sets would you recommend having).

If you have a passion for what you do you will succeed. Don't under-estimate the power of networks – volunteer within the professional community. Teach, for you will also learn. Have realistic expectations. Be true to yourself (authenticity). Large companies aren't necessarily conducive to a caring environment (especially during downturns) – it has to come from individuals. Be resilient, be positive, and be flexible – for one constant in your career will be change. Finally, constantly challenge yourself – if you are comfortable you are not growing.

3) What are some key messages you would like to share with the industry professionals that have just started their careers? (Starting to collect, analyze and apply geologic/ exploration data)?

Keep up on the latest software (something I could have done better), coming technologies and have a voracious appetite for technical journals. However, remember that even though you can create a lovely looking map by computer it needs to have proper geological insight applied. Creating geological contours by hand (as I did when I started my career) forces you through a certain thought process that perhaps is missed by those relying on today's powerful software.

Plan your projects well. Before you start, what are you trying to answer? What do you need to get there? Also, don't get stuck on one answer, consider alternate scenarios. While jargon can be useful amongst your geological peers it can be a barrier with other subsurface disciplines on your team. I recall at a meeting on my first well in 1995 – a horizontal in Jumping Pound West – trying to describe the nature of the faulted strata. The drilling engineer asking me "what's this allochthonous monster you are talking about?" Since then I have strived (against my own tendencies) to go light on technical jargon.

4) Can you describe some major achievements or favourite projects over your industry career?

What I have appreciated in my career is the diversity of projects I have been involved in from frontier exploration offshore Newfoundland to the drilling of some of the last wells in the Jumping Pound Fields at all points along the hydrocarbon maturation chain. I cannot pick out one and would rather say that my favourite is whichever one that I am working on at the time. For me currently that is a pair of heavy oil fields in North Kuwait. While they have strong similarities to Canadian analogues they also differ in depositional settings and have unique challenges because of strong diagenetic overprints, dramatic permeability contrasts and are very shallow (but too deep to mine). The fields are at an early stage of development and will have surface footprint of thousands of closely spaced wells, and yet we must take into account the joint development of a deep sour gas target, existing farmland and a precious aquifer in this parched landscape.

Questions centered on more general / personal items:

1) What have you learned about yourself from the most recent industry downturn?

Similar to many, for the last few years my work future has been uncertain. With company divestments and staff reductions on the table I have seen good people lose their jobs, and I have to make decisions on staff reduction on my own team. It has not been an easy time, but with challenge has come an opportunity for growth. While you cannot always control what happens, you can always control how you respond to it. I have learned resilience, humility and sensitivity to what others are going through. I have tried to keep my sense of humour and I have kept a positive outlook.

I have also been prepared to make sacrifices. Last year I worked in five different countries, working on new projects, having to learn who the stakeholders were, starting from scratch multiple times. At one point last year I found myself in northern Sakhalin with a Russian geologist who spoke no English. We were trying to mime to each other our observations of hummocky cross-beds in the field. It was both comical and frustrating but it made me realize if I hadn't taken a chance and been willing to be "uncomfortable" I would not have be there and would have missed an experience that will always stay with me.

2) Tell us something about the personal side of Philip Benham. What are your interests outside of work?

I enjoy hiking, photography, writing and planning my next adventure!

3) What are your plans/goals for the next 3 to 5 years outside of work?

When I return to Alberta I hope to continue my role with the Burgess Shale GeoScience Foundation as I still have a passion for public education. I also have a backlog of international Go Take a Hike articles to write… so keep an eye on the Reservoir.

GEOLOGY: REST IN PEACE

Jon Noad, DigitCore

The world is blessed with a vast abundance of geological landmarks, many of them stunning to behold. The Grand Canyon, the Giant's Causeway, Ha Long Bay and Meteor Crater all spring readily to mind, and I am sure that every reader has their own favourite. However, the processes of weathering and erosion are relentless, and eventually even the largest and most robust of these structures will crumble to dust. Over the last fifty years, several high profile geological wonders have met their maker, as detailed below. One of them, the Finger of God, even had its own official obituary, published in a geological journal shortly after its demise. The featured stories serve as a reminder of the transient nature of the geology around us.

The Azure Window, Malta

The world famous Azure Window, located near Dwejra Bay on Gozo, in the Mediterranean, collapsed on 8th March, 2017 (Figure 1). At the time of the collapse there was a heavy sea raging below, and several witnesses saw it plummet into the sea "with a loud whoomph". The news was considered important enough in Malta to merit comment from Joseph Muscat, the Maltese prime minister, who tweeted the news as "Heartbreaking". Not to be outdone, the opposition leader, Simon Busuttil added that "This was a sad day for Malta. We have just lost an icon…". Hundreds of residents flocked to the coast to pay their respects.

The Window was a 28 metre tall, natural arch, composed of Miocene Lower Coralline Limestone, likely to have been created as a result of cave collapse around 1870. It was located near a large sinkhole (the so called Inland Sea) and other smaller arches and stacks. The arch was first photographed in the early 1870's. It featured in a number of international films including "Clash of the Titans" and "The Count of Monte Cristo", as well as in Game of Thrones. The arch was included in a Special Area of Conservation, and on a list of possible UNESCO World Heritage Sites.

Figure 1. Azure Window, Malta, before and after its collapse (photos by Schoschi, Germany, Wikipedia)

Several geotechnical surveys had already flagged that the arch was at risk, and natural erosion had already led to parts of the arch sloughing into the waves, increasing its overall dimensions. A large slab of rock on the outer edge of the cavity collapsed in April 2012, and fishermen began avoiding the area. An emergency order published in December 2016 forbade people from walking on the arch. The arch finally collapsed at 9:40 am local time on that fateful day, leaving nothing visible above the water. The pillar gave way first, causing the top of the arch to collapse along with it. The Environment and Resource Agency, the Church and local councils all weighed in with their sentiments. Efforts to develop a fitting memorial have so far proved fruitless.

The Twelve Apostles, Victoria, Australia

These are a collection of limestone stacks, now eight in number, close to the Great Ocean Road in southern Australia. They were originally known as the Sow and Pigs, with the latter renamed as the Twelve Apostles in the 1930's to generate tourism, despite the presence of only nine stacks at that time (Figure 2a). They are made of soft limestone, around 20 million years in age, which initially weathered to form caves, then arches which later collapsed leaving stacks up to 50 metres tall. This process, from headland to stack, is estimated to take around 600 years, facilitated by the presence of softer basal layers of limestone and marls, overlain by more cemented limestone, leading to undercutting of the cliffs. The rate of erosion at the base of the stacks is estimated at around 2 cm per year,

Figure 2. The Twelve Apostles before (2a) and after (2b) the collapse of the ninth sea stack (photos by Cookaa and Richard Mikalsen, Wikipedia)

helping to explain the frequent collapses. It is estimated that the coastline has retreated up to a kilometer in the last 6000 years.

The ninth Apostle, known as "Judas", collapsed dramatically on July 3rd, 2005, in front of a crowd of stunned sightseers (Figure 2b). Eye witnesses said that it shuddered and then fractured and collapsed downwards, reminiscent of a building demolition. Only a small pile of rubble remained. Another stack collapsed in 2009, but was from a separate group, the Three Sisters. The London Arch was part of a double span bridge until 1990, when it fell, leaving two tourists stranded offshore, later rescued by helicopter.

Mukurob Formation, Finger of God, Asab, Namibia

The Mukurob, or Finger of God, was a huge sandstone block 12 metres in height, weighing around 450 tons. The "neck" of the pillar was only 3 m by 1.5 m, making it much narrower than the block it supported, suggesting that it was defying gravity (Figure 3). The structure topped a pyramidal base some 20 metres high, all of which was composed of Permian glacial deposits, from the end of the Gondwanan ice age. The Finger was once part of the Weissrand Plateau, a low relief structure covering thousands of square kilometres, and was gradually carved out of the plateau by erosion.

Prior to its collapse on December 7th, 1988, the Finger of God was one of Namibia's top tourist attractions (Figure 4). It was given

Figure 3. The Finger of God, Namibia (Heiner Dillman)

Figure 4. Stamp showing Mukurob, the Finger of God (Gondwana Collection)

National Monument status in 1955, which continues to this day, and several songs were written about the monolith. It is not known what triggered its collapse, which was only discovered (by a farmer and his sons) the following morning, but both a rainstorm the preceding week, and the

(Continued on page 12...)

(Continued from page 11...)

Spitak earthquake in Armenia, some 11,000 km away (registering 6,9 on the Richter scale), have been fingered as the culprit leading to its downfall. A study showed that the earthquake strongly affected Namibia, and it seems likely that the cause was a combination of rain, the weight of the rock formation and a seismic trigger.

The Finger of God was known to the Nama people for generations. Legend has it that the competing Herero tribe tried to topple the rock, but were unable to do so, leading the Nama to shout "Mû kho ro!", which translates as "There you see", possibly the origin of the Finger's name. Another tradition suggested that colonial power would end when the structure collapsed, and indeed South Africa relinquished control a few weeks after Mukurob's collapse.

A second rock pillar, the Vingerklip, still stands in Damaraland, but does not have the same ethereal quality as Mukurob. Several smaller models of the Finger can be found around Namibia, although a plan to replace the original with a fiberglass replica never materialized. The Finger of God has the unique cachet of having had an official obituary published in a geological journal after its "death". A similar structure in the Canary Islands in Spain, El Dedo de Dios ("God's Finger"), the signature landmark of the islands (Figure 5a), was broken off by the near hurricane strength, Tropical Storm Delta in November 2005 (Figure 5b). The sea stack was originally formed by erosion of basalt, created during Miocene shield volcanism. Its loss left the islanders in shock.

Figure 5. El Dedo de Dios, Canary islands, before (5a) and after (5b) collapse (Wikipedia)

Old Man of the Mountain, White Mountains, New Hampshire, USA

High above the Franconia Notch, in New Hampshire, the profile of an old man stared out from Cannon Mountain (Figure 6). The facial profile was composed of Jurassic Conway red granite, and was an illusion formed by five ledges, which only formed a face when viewed from an area close to Profile Lake. The profile was thought to have been shaped initially by movement of the most recent ice sheet that covered the Franconia Mountains, and later sculpted by freeze-thaw action in crevices within the bedrock. The face was 13 metres high, with the five slabs making up the chin, upper lip, nose and the upper two the forehead. Daniel Webster, a famous politician of the 19th Century, described the face thus: "... God Almighty has hung out a sign to show that there He makes men".

The beloved icon was first recognized by road surveyors in 1805. It was adopted as the official emblem of New Hampshire in 1945, and is featured on New Hampshire's State Quarter (Figure 7) and on several stamps. From the 1920's onwards, the Old Man was shored up with chains, cement, steel rods and turnbuckles, but on May 3rd, 2003 he finally fell (Figure 8). Years of erosion, freeze-thaw and vibrations from traffic on the nearby Highway I-93 took their toll. The entire weight of the stacked granite ledges rested on the chin, which was a smaller slab of granite, held in place by only two feet of granite that was supported by an underlying mountain ledge. Water erosion gradually changed the chin's centre of gravity and eventually it fell, together with the rest of the face.

Flowers were left by locals after the collapse, and it was initially suggested that a replica should be built at the same location. The idea was rejected by a task force headed by the former governor, but in 2010 the

Figure 6. The Old Man of the Mountain in happier times (Wikipedia)

Figure 7. The New Hampshire State quarter (Wikipedia)

Figure 8. The Old Man of the Mountain, before and after the fall (http://www.oldmanofthemountainlegacyfund.org)

Friends of The Old Man of The Mountain began working on a series of memorials in the area, including viewing platforms, as well as "profilers" at Profile Plaza, which are designed to replicate the optical illusion that created the Old Man's original profile.

Wall Arch, Utah, USA and other structures "barely hanging on"

Wall Arch was one of the largest natural sandstone arches in Arches National Park, with a span of 22 metres and a height of 10 metres (Figure 9a). It was made of the Slick Rock Member of the Entrada Sandstone, composed of Middle Jurassic age, cemented, beach sands. The Arch was first recorded in 1948, and was one of over 2000 arches in the Park. Wall Arch collapsed on August 5th, 2008 (Figure 9b), temporarily blocking the Devil's Garden Trail. No one observed the fall, which has been attributed to erosion and gravity. It was the first major collapse in the Park since Landscape Arch fell in 1991.

Balanced Rock stands 38 metres tall, and is also located in Arches National Park. The Slick Rock boulder sits atop a pedestal of Dewey Bridge mudstone (Figure 10). The 3600 ton rock appears to defy gravity, but sooner or later will come tumbling down. Another structure that could go "at any moment" is the curious, sombrero-shaped rock formation outcropping on the northeast edge of Mexican Hat in Utah (population 31 at the last census). The "Hat" has a diameter of around 60 feet (Figure 11), and is composed of weathered, Cutler Formation, sandstone beds, originally deposited on the coastal plain around 290 million years ago, and roughly equivalent in age to the Wolfcamp reservoir. The "Hat" has two climbing routes ascending it.

Conclusions

The forces of tectonics, gravity and erosion will no doubt continue to wreak havoc on the geological marvels around the world, yet it is important to remember that the same forces of nature helped to create them in the first place. While erosion is probably the most prevalent cause of collapse, tectonic forces can also destroy structures. Three of the Seven Wonders of the Ancient World were destroyed by earthquakes, and innumerable Natural Wonders have suffered a similar fate through Earth history. The featured structures here are mainly stacks and arches, as these are most liable to sudden collapse.

Where things get ugly is when humans take things into their own hands. In 2013 a video surfaced showing two men pushing over a hoodoo in Utah's Goblin Valley State

Figure 9. Wall Arch before (9a) and after (9b) collapse (Wikipedia)

Figure 10. Balanced Rock, Arches National Park, USA (Jon Noad)

Figure 11. Mexican Hat, Utah (photo by Averette, Wikipedia)

Park. The men received hundreds of death threats, and tried to justify their actions as being in the interests of safety. They were eventually charged with third degree felonies and were fined heavily. In a similar story, the Duckbill, another hoodoo in Cape Kiwanda State Natural Area, in Oregon, was initially thought to have succumbed to Mother Nature, but a video later showed that vandals were responsible for pushing it over. When caught, they claimed to be doing the world a favour. We can only hope that the negative publicity associated with geo-vandalism of this kind will deter others from the same path, and leave nature to take its course.

REFERENCES

A variety of material was drawn from Wikipedia

http://www.visitmelbourne.com/

https://tracks4africa.co.za/

http://www.oldmanofthemountainlegacyfund.org/

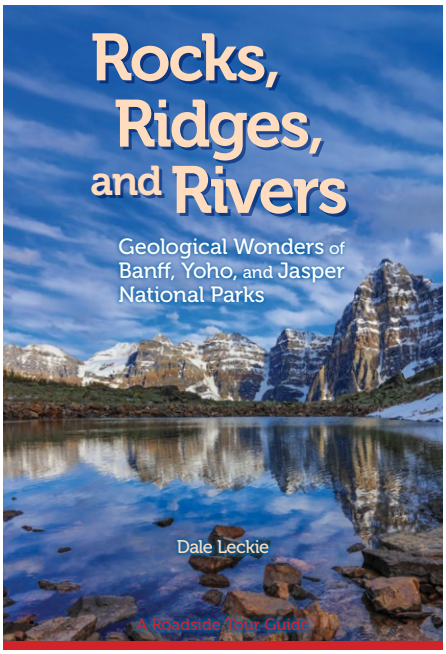
Other data sources available upon request

THE SCENIC WONDERS OF CANADA'S MOUNTAIN PARKS ARE ALL ABOUT THE GEOLOGY

Dale Leckie, Ph.D., P.Geol.

Banff, Yoho, Jasper, and Kootenay National Parks, with Mount Robson, Mount Assiniboine, and Hamber Provincial Parks, make up the UNESCO Canadian Rocky Mountain Parks World Heritage Site. These parks are officially recognized by the United Nations for their "rugged mountain peaks, ice fields and glaciers, alpine meadows, lakes, waterfalls, extensive karst cave systems, and deeply incised canyons." The Canadian mountain parks "illustrate active glacial processes taking place along the Continental Divide, where erosion is happening in uplifted, folded, and faulted sedimentary rocks." Simply put – the United Nations has recognized Canada's mountain parks and designated them with very prestigious global status because of their beautiful scenery, which is due to their geology.

Many agree. Parks Canada visitor attendance to the mountain parks has been increasing yearly over the past decade. During 2017 more than eight million tourists visited Banff, Yoho, and Jasper National Parks. These travellers want to be amid, and to appreciate, that spectacular mountain scenery. Visitors come by car, by camper, and by bicycle. They hike the ridges and along the rivers. Tour buses are full, and there are many of them.



With all that in mind, where should you go and what should you stop to see to take in that United Nations–recognized scenery? Following are my ten favourite spots to visit in the Canadian mountain parks, taken from my new book *Rocks, Ridges, and Rivers: Geological Wonders of Banff, Yoho, and Jasper National Parks.*

1. Canyons, caves, and lakes of the Maligne River, Jasper National Park

A spectacular feature of Jasper National Park is the Maligne River system, including its canyons, caves, and lakes. The Maligne River enters the Athabasca River valley as a 90-metre-high hanging valley carved by a glacier, flowing over 365-million-year-old limestones. At Maligne Canyon, multiple waterfalls, potholes, and outlets of underground springs are preserved from what may well be an old and exhumed cave system. The hike along Maligne Canyon, with the waterfalls, deep chasms, and gushing springs, is breathtaking.

Farther upstream, a spectacular and unique cave drainage system at the bottom of Medicine Lake is one of several reasons for the region's designation as a UNESCO World Heritage Site. Medicine Lake rises and falls as much as 19 metres every year due to fluctuations in snowmelt and rainfall. At the bottom of the lake, much like in a bathtub, is a drain (two drains, actually) that try to empty the lake year-round. The river valley that exits Medicine Lake is dry most of the time because most of the lake drains away through its underground cave plumbing system. The water draining from the lake moves downstream through underground caves for 16 kilometres to emerge as a series of gushing springs at the lower end of Maligne Canyon, just above the Athabasca River valley.

2. The immense scale of mountain building from Mount Norquay Lookout, Banff National Park

The viewpoint above Banff townsite at Mount Norquay Lookout gives you a sense of the enormous forces involved in mountain building. The vista is a spectacular panorama across the Front Ranges of the Rocky Mountains. If you want to feel the tremendous vertical and horizontal scale of mountain building, you must go here. From the vantage of the lookout, you can see how the mountains are stacked against one another, much like shingles on a roof.

Looking down, you can see where the Bow River cuts across several enormous thrust sheets. There are Mount Rundle, Sulphur Mountain, and Mount Borgeau, each on separate thrusts. Cave and Basin National Historic Site is located at the junction separating two thrust sheets. Imagine cold snowmelt and rainwater from the mountaintops across the valley, percolating down to 3.2 kilometres' depth, becoming heated by geothermal processes, and then rising as hot water along Sulphur Mountain Thrust to Cave and Basin National Historic Site.

What else can you see? The mountains were uplifted, literally kilometres. Now they are being eroded. Consider the amount of erosion that has taken place. Over the last 55 to 60 million years, between 4.5 and 7.5 kilometres of sediment have been eroded from the mountaintops and valleys in front of you. This does not mean that the mountains were that much higher in the past. Rather, as material is eroded from the mountaintops, they rise up, much as melting icebergs in the ocean are buoyed as they melt.

3. Thermal springs at Cave and Basin National Historic Site, Banff National Park

The viewpoint above Banff townsite at Banff National Park owes its existence to railway workers' encountering an open, steaming vent that led down to a cavern with a pool

of hot water. Snowmelt and rainwater from nearby mountain peaks trickle down to a depth of 3.2 kilometres before being heated and recirculated up a major thrust fault to emerge as hot springs. Water temperatures are 27–47°C at the surface, varying seasonally and at the different springs.

At Cave and Basin National Historic Site, you enter through the main building to see the hot springs pool with glacial till overlain by a layer of travertine flowstone. The thermal spring waters flow at the contact between the travertine and the till. The till has been eroded by the stream flow, and acidic hydrogen sulphide coming out of solution from the spring water corrodes the travertine. The two caves and the outside collapsed cave formed because of stream erosion of glacial till and travertine dissolution by acid gases.

The combination of temperature range and chemistry at the thermal springs has created a unique habitat for the endangered Banff Springs snail (*Physella johnsoni*). This half-centimetre-long snail lives nowhere else on Earth and can be found on the algal and bacterial mats on the surface of the hot spring water.

4. Fossils of the Burgess Shale and the edge of a continent, Yoho National Park

The Burgess Shale fossils in Yoho National Park provide a view into life that existed 505 to 510 million years ago, after a period called the Cambrian Explosion. What is so exciting and unique about these soft-bodied fossils is the preservation of features such as eyes with retinal and brain tissues, livers, hearts, neural tissues, stomachs, and even eggs containing embryos. Many of these fossils are predecessors of species that exist today, including humans. The Burgess Shale was deposited into the comparatively deep water in front of an extensive, shallow-water algal carbonate platform. At this point, animals having jointed limbs allowing them to move had evolved. They could crawl and swim to eat algae, scavenge dead organisms, and prey on living ones. Several organisms were predators, indicated by shells in gut contents, bite marks, and hard, defensive spines on prey species. At that time on land, there was still no life, not even plants.

Today's village of Field, close to the Burgess Shale site, was near the western edge of North America (itself located just south of the equator) half a billion years ago. To the east, towards Lake Louise, was a shallow-water carbonate platform only a few metres deep. At Field, there was a steep underwater cliff 100–200 metres high. Directly in front of this cliff lived the small organisms that were to become the Burgess Shale fossils.

You may want to do the guided hike to see the Burgess Shale fossils high on the side of Mount Burgess. It is well worth the effort. To do so, you must reserve a spot with either Parks Canada or the Burgess Shale Foundation

5. The natural hazard of debris flows at Spiral Tunnels, Yoho National Park

Descending from Kicking Horse Pass, heading westward from the Continental Divide, there are large, earthen and concrete works constructed to contain debris flows that affect the railway and highway. These civil-engineering efforts prevent debris flows from burying or washing out the Trans-Canada Highway or the CPR main line. Debris flows – consisting of liquefied, water-saturated sediment resembling a concrete slurry – can be extremely destructive natural hazards.

Cathedral Mountain and Mount Stephen, on the south side of the highway, rise high above the floor of the Kicking Horse River, where the valley is less than a kilometre wide.

Debris flows and Cathedral Crags. Cathedral Mountain in Yoho National Park. Up to 20 km of material may have been eroded from the tops of these mountains in the last 65 million years. A debris-flow chute comes down from Mount Stephen on the right side of the image. Note the large levees in the shoot constructed to constrain debris flows. Not also the concrete tunnel protecting the railway from these destructive flows.

The debris flows coming down Cathedral Gulch are triggered by meltwater stored in the glacial lakes on and within Cathedral Glacier. Periods of heavy and steady rains on the upwind, westward side of the mountains also trigger debris flows.

The best place to see evidence of the destructive debris flows, and the civil engineering efforts to contain them, is below Mount Stephen along Yoho Valley Road. The concrete tunnel over the railroad and large manmade berms are attempts to constrain the debris flow chute draining the mountain.

6. The Icefields Parkway along the spine of the Rocky Mountains, Banff and Jasper National Parks

The Icefields Parkway is one of the most spectacular and scenic highways in North America, if not the world, especially on a clear, blue-sky day. The Icefields Parkway follows the mountain peaks of the Main Ranges northward from Lake Louise to Jasper, along the Continental Divide, passing by as many as a hundred glaciers, many of which are visible from the highway. The road passes beside wide and narrow braided-river floodplains, narrow entrenched canyons, alluvial fans, and lakes that have been dammed by moraines or alluvial fans. There are rock glaciers, hanging valleys, and large rock slides.

Drive the Icefields Parkway with your eyes wide open to take in all the scenic wonders created by geology. It seems to never end.

7. Recently glaciated splendour at Mount Edith Cavell, Jasper National Park

Mount Edith Cavell is a harsh, rugged, and beautiful mountain environment that was just recently occupied by glaciers. This area is constantly changing. For example:

- Cavell and Angel Glaciers were much more extensive only three hundred years ago. During the 1700s, Cavell Glacier extended to the parking lot, leaving impressive lateral and end moraines.

- In front of lower Cavell Glacier is small glacial lake that formed in 1960. The lake now fills and drains seasonally. In the summer, blocks of ice from the steep front of the glacier calve into the lake.

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- Ghost Glacier is the highest of the glaciers on the north face of Mount Edith Cavell. In 2012 a 20-metre-thick ice block detached from the glacier into the small lake, creating a large surge wave of water. Blocks of ice up to 4.5 metres across and quartzite boulders up to 1 metre across were hurled downstream and a new channel was cut through glacial moraine that dams the lake. Portions of the highway and parking lot were badly damaged.

Mount Edith Cavell. There is so much to see at Mount Edith Cavell. More than a kilometer of the Cambrian Gog Quartzite; receding glaciers including Angel Glacier; Little Ice Age glacial moraines; and modern permafrost with stone stripes and solifluction lobes. That is the record of half a billion years of intermittent activity.

8. Waterfalls are everywhere in Banff, Yoho, and Jasper National Park

The mountain parks are full of water falls, including Athabasca Falls, Maligne Canyon, Mistaya Canyon. Natural Bridge, Sunwapta Falls, and Takakkaw Falls. These cascades are all due to past glaciations. Mistaya Canyon and Sunwapta Falls, for example, were created where rivers flowed over a hanging valley that entered into a larger valley. The Sunwapta River flows into the Athabasca River, creating Sunwapta Falls, which has since eroded a deep gorge into the limestone and dolostone of the Middle Cambrian Cathedral Formation. The Sunwapta River drops about 18 metres over the upper and lower falls, making several 90° bends due to jointing of the rocks. There are impressive potholes up to 1 metre deep.

Athabasca Falls plummets over a 25-metre deep gorge that is only 18 metres wide. The powerful torrents create a backdrop of roaring water and fine mist. During the last glaciation, blocks of quartzite from the highly resistant Cambrian Gog Group were plucked at the base of the ice to form a ridge with a vertical cliff. After deglaciation, the narrow gorge was carved through the quartzite by the river.

9. Permanently frozen ground along Cavell Meadows Trail, Jasper National Park

Cavell Meadows trail is perhaps one of my most favourite hikes in the Rocky Mountains. It takes you above the tree line to meadows, providing outstanding views of Mount Edith Cavell and its glaciers. Periglacial features of patterned ground – stone polygons, stone stripes, and sorted and non-sorted circles – can be seen.

When you get above tree line, look for circular patterns of boulders that are several metres across. The stone stripes are elongate alignments of boulders that extend for up to 10 metres. These features form because of freeze–thaw action that causes frost heaving and seasonal ice within the ground. Watch for solifluction lobes on sloping surfaces along the trail. Solifluction lobes are steep-fronted, vegetation-covered, large, bulbous tongues of sand and silt that make their way downslope by creep and shallow shearing.

10. Edge of the mountains at Mount Yamnuska, Bow Valley Provincial Park

Located east of Banff National Park, Mount Yamnuska provides a spectacular panoramic overview of the abrupt boundary between the Rocky Mountain Foothills and the Front Ranges. Grey limestone cliffs of the Cambrian Eldon Formation were transported 32 kilometres northeastward by fault movement to be placed above the fluvial sediments of the Upper Cretaceous Brazeau Formation. The rocks above the fault are 400 million years older than the rocks below.

The abrupt vertical escarpment is the result of thrusting on the McConnell Fault followed by differential erosion of the resistant Cambrian carbonate sediments and easily eroded Mesozoic sandstones and mudstones to the east. The nearly horizontal thrust is clearly visible at the base of the vertical cliff of Cambrian limestone, overlying the gentle slopes of more easily erodible Cretaceous deposits.

Sand dunes along the Athabasca River. A view of the Front Ranges looking west along the Yellowhead Highway north of Jasper. Jasper Lake (left) and Talbot Lake (right) are separated by sand dunes. The Athabasca River flows through Jasper Lake. When water levels are low, sand flats are exposed, and the sand is transported by the westerly winds.

Several small springs upwell to create a series of ponds along the southward extension of the McConnell Thrust from Mount Yamnuska into Bow Valley Provincial Park. Along Many Springs trail in the park, water comes to the surface at a year-round temperature of between 11 and 13°C and does not freeze in winter. This water originates from precipitation in areas above the McConnell Fault and makes its way down to a depth of ~600 metres. Geothermal heat warms the water before it is circulated upward through a porous and permeable zone along the fault plane.

With all this in mind, go out to explore and enjoy Canada's mountain parks that the United Nations has so rightly recognized because of their natural by beauty. Remember – geology makes great mountain landscapes. Learn why.

Biography

Dale Leckie is the award-winning author of the #1 bestselling *Rocks, Ridges, and Rivers: Geological Wonders of Banff, Yoho, and Jasper National Parks*. (Broken Poplars, 2017). Available at bookstores, CSPG office, and online. Rocks, Ridges, Rivers received grants from the Canadian Geological Foundation and Alberta Historical Resources Foundation. *brokenpoplars.ca*

Dale is a past-President and Honorary Member of CSPG and SEPM (Society for Sedimentary Geology) and is Adjunct Professor in Geoscience at University of Calgary.

GEOLOGY IN YOUR NEIGHBORHOOD

Clint Tippett

Calling all Rock Hounds! Break out your observational skills for a fun Geological contest, where we are calling on you to answer questions related to the following 12 photos. What's on the line? Pride, bragging rights, notoriety, fame... at the very least a good walk about. Please e-mail in your responses to either Travis Hobbs (travis.hobbs@encana.com) or Jason Frank (jfrank@atha.com), and we'll post the answers in an upcoming edition of the Reservoir.

Good luck and have fun!

1. Location, name of fossil, age and significance of surface texture.

2. Location, name of fossil and age.

3. Location, type of structure and origin of rocks used.

4. Location and historical significance.

5. Type of equipment and industrial significance.

6. Location, type of rock and origin of large grain.

(Continued on page 18...)

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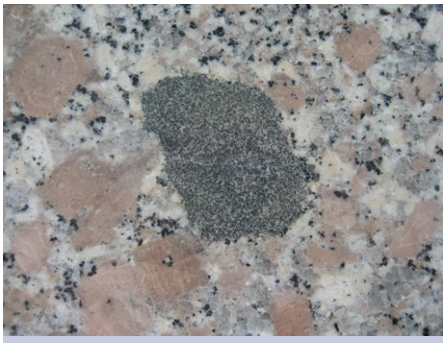
7. Location, rock type, age, analog and significance.

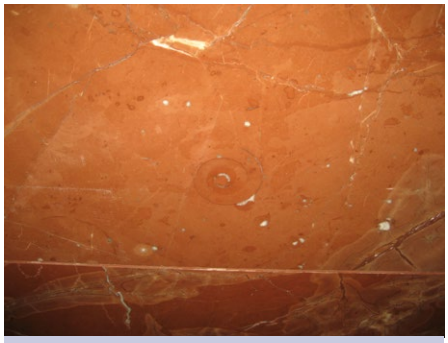
8. Location, formation and nature of the sedimentary structure.

9. Location, type of rock and significance.

10. Location(s), type of rock, formation, age and significance.



11. Location, term for inclusion and reason for varying crystal sizes.



12. Location, name of fossil, age and depositional environment.

Photos collected by Clinton Tippett

EARTHCACHING

Jason Frank, Athabasca Oil Corporation

Introduction

The purpose of this article is to shine a little light on a hobby and game known as Geocaching, and more importantly for our readers a side branch of the hobby known as EarthCaching.

I'm sure to anyone walking by, the scene must have looked a little ridiculous. 2 parents, 2 kids and a dog all face down in the bushes and grasses looking for something...had they lost their keys, wallet, sanity? No, they were Geocaching. Looking for "treasure" without too much of a care what other people thought of them.

What is Geocaching?

Most of you are familiar with the technological marvel that is GPS. It's the satellite system that enables anyone with a GPS device (yes smart phones work) to accurately know their location. Paired with a database, GPS can basically function as a portable map, showing where you are on the surface of the planet compared to many other geographical locations.

I'm going to assume that even more of you are familiar with the concept of a treasure hunt. You have a map with a big X on it, and you have to follow the path in order to find the treasure.

Geocaching is simply a combination of these two things. A geocache is a "treasure" that someone has put out there in the real world. It's usually some type of waterproof container or box. Some are as small as a pill bottle, while others are almost the size of chests.

Caches have been set up all over the world by thousands of people in thousands of places. The official website: www.geocaching.com has over 3 million geocaches in over 190 countries!

Once found, a cache may provide the visitor with a wide array of rewards, including trinkets, messages, or other surprises. The geocacher can then physically log his or her visit and, if they want take a trinket or 'treasure' from the cache and leave one in its place. This is the part that my kids really love!

As you can imagine leaving waterproof containers throughout the pristine wilderness and in some naturally unspoiled areas did not appeal to caretakers of National Parks and other nature preserves, as a result the virtual "EarthCache'' was created.

What is an EarthCache? (taken from earthcache.org)

Started in 2003 through the GSA (Geological Society of America), the EarthCache was designed to educate the 'non-geologists' in our communities. Virtual caches were created to provide the visitor that finds them with new knowledge or insights about the location itself. Instead of leaving or taking anything from the site, visitors get an 'educational treasure' instead.

An EarthCache site is a specific geological location that people can visit to learn about a unique geoscience feature or aspect of Earth. Visitors to EarthCache sites can see how our planet has been shaped by geological processes, how we manage resources, and how scientists gather evidence.

How do I find an EarthCache?

EarthCache sites are listed on geocaching.com. Start by signing up on the website and create a free account. You can search for EarthCache listings using a web browser or a geocaching app. The app makes it easy to find EarthCache locations quickly. If you are using a web browser, use the geocaching website to search for EarthCache listings. Start by clicking "Play," then "Find a Geocache." Enter a location, such as a street address, city, or postal code. Click "Add Filters," and make sure to check the EarthCache box under "Geocache Types." You can un-check the boxes for other geocache types if you are only looking for an EarthCache. You can also add other filters to narrow your search. Your search should bring up a list of EarthCache sites;

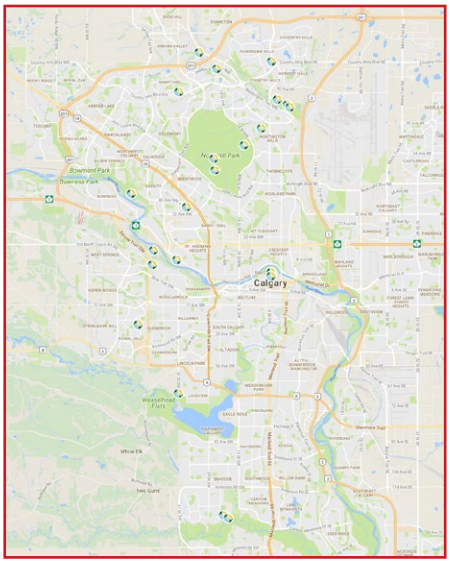


Figure 1: The location of 23 EarthCaches within 15 km of Calgary's Downtown.

on a specific EarthCache in the list to view its full description. This will include the location data for your GPS devise or smartphone, some reading materials about the site, and a list of educational logging tasks that you will need to undertake.

Using Calgary as the centre of my search I discovered 23 EarthCaches within a 15 km radius of downtown (Figure 1, Table 1), two of which are in the downtown core. A quick scan of these caches reveals a vast array of geological topics: geomorphology, mineralogy, sedimentology, structural geology, economic geology to list just a couple.

In fact, each EarthCache that is placed needs to be reviewed and accepted by a review panel before it is published. Topics that are acceptable include:

- Geological materials such as rocks, minerals, fossils, sands, and soils.
- Geological processes such as erosion, weathering, deposition, volcanic activity, and glacial action.

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Geocache Name	Distance	Favorites	Size	Difficulty	Terrain	Last Found	Placed On
Calgary Building Stone Tour: Larvikite EarthCache | GC1EXJV by Shearzone	0.04km E	18	Other	1.5	1.0	04/14/2018	08/04/2008
Calgary Building Stone Tour: Tyndall Limestone EarthCache | GC19HC5 by Shearzone	0.17km S	36	Other	2.0	1.0	04/14/2018	02/20/2008
Wildwood Landslide EarthCache | GC1Q2YR by bish0p	5km W	1	Other	1.5	1.0	05/06/2018	04/15/2009
A Reef in Calgary EarthCache | GC36Q25 by Carretti	5.7km NW	27	Other	1.0	1.0	01/13/2018	10/27/2011
Another Nose Hill Erratic EarthCache | GC17708 by One Bad Ant	6.2km NW	4	Other	1.0	1.5	04/22/2018	11/05/2007
Calgary: Rebirth of the Sandstone City Earthcache EarthCache | GCQSFG by Sleepy_hollow	6.3km W	3	Other	1.0	1.0	05/12/2018	08/15/2005
Edworthy Park - Bow Valley Overview EarthCache | GC11J9V by GeoKs	6.4km W	8	Other	1.0	1.5	05/12/2018	03/19/2007
Nose Hill Erosion Earthcache EarthCache | GC615C6 by Fonty Family	6.8km NW	2	Other	1.5	3.0	05/13/2018	08/08/2015
Nose Hill Glacial Erratic EarthCache | GC119A4 by Sleepy_hollow	6.9km N	15	Other	1.5	2.0	03/24/2018	03/05/2007
Sienna Hills Erratic EarthCache | GC11J90 by GeoKs	7.6km W	16	Other	1.0	1.0	05/11/2018	03/19/2007
Nose Hill Spring EarthCache | GC17NCF by GeoKs	7.7km N	22	Other	1.5	1.5	04/12/2018	11/27/2007
Weaselhead - Elbow River Delta EarthCache | GC11J7A by GeoKs	8.1km SW	10	Other	1.0	1.5	05/06/2018	03/19/2007
Silt, Slump, Slide EarthCache | GC1TEHC by GeoKs	8.5km NW	1	Other	2.0	1.5	05/01/2018	06/08/2009
Rocks Up EarthCache | GC17X0R by pender-cal	8.9km N	5	Other	1.0	2.0	03/24/2018	12/10/2007
A Misfit in West Nose Creek Park EarthCache | GC1B9W8 by oldwolfcub	9km N	5	Other	1.0	2.5	05/06/2018	04/16/2008
Nose Creek Sandstone Quarry EarthCache | GC14NNE by bish0p	9.2km N	13	Other	1.0	1.5	05/06/2018	07/27/2007
Nose Creek Pathway Erratic EarthCache | GC11FPM by bish0p	9.3km N	18	Other	1.0	1.5	05/06/2018	03/16/2007
Erratic Behavour in Edgemont EarthCache | GC1Q1KY by bish0p	10.8km NW	7	Other	1.5	1.0	03/24/2018	04/14/2009
Hidden Valley Erratic EarthCache | GC1Q1M2 by bish0p	11.2km N	5	Other	1.5	1.5	04/16/2018	04/14/2009
Crater Rock EarthCache | GC17857 by Sleepy_hollow	11.3km N	14	Other	1.0	1.0	04/08/2018	11/07/2007
Kincora Erratic - CCARW09 EarthCache | GC1PM86 by Neko&Hiiri	12.4km N	4	Other	1.0	1.5	04/20/2018	04/06/2009
Raven Rocks EarthCache | GC116DQ by GeoKs	13.2km S	12	Other	1.0	1.5	04/20/2018	02/28/2007
Mazama Ash - Calgary EarthCache | GC1RBCZ by GeoKs	13.3km S	7	Other	1.0	1.5	04/20/2018	05/14/2009

Table 1: Listing the 23 EarthCaches within 15 km of Calgary's Downtown.


Bronze EarthCache Master


Silver EarthCache Master


Gold EarthCache Master


Platinum EarthCache Master

Table 2: Details on the EarthCache Master levels.

- Geological landform evolution such as glacial valleys, reverse topography due to rock properties, waterfalls with geological explanations, and use of geological materials like building stones.

- Geological phenomena such as impact craters, geysers, and mineral springs.

- Tools used by geologists, such as index fossils, rocks, and historical geology sites.

Need more incentives to find an EarthCache?

As you find and develop more EarthCaches you can up your 'status' in the Geocaching world. There are four EarthCache Master levels:

- Bronze EarthCache Master, awarded for visiting three or more EarthCaches, which have to be in two or more countries, provinces or states;

- Silver EarthCache Master, awarded for both (1) visiting six or more EarthCaches, which have to be in three or more countries, provinces or states, and (2) developing one or more EarthCaches;

- Gold EarthCache Master, awarded for both (1) visiting 12 or more EarthCaches, which have to be in four or more countries, provinces or states, and (2) developing two or more EarthCaches;

- Platinum EarthCache Master, awarded for both (1) visiting 20 or more EarthCaches, which have to be in five or more countries, provinces or states, and (2) developing three or more EarthCaches.

With summer in full force, and with so many EarthCaches available within our backyard and beyond - there really is no excuse not to take part in this great hobby. I know that my family has enjoyed the treasure hunt, and if you can sneak in a little Geology knowledge, it's never a bad thing! Happy EarthCaching!

BLAST FROM THE PAST

Thank you to Bill Ayrton, Long-Standing CSPG Member, who has provided the content for this issue's "Blast from the Past" page.

Ann Landers: Are geologists "different"? Spouses have stories:

Dear Ann Landers: This letter, my first ever to an advice columnist, was sparked by your column about the geologist's wife who asked, "Are all geologists the very embodiment of all the virtues and qualities that are universally admired in humankind? Have they alone, of all the professions, achieved a state of grace far beyond that ever speculated by history's most hopeful philosophers and theologians?" The answer is *ABSOLUTELY*! My father is a geologist. My three brothers and four uncles are geologists. Geologists *are* a different breed. They are wise, often strikingly handsome, kind to small children and animals, sensitive to the subtleties of everything around them, and when it comes to relationships, well, Mom, my three sisters-in-law, and my four aunts seemed always to have a serene, deeply satisfied look of complete contentment. If only I could have hitched up with one too.

- *A Jealous and Bitterly Resentful Wife of an Engineer*

Ann Landers replies:

Dear Jealous:

I've been swamped with letters from the lucky wives, daughters, husbands, mothers, and sisters of geologists. They've given me a real education, and made me feel a little jealous, too.

Read on:

Portland: Geologists ARE different. And I say "Vive la difference!" I thought maybe I was the luckiest woman ever to have been born, but I have found that other geologists' wives have similar experiences. My geologist husband has more sensitivity and consideration than 10 "normal" men, selflessly making life safe, loving and meaningful for others. I am so lucky to have this man in my life!

Denver: Ann, the best piece of advice you could pass along to your readers is this: if you can't be one yourself, do whatever it takes to associate with as many geologists as you can. My life has been rich, so meaningful, since I divorced the egghead engineer I was married to for 12 years. If I weren't so ecstatic nearly all my waking hours, I would be in despair over all that wasted time. But in retrospect, I would have traded fifty years with "Mr. Pocket-Protector" for just a few weeks of the blissful existence I have with my big lovable rockhound. He has shown me all the richness that life holds. I spend hours just basking in the warmth of his vast knowledge of life, the universe, and everything. He has so much beauty and understanding. And he's always ready to share that gift. He's able to explain the most incredibly complex concepts in a way that helps you understand, and makes you feel just plain good all over. And how can anyone be so perfect, yet so warm and sensitive to the needs of others? Think of the world we would have if everyone were a geologist!

OLD GEOLOGISTS NEVER DIE,

THEY JUSY SIMPLY PETRIFY

CONFERENCE OVERVIEW

With the proliferation of geologists applying Geomodeling techniques, Gaps persist between the applications of Geomodeling, Geostatistics, the software tools and the appropriate practice of those techniques in the broader community. The challenges grow. The meeting gathers world-wide expertise from practitioners, software vendors and Geostatisticians to present and discuss materials to help focus the participants on the path to ensure the continuing success of the Geomodeling community. This event will deliver many levels of exciting technical discussion around innovations, use of effective and efficient geomodeling methods and spark insights. Shared experience is a key. We can bridge the Gap.

Conference Registration Rates:

Member Rate	$1625 CAD
Non-Member Rate	$1825 CAD
Presenter Rate	$1425 CAD
Spouse Rate	$ 290 CAD
Student Rate	$1225 CAD

Conference Overview: (subject to change)

Monday October 8, 2018: Registration & Opening Reception
(night 1 of included accommodation)
Tuesday October 9, 2018: Technical Sessions
(night 2 of included accommodation & food package- no dinner)
Wednesday October 10, 2018: Technical Sessions
(night 3 of included accommodation & food package- Conference Dinner)
Thursday October 11, 2018: Technical Sessions
(check-out & food package)

Check us out at
www.cspg.org/gussow
for more information
and to register today!

GUSSOW 2018: TECHNICAL PROGRAM

Presenter	Title of Abstract
David Garner *TerraMod Consulting*	**Introduction to Closing the Gap III**
Session 1: Reservoir Management and Decision Making	
Session Chairs: Clayton Deutsch & Colin Daly	
Clayton Deutsch *University of Alberta, Canada*	**Actionable Research in Petroleum Geostatistics**
Graham Janega *Canbriam Energy Inc., Canada*	**Geomodelling as a tool for optimizing completions in the Montney Formation**
Jo Eidsvik *NTNU, Gløshaugen, Norway*	**Value of information of time-lapse seismic data for infill drilling decisions**
Guillaume Caumon *Université de Lorraine, France*	**Associating subsurface data with geological rules: on some new methods to address structural, stratigraphic and sedimentological uncertainties**
Enrique Gallardo *Ecopetrol, Colombia*	**Approximate Physics Discrete Simulation of the Steam-Chamber: A tool to embrace Geological Uncertainty in SAGD Reservoir Management**
Pippa Murphy *Velvet Energy Ltd., Canada*	**The importance of a fully integrated geomodel in the simulation of hydraulic fracture geometries, examples from 2 different plays in Alberta**
Colin Daly *Schlumberger, U.K.*	**Advantages of integrating machine learning into property modelling**
Session 2: Integrating Geology in Geomodeling	
Session Chairs: Petter Abrahamsen, Helena van der Vegt, Lisa Stright	
Ingrid Aarnes *Norwegian Computing Centre, Norway*	**Traversing the gap from sedimentary process models to facies modeling**
Helena van der Vegt *Delft University of Technology, The Netherlands*	**From depositional processes to connected geo-bodies using process-based modelling**
Lisa Stright *Colorado State University, USA*	**The impact of bed- to geobody-architecture on subsurface reservoir modeling: Testing hypotheses based on deep-water channel outcrops**
Samuel M. Hudson *Brigham Young University, USA*	**Characterization of High Net-to Gross Fluvial Strata of the Cretaceous Ericson Sandstone Through Outcrop Studies – Dealing with Intrinsic Data Bias at Multiple Scales in the Pursuit of a Representative Geomodel**
Jaime Vargas *Chevron, USA*	**Vaca Muerta Facies Modeling: Application of 3D Seismic Impedance and Sequential Indicator Simulation for Reservoir Prediction in an Unconventional Setting**
Dan Bossie-Codreanu *IFPEN, France*	**New operational modeling methods integrating stimulation complexity as seen in the field**
Olena Babak *Cenovus Energy Inc., Canada*	**Uncovering potential of seismic for reservoir characterization in Canadian oil sands**
Session 3: Multi-scale Data and Multi-variate Modeling in Practice	
Session Chairs: Sanjay Srinivasan & J. Jaime Gómez-Hernández	
Sanjay Srinivasan *Penn State University, USA*	**From Face Detection to Fractured Reservoir Characterization: Big Data Analytics for Re-Stimulation Candidate Selection**
Dario Grana *University of Wyoming, USA*	**Bayesian inversion of seismic, electromagnetic, and production data for rock and fluid property prediction**
Vasily Demyanov *Heriot-Watt University, Scotland*	**Multi-scale hierarchical uncertainty quantification through history matching**
J. Jaime Gómez-Hernández *Universtat Politècncia de València, Spain*	**Ensemble filters vs. ensemble smoothers vs. musical ensembles**
Benham Jafarpour *University of South Carolina, USA*	**Conditioning Facies Simulation from Training-Images on Flow Data**
Steve Lyster *Alberta Energy Regulator, Canada*	**Large-Scale Unconventional Resource Modelling: 3D Modelling vs. 2D Mapping**
Yevgeniy Zagayevskiy *Halliburton Landmark, USA*	**Petroleum Reservoir Characterization with Machine Learning and Geostatistics**

**Technical Program subject to change*

Session 4: Challenging Properties, Workflows and Case Histories	
Session Chairs: Michael Pyrcz, Mohan Srivastava, Matthew Casey	
Michael Pyrcz *University of Texas, USA*	**New Geostatistical Workflows for Modeling Uncertainty for Unconventionals**
Amilcar Soares *Instituto Superior Téchnico, Portugal*	**Integration of seismic reflection and production data in a geostatistical history matching procedure.**
Martin Huang *Imperial Oil Ltd., Canada*	**Fluvial Point Bar Modeling with MPS - Modern Analog Training Images and Application to the Kearl Oil Sands Mine, Alberta, CA**
Alex Boucher *Advanced Resources and Risk Technology, LLC, USA*	**Geostatistics on the Cloud: workflows, strategies and solutions**
Richard Chalaturnyk *University of Alberta, Canada*	**Looking Beyond Flow in DFN's for Caprock Integrity Assessments - Deformation Matters!**
Yamina Aimene *FracGeo, France*	**3D Planar Frac Design Using Inputs from Full 3D Geomechanics and Geostatistics**
Dimitri D'or *Ephesia Consult, Belgium*	**Opening new horizons in petroleum geostatistics: the SPDE approach**
Session 5: Modeling uncertainty: what is next?	
Session Chairs: Claude Scheepens & Emmanuel Gringarten	
Arne Skorstad *Emerson/Roxar, Norway*	**Uncertainty modeling – from sequential silos to integrated approaches**
Yann Dexcote *Shell E&P, USA*	**The business case of carrying multiple interpretations through iterative workflow across disciplines in the brownfield space: an example from a Deepwater field**
Claude Scheepens *ConocoPhillips, USA*	**Lessons learned from dynamic ranking of 3D geological models**
Céline Scheidt *Stanford University, USA*	**Bayesian Evidential learning: Reformulating the prediction problem**
Sarah Vitel *Chevron, USA*	**Updating probabilistic forecasts with new data without updating reservoir models**
Jef Caers *Stanford University, USA*	**Quantifying structural uncertainty using level sets with stochastic motions**
Emmanuel Gringarten *Paradigm, USA*	**Modeling uncertainty: what is next?**
Posters	
Rhonika Kaplan *Chevron, USA*	**Have you validated your static model with seismic lately?**
Thomas G. M. Jerome *GMDK, Canada*	**Closing the Gap… by codifying what efficient team work should be in geomodeling projects**
Sasan Ghanbari *Emerson/Roxar, Canada*	**Model Driven Interpretations**
Yamina Aimene and Catalina Luneburg	**Mechanical versus kinematic modeling of folded geologic structures, their stress/ strain fields and fracture distributions**
Luke C. Johnson *Cognitive Geology, Scotland*	**De-standardizing Variograms**
Mahshid Babakhani *Alberta Energy Regulator, Canada*	**Uncertainty Analysis in Geological Surface Modelling (Duvernay and Leduc Formation Case Studies)**
Hojjat Khani *University of Calgary, Canada*	**The Use of Multiple-point Geostatistics and Probability Perturbation for Modeling and History Matching Complex Fracture Networks in Tight Formations**
Dimitri D'or *Ephesia Consult, Belgium*	**Improved non-stationary Pluri - Gaussian Simulation**
Daniel Otoo *University of Manchester, UK*	**Applying forward stratigraphic modeling approach to enhance facies characterization and fluid mobility prediction in geological models of basin floor fans**
Sochi Iwuoha *University of Calgary, Canada*	**Pore-scale variability and fluid distributions in Montney Formation: New insights from three-dimensional reservoir characterization and modeling**
Xingjun Gao *Petrochina, China*	**Digitalized Construction Methodology of the Complex-shaped Lateral Accretion Surface for Geomodeling of Point Bar in Meandering River**

Technical Program subject to change

UPCOMING EVENTS

Reservoir Geology of the Montney Formation from analysis of flowback and produced fluids, petrophysics and lithofacies analyses

SPEAKER

Marc Bustin, Ph.D., P. Geol., FRSC
| University of British Columbia,
Department of Earth, Ocean
and Atmospheric Sciences

Time: 11:30 am doors open
Date: September 18, 2018
Location: Marriot Hotel,
Kensington Ballroom
110 9 Ave SE, Calgary AB T2G 5A6

CSPG member ticket price: $44.50+gst
Non-member ticket price: $55+gst
Please note: The cut-off for ticket sales is 1:00pm, five business days before the event. September 11, 2018.

ABSTRACT

R.M Bustin, A.M.M. Bustin, and J. Owen

Detailed analysis of fluids and solids mineralogy and fabric from flowback waters from fifty Montney Formation horizontal well completions in Western Canada, when coupled with petrophysical and lithological analysis of core, provides insights into the reservoir geology, which in turn enables strategies for optimising well completions, production, and well surveillance.

The chemistry and volume of flowback fluids following well completions is a complex product of the mixing of connate water and completion fluid and fluid-rock interactions that includes precipitation and dissolution of minerals, ion exchange, imbibition, and diffusion/osmosis. In general, the chemistry and volume of flowback waters from Montney completions varies with the completion program, reservoir lithofacies, depth of burial, and hence geographically and stratigraphically. In detail; however, the flowback volume and chemistry varies with a plethora of variables most of which have multicollinearity. These variables include, completion fluid chemistry, number of stages, shut-in time, surface area of the fracture network/stimulated reservoir volume, length of flowback period, connate water chemistry, and ambient stress field.

The cumulative volume of flowback fluid from Montney completions ranges from about 15% to 30% of the volume injected. The proportion of connate water in the flowback water, based on conserved element and isotope analyses, varies from about 10% to 60%, and the proportion of connate water increases with time of flowback. The total dissolved solids (TDS) of Montney flowback fluids range up to 230 000 mg/L, with Cl and Na ions accounting for about 75% to 95% of the total dissolved solids. Other major ions are Ca, K, Mg, Sr, and locally SO4. With cumulative flowback, the TDS and most ions, for all wells, increases linearly, although the rate of increase varies between wells, and with stratigraphy, lithofacies (parasequence), and geographic area. Deviation from the

(Continued on page 26...)

(Continued from page 25...)

linear increase in TDS and conserved elements with cumulative flowback, reflects opening or closing of the fracture system(s) with declining pore pressure, variation in connate water chemistry and reservoir geology along laterals, and/or fractures that have grown out of zone. Geochemical modeling also indicates that the ions that deviate from the linear mixing model are impacted by fluid-rock interactions including precipitation, dissolution, and/or ion exchange reactions. Reservoir surveillance using geochemical models coupled with analysis of the flowback and produced fluids provide a means of predicting and mitigating against salting and scaling in the reservoir, due to dehydration of saline connate water during gas production.

The mechanics of mixing between completion fluid and connate water is complex and poorly understood. Analysis of connate water and fluid saturations indicate that most of the unconventional Montney Formation is below irreducible water saturation. Yet the isotopic data indicates that a significant proportion of the flowback is connate water, even though the total volume of water recovered is generally much less than 30% of the total volume injected. Imbibition experiments and measures of wettability indicate the Montney has mixed wettability, but is preferentially oil wet. The spontaneous and forced imbibition/osmosis of drilling and completion fluids results in significant fracture skin damage, resulting in a decreased relative matrix permeability by up to two orders of magnitude. In addition, the imbibed completion fluid, depending on composition, may weaken and 'soften' the fracture face promoting proppant embedment, early collapse of non-propped fractures, and creation of fines, which in turn may plug the proppant pack and stabilise emulsions.

The variably large proportion of completion fluid remaining in the reservoir after flowback is a product of the low initial reservoir water saturation, the increase in capillary pressure of imbibed completion fluids due to fluid-rock interactions, and much lower differential pressure during flowback than during completions.

BIOGRAPHY

R. Marc Bustin is a Professor in the Department of Earth and Ocean Sciences at the University of British Columbia and president of RMB Earth Science Consultants. Bustin received his BSc and M.Sc. degrees from the University of Calgary and his PhD from the University of British Columbia.

Bustin is an elected Fellow of the Royal Society of Canada and a registered professional geologist in the province of British Columbia.

CSPG STRUCTURAL DIVISION TALK

Fracture characterization and vugular porosity distribution in Devonian carbonates using image logs and core data

SPEAKERS

Dragan Andjelkovic, Hakima Ali Lahmar, Gabriel Garcia Rosas (Schlumberger)

Simona Costin & Becky Rogala (Imperial Oil Limited)

Time: 12:00 pm
Date: Thursday, September 6th 2018
Location: Schlumberger Palliser One Building
200, 125 - 9th Ave SE, Calgary

ABSTRACT

Resistivity borehole images (FMI) were acquired in a series of wells drilled in the Devonian Elk Point and Beaverhill Lake Groups, in oil sands leases in NE Alberta. The data were used for characterization of fractures and porosity systems in these formations, and in particular to identify zones suitable for water disposal. Since the images were of excellent quality, the geological data derived could be interpreted with a high level of confidence.

The borehole image analysis shows that the Keg River Formation contains substantial porosity heterogeneity, which varies spatially due to the presence of natural fractures and vugs. The objective of this study was to characterize and quantify this heterogeneity, using FMI images, and validate the results with core data (Fig 1).

Another aim of this study was to examine if fractures exhibit regional systematic trends, or if they are more localized and random. Cross cutting relationships of the fracture sets and vugs were examined, in order to determine relative chronology of events.

Two main fracture cluster intervals were identified within the Keg River and Waterways Formations, dominated by partially open non-systematic fractures. Fracture intensity curves in the Elk Point Group show values between 10-20 fractures per metre. The average total vugular porosity (VISO) estimated from image logs is 2%, within certain discrete depth intervals, and can be attributed to the presence of connected vuggy areas and fractures. The heterogeneity analysis show that the base of the Keg River Formation is most suitable for water disposal. This talk presents the results within a regional context of fracture orientation and distribution within the Devonian.

BIOGRAPHY

Dragan has been with Schlumberger Canada for 11 years working as a borehole geologist. His previous experience includes 10 years in the mining industry in Ontario and eastern Canada. He holds a masters in geology from the University of Belgrade.

Hakima has been with Schlumberger for 12 years working in various parts of the world, including Algeria, Kuwait and Canada. She holds an engineering degree in petroleum geology .

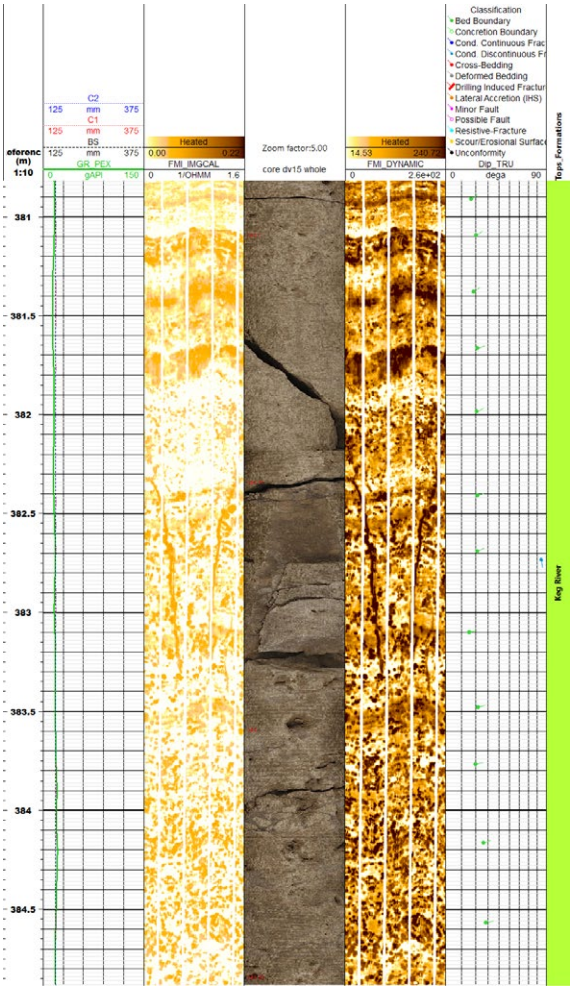


Fig. 1. An example of partially open fractures and vuggy facies, as seen from both the FMI image and core.

Fall 2018 Field Trip: A Structural Excursion along the Rundle Thrust in the Front Ranges, Canmore, AB

Field Trip Leaders: Francois Tremblay, P.Geo. and Leena Markatchev, Geologist
With contributions from Dr. Gerry Reinson

Saturday, September 22, 2018

REGISTRATION IS REQUIRED FOR THIS EVENT

Register by visiting www.cspg.org/structural

The Rundle Thrust Sheet is composed of Cambrian to Triassic rock thrust on Mesozoic shales, sandstones and coals. In the lower part of the thrust sheet, several faults complicate the stratigraphy. A section of Cambrian and the Fairholme Group strata appear to have been thrust upon an additional section of the Fairholme Group. This trip aims at recognizing the different faults making up the Rundle Thrust and reconciling its structural architecture.

The trip consists of a strenuous hike on the southwest side of the Bow Valley along the Rundle Thrust in Canmore. We will gain exposure to key outcrops by venturing up several gullies for short distances. Participants will have to be a in good physical condition and willing to get their feet wet (depending on water levels).

Figure 1. Folded Sulphur Mountain Formation in the footwall of the Rundle Thrust

Figure 2. Panorama of the Rundle Thrust Sheet in the Bow Valley at the Town of Canmore

Logistics:
The trip is weather dependent, and if the forecast is poor it may need to be postponed. The group will meet at a prespecified location in Canmore and start hiking at 9am. We will aim to return to the cars at 5pm. Participants have to cover their own food (breakfast/ lunch).

Registration:
The trip will be limited to 20 CSPG members. For those that are not able to make it, we will try and organize a summary and discussion session for one of the regular lunchtime talks.

To register visit:
www.cspg.org/structural

What to Bring:
Daypack, sunscreen, 2 liters of water, your own food, pencil, notebook, sturdy hiking boots and a helmet.

Optional: hiking poles, sun-glasses, and layered clothing appropriate for the weather conditions.

Elevation Gain and Distance:
Approximately 7.5km roundtrip and 650 meters elevation gain.

ROCKS 101 – BACK TO BASICS

The annual CSPG Core Conference was once again a success, held at the world class AER Core Research facility May 10-11th, 2018 here in Calgary. Our focus this year was to challenge delegates to get back to the rocks and refresh their current understanding, so that new opportunities are discovered or new approaches to existing plays can be used. This year's theme, Rocks 101; Back to basics, highlighted the challenges in analysis and interpretation all Geoscientists strive to navigate. With unconventional plays continuing to evolve as critical energy sources, as well as the enduring nature of many of our existing conventional reservoirs, our industry is challenged to continue to unlock additional potential by revisiting the rocks and extracting new ideas to find opportunity where others have not.

This year's conference had a total of 750 registered attendees, and attracted a great deal of attention and conversation around some of the industry's hot spots in the Montney, Duvernay, Cardium, and Charlie lake plays. As well as highlighting new learnings and applications in the Oil Sands, Viking, Falher and Carbonate plays throughout our prominent basins. This year's program consisted of twenty one presentations from all across Canada, with an added international twist from Turkey. The breadth of knowledge presented this year was outstanding. Delegates were able to take away new and different ideas that they can apply directly to their day to day work, re-connect with old colleagues and make new connections.

Core Conference would not have been possible without all our sponsors; Tourmaline (Title sponsor), AGAT Laboratories (for an always great core meltdown), Weatherford (delicious BBQ lunches), Core Laboratories (for keeping us happy with coffee and sweets), Loring Tarcore and DigitCore, Reservoir Group, Rockhound Advisory Corp, Freehold Royalties, Enersoft, Freeman Audio Visual and the Alberta Energy Regulator, for which we are extremely grateful for their ongoing support. We would also like to extend our thanks to the CSPG staff, especially Candace Jones for organizing the logistics of the conference, all members of the organizing committee, and Ashley Moisson and the staff at the AER. Finally, many thanks to all of the fantastic presenters, without which we would not have had the outstanding technical content and program to share with all our delegates.

We would like to congratulate this year's Core Conference Award winners:

Best Core Presentation

Gord Stabb & Michael Webb

Abstract Title: ***Geologic Considerations of shallow SAGD Caprock; Seal Capacity, Seal Geometry and Seal integrity, Athabasca Oilsands, Alberta Canada***

Best Student Core Presentation:

Sarah Schultz

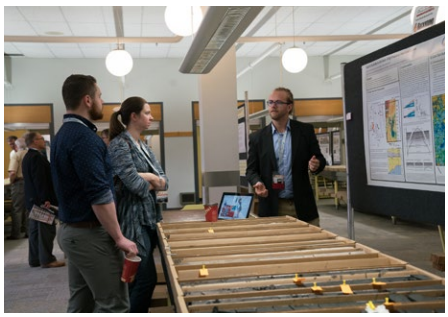
Abstract Title: ***Delta Accumulation an Along Strike Facies Variations across a Structurally Controlled Area of the Viking Formation, Central Alberta***

Next year will mark the 50th year of the CSPG Core Conference! We look forward to another strong technical program with a diverse and always interesting display of core and talks. If you are interested in submitting an abstract, email coreconference@cspg.org for more information. Mark your calendars for May 16 & 17th, we look forward to seeing you all there!

2018 CSPG Core Conference Planning Committee
Adam Fraser – Husky Energy
Christa Williams – Trident Exploration Corporation
Kelsea Pedersen – Cenovus Energy
Brent Kuntz – Cenovus Energy
Ray Geuder – Independent Geoscientist
Liese Mclaren – Consultant
Chad Bobier – Consultant
Tom Plumridge – Rife Resources
Kelty Latos – ConocoPhillips

Per Pedersen (in green)

Pavel Kabanov (in the red shirt)
Christa Williams (blond hair beside Pavel)



Lucian Rinke – Hardekopf (in the suit jacket)

All the photos were taken by Michael Le.

2018 STUDENT INDUSTRY FIELD TRIP

By: Jesse Schoengut and Vanessa Huey

The student industry field trip (SIFT) was first run in 1977 as a means to introduce geology students from across Canada to the Canadian petroleum industry. Building on the 40 year tradition of SIFT, we had 32 students from 30 different Universities across Canada to Calgary attend SIFT from April 30 to May 13, where they were given a jam-packed , two week crash course in the role of an oil and gas geologist. In attendance was a combination of second-, third-, and fourth year students, with a variety of geologic backgrounds: soft rock, hard rock, hydrogeology, geological engineering, and even a geophysicist. Over the two weeks, the students attended lectures and seminars taught by industry experts, went on field trips to Dinosaur Provincial Park and through the Rocky Mountains, and had the opportunity to attend both GeoConvention and the Core Conference.

Bill Ayrton Award for the team with the best technical presentation: Alexandra Grey, Kushmeet Gill, Bill Ayrton (presenter), Emily Archibald, and Ruth Orlóci-Goodison (Photo credit: Colin Etienne)

For the duration of SIFT, the students are teamed up to form their own oil and gas exploration companies, and tackle the Exploration Game. Throughout the game they use real well data to explore and exploit the complex play in the area. For many individuals, this is the first time that they have ever had to interpret a well log! They are not only forced to use their geological skills to map and correlate the pay intervals, but must also navigate their way through land sales, drilling and recompleting wells, and swap/farmin deals with other companies. For the majority of the students, this is their first exposure to the role of an Exploration Geoscientist, as is quickly evident after the first land sale where sections sold for ~$100,000/ha! At the end of the two weeks, they present their geological interpretation, play overview, and financial summary to their Board of Directors – a panel of industry professionals – and awards are presented to the team with the best technical presentation (the Bill Ayrton Award) and the best financial standing (the Larry Strong Award). We would like to congratulate our Technical Award winning team ONEX: Ruth Orlóci-Goodison (Lakehead University), Khushmeet Gill (University of Waterloo), Alexandra Gray (University of New Brunswick), and Emily Archibald (Brock University), and our Financial Award winning team (who were able to turn a $170,000 profit!) SACKs: Austin Goncalves (University of Manitoba), Charlotte Stone (Laurentian University), Sean Freeborne (St. Francis Xavier University), and Stephanie Quach (Simon Fraser University).

SIFT would not be successful without the help and hard work of our volunteer committee. Planning for the following years SIFT begins immediately when the current year's ends, and organizing the different speakers, booking accommodations and meals, and coordinating the activities and movements of 32 students for 2 weeks is a huge task. We were fortunate enough to have over 30 people on our planning and organizing committee, and an additional 40 people volunteer to give lectures, seminars, run the field trips, and come out at night to help the students at the Exploration Game. It's a fortunate position to be in when the list is too large to thank each one of them individually, but we want everyone to know we really appreciate all the hard work they put in.

SIFT would also like to thank the financial and in-kind support that was received again this year from numerous companies and individuals. The majority of SIFT is sponsored by the CSPG Foundation and their goal of supporting University Outreach programs that help to advance and raise awareness of geoscience in the petroleum industry. Financial support from industry was again strong this year, and we would like to thank Imperial, Husky, Devon, Nexen, Canbriam, CNRL, Repsol, Birchcliff, and Saguaro for their help in funding the program. The University of Calgary made a significant in-kind donation of allowing us to use their classrooms and meeting rooms for

the Exploration Game. We would also like to thank Nexen, Grizzly, and Tangle Creek for participating in the job program this year.

It is always rewarding to hear students talk about how participating in SIFT changed their outlook on a career as an oil and gas Geoscientist, or how it changed their perspective on classes to take the following year in University. For many of the students it is their first time gaining a "real world" outlook on their potential future career, and the opportunity to network and ask questions and mingle with industry professionals is invaluable.

The 2018 SIFT committee would again like to thank all of the volunteers and sponsors, and congratulate all of the 2018 SIFTee's for the hard work and effort they put in over the two weeks – we hope that some of the things you learn stick with you throughout your career, and that they friendships you made will last for years to come. Vanessa and I would also like to wish Colin Etienne and Nicole Hunter luck as they take over as co-chairs for SIFT in 2019.

Larry Strong Award for the team with the best financial standing:Austin Goncalves, Sean Freeborne, Larry Strong (presenter), Charlotte Stone, and Stephanie Quach (Photo credit: Colin Etienne)

Students on field trip to Dinosaur Provincial Park (Photo credit:Vanessa Huey)

UNIVERSITY OUTREACH – 2018 LECTURE TOURS

The CSPG University Outreach Committee would like to thank this year's volunteers for their time and thoughtful insights offered to Geoscience students across Canada. Three speakers provided lectures for the 2018 CSPG University Lecture Tour, Sasan Ghanbari, P. Eng., visited Western schools; Nikole Bingham, PhD, P.GEO, visited Central schools; Bryce Jablonski, MSc, P.GEO, visited East coast schools.

The committee requested that lecturers discuss the current climate of the oil and gas industry, deviating from the technical presentations that generally provide students with insight into specific projects the speakers have worked on. This new approach offered students a fresh perspective from experienced industry professionals on how to attack looking for work upon graduation.

SASAN GHANBARI - WEST COAST LECTURE TOUR

Sasan toured the West coast, visiting Simon Fraser University, Mount Royal University, University of Calgary, and the University of Alberta of which he is an alumnus. His lecture included discussion around what has changed in the geoscientist profession, survival tips, and the importance of broadening your knowledge by gaining understand of multiple disciplines. The reaction from students was very positive, with lots of appreciation for the advice on industry, general career tips, and finance. Sasan has been working with Roxar Software Solutions (a business unit of Emerson Automation Solutions), since 2004.

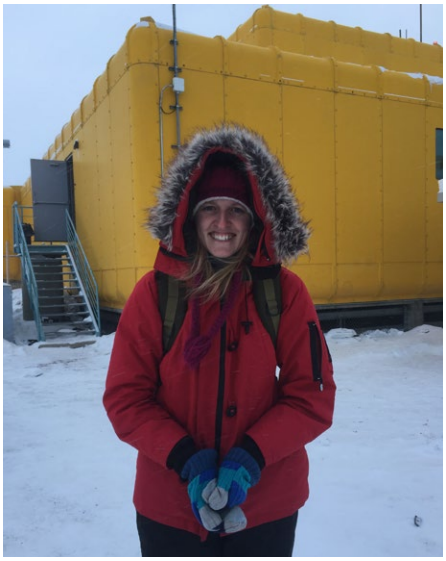
"Talk was a very honest view on what we as students can expect after graduation. It was a refreshing alternative to the technical talks we are used to"

"It's great to hear someone talk bluntly about the industry and the ups and downs. Sasan didn't sugar coat anything, instead he gave us valuable advice on how to succeed in our chosen discipline"

"I think I learned more about finances in that one talk than all of my undergraduate years"

"I sincerely hope CSPG will organize a similar talk again in the future"

Sasan Ghanbari, Photographer is unknown because it was a personal photo submitted by Sasan.



Nikole Bingham, Photographer is unknown because this was a personal photo submitted by Nikole.

NIKOLE BINGHAM – ONTARIO AND WESTERN QUEBEC LECTURE TOUR

Nikole Bingham-Koslowski was asked by the Canadian Society of Petroleum Geologists (CSPG) to take part in their University Outreach Lecture Tour and speak to schools in Ontario and western Quebec about her experiences as an early career geoscientist. She presented lectures at the University of Western Ontario in London, Ontario on February 9th, at Queen's University in Kingston, Ontario on February 12th, at McGill University in Montreal, Quebec on February 13th, at Carleton University in Ottawa, Ontario on February 14th, and at the University of Toronto in Toronto, Ontario on February 15th. She spoke to the students about her choices in academia, her industry internship experience, her struggles with unemployment, as well as her current research with the Geological Survey of Canada. Her talk offered advice on finding a job, staying relevant during an industry downturn, and current student opportunities available through the Geological Survey of Canada. Nikole capped the tour off with a visit to her high school, Thomas A. Stewart Secondary

School (TASSS), in Peterborough, Ontario on February 16th. She spoke to five Grade 10 science classes (over three periods) about basic principles of geology with a focus on interpreting ancient environments from sedimentary rocks. Nikole also addressed two Grade 12 university science courses about life in university and shared with them her experiences from school, through unemployment, to working at the Geological Survey of Canada. Taking part in this tour provided Nikole with an incredible opportunity to give back to the schools that helped foster her love for science (TASSS, Queen's, and Western in particular) and for that she is very grateful. With the support of the GSC and CSPG she was able to connect with students and hopefully offer encouraging and useful advice as they embark on their own career journeys.

Bryce Jablonski, Photo taken by Grant Wach

BRYCE JABLONSKI – EAST COAST LECTURE TOUR

A familiar face at the CSPG, Bryce Jablonski of Devon Energy took his invaluable career advice on the road in winter 2018, lecturing at Memorial University in St. John's, Dalhousie University in Halifax, Acadia University in Wolfville, St. FX University in Antigonish and UNB in Fredericton. Taking a practical approach to the energy industry, Bryce spoke frankly about the past 10 year's record high oil prices and depressed lows, discussed how transport capacity and strict and necessary environmental regulations result in the sale of Canadian oil at discount about challenges he has faced in his own career. Additionally, he explained that geology is in the midst of a data revolution, as new geoscience software allows for unprecedented data collection and analysis. Building on these factors in the changing game of petroleum geology and the realities facing students, Bryce advised on building blocks students can focus on today that will help them create a toolkit to improve their chances of success in an increasingly competitive Canadian Oil Industry. With rave reviews from both professors and students alike – Bryce's talk no doubt left a lasting impression and advised students to up their quota of technology, economics and data analysis skills while they still have the resources at their fingertips in university.

Photo taken by Grant Wach

MEDAL OF MERIT 2016 - MARK BARTON

Submitted by Ross Kukulski – Chair Medal of Merit Committee

As specified in CSPG bylaws the Canadian Society of Petroleum Geologists Medal of Merit is awarded annually for the "best paper related to Canadian petroleum geology" published during the previous publication year, in this case for peer reviewed papers published in 2016. The medal is important recognition of excellence in Canadian petroleum geoscience research and writing and has been awarded since 1952. The paper awarded the Medal of Merit for 2016 was written by Mark Barton and is entitled "The architecture and variability of valley-fill deposits within the Cretaceous McMurray Formation, Shell Albian Sands Lease, northeast Alberta". The paper was published in the Bulletin of Canadian Petroleum Geology, Vol. 64, No. 2, p. 166-198 (June 2016).

This paper provides a detailed interpretation of the McMurray Formation in and around the Albian mine near Fort McMurray, Alberta. The study includes over 2500 cores, well logs and numerous kilometer scale mine outcrop exposures that allow for excellent sedimentologic and stratigraphic control within the ~200 km2 study area. The author uses facies associations, stacking patterns and unconformities to divide the middle-upper McMurray Formation into 4 packages. Broadly, inclined estuarine deposits dominate older strata and flat bedded nearshore marine and coastal plain deposits increase upwards. Significant stratigraphic, sedimentologic and spatial complexity within these packages is documented and clearly interpreted with paleogeographic maps. The geologic complexity is interpreted to be the result of incised valley cutting, stacking and filling with an overprint of variable tidal, fluvial and wave processes affecting each package through time.

This work is an important contribution to Canadian petroleum geology as it provides a thorough description and interpretation of the geologic setting and stratigraphic complexity of a portion of the McMurray Formation currently being produced with open pit mining. This detailed study of a data rich area is not only useful for other nearby mining projects, but it is important for the broader paleogeographic and sedimentologic study of the McMurray Formation, as well as other shallow marine and fluvial systems worldwide.

Mark Barton obtained his PhD from the University of Texas at Austin, in 1994 where upon graduating spent four years at the Bureau of Economic Geology working on outcrop and reservoir characterization studies in Utah, West Texas, Argentina, and Brazil. In 1998, Mark joined Shell Exploration and Production in Houston, Texas, as a research geologist responsible for investigating the reservoir architecture of baffles/ barriers and their impact on fluid flow. In 2012, he took a geologic advisor position in Calgary with Shell Canada, and had the opportunity to describe and map the stratigraphy of oil sands in the Peace River and Athabasca regions of Alberta. In 2016, he returned to Houston to work as a development geologist for Shell Exploration and Production on unconventional assets in the Haynesville and Marcellus Formations.

H. M. HUNTER AWARD AWARD CITATION - TRAVIS HOBBS

Travis Hobbs is an undergraduate from the University of Calgary and holds a Masters in Geology from Simon Fraser University. Professionally, he has worked both domestically and internationally for 19 years in the Oil & Gas industry, and is currently celebrating 15 years with Encana. Industry roles have included development, exploration, management and business development.

Travis has been an active CSPG volunteer for much of his career and is currently a Technical Editor for the Reservoir. Prior to the Reservoir, Travis has held previous roles on convention committees and was the Chair of Continuing Education committee for six years. As free time permits, Travis enjoys cycling, cross-country skiing and teaching his two daughters violin.

CSPG FOUNDATION

CSPG
Canada's Energy Geoscientists

cspg.org

30th Annual CSPG/CSEG/CAPL 10km/5km Road Race and Fun Run

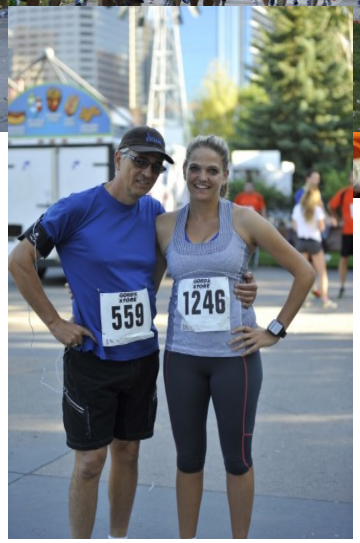
Thursday, September 20, 2018

Register NOW!

To register please go to www.cspg.org

Member Rate: $40+gst | Non-member rate: $50+gst | Student & In-Transition rate: $25+gst

Join us on race day on an out-and-back course along the beautiful Bow River pathway. If you are looking for a competitive race or just want to have fun, come join us!



H. M. HUNTER AWARD CITATION - COLIN YEO, P.GEO.

Colin Yeo is a long-time member of the CSPG and one of its most dedicated volunteers. For more than 4 decades he has and continues to freely give his time to our society and our profession. The CSPG owes it success and longevity to volunteers like Colin. He has participated in committees, chaired committees and has also served as CSPG President. The volunteer legacy Colin has created is an inspiration to all members; he has proven that being a geologist is much more than the rocks it is about being and taking part in the larger community.

Colin is a retired petroleum geologist, having enjoyed a 40 year career with Amoco Canada and Encana Corp. Colin worked in exploration, production and A&D, primarily in Western Canada. He graduated from McMaster University, joined the CSPG in 1974 and became a professional member of APEGA. During his career, Colin has had an opportunity to make discoveries, develop fields, conduct detailed technical work, restructure organizations and processes, supervise great teams and learn new things every day.

Colin was introduced early to the CSPG when his supervisor and mentor, Bob Creed, came into his office and said "As a geologist, you will join the CSPG and, as your boss, you will serve on my CSPG committee". Working on the Public Relations Committee allowed Colin to see how the giants of the Canadian petroleum industry could set aside corporate rivalry and secrecy to work on projects and services for the benefit of all CSPG members. It showed him how the industry worked and he learned of new, exciting plays from discovery to development. Most importantly, he met many great people and forged lifelong friendships that he cherishes to this day.

Colin has volunteered extensively. His service includes:

1977-1980	Public Relations Committee
1982-1992	CSPG History Committee
1986	CSPG Art Event
1995	Chair, Core Conference
1999-2000	Executive Committee, Service Director
2001-2006	Volunteer Management Committee, Member
2006-2008	CSPG Executive Committee
2007	President, CSPG
2008-2012	Assistant Editor, Reservoir
2009-2016	APEGA Council
2013-2014	President, APEGA
2015-Present	Ambassador Program, Chair and Co-Chair
2015-Present	Awards Task Force, Chair and Co-Chair
2017-Present	Geoscientists Canada, Director, APEGA

Additionally, Colin co-authored industry activity overviews in the Bulletin and co-authored Reservoir series on petroleum economics and reserves and resources. He has represented the geoscience profession with APEGA and currently serves as APEGA's Director to Geoscientists Canada.

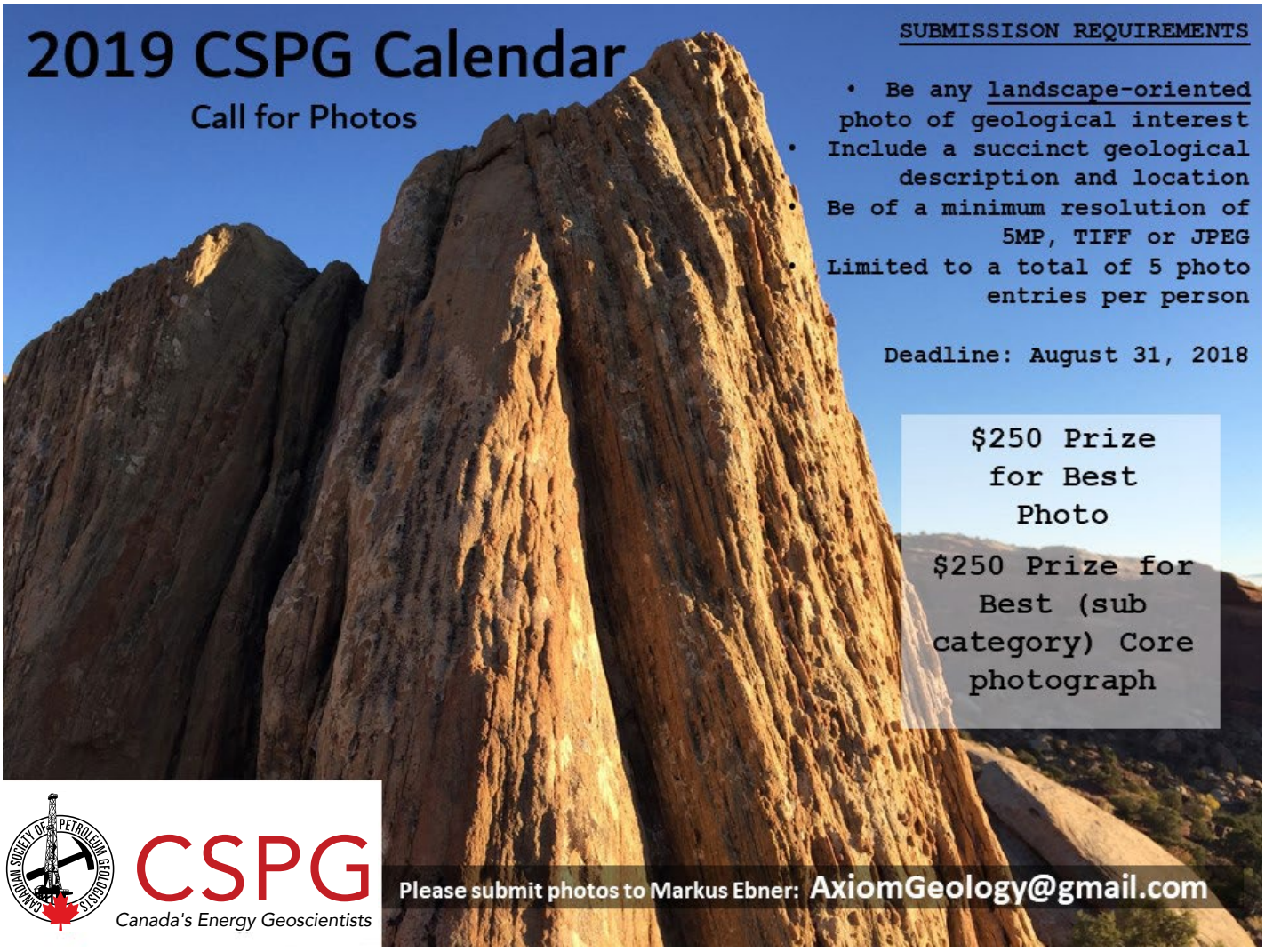
He is also a member of the CSEG, CWLS and AAPG.

Colin understands that the strength and value of technical societies and self-regulating professions is directly proportional to the enthusiasm of volunteers. The professional development and career enhancement that comes from volunteering is an invaluable benefit. He has learned that you get what you give.

RJW DOUGLAS MEDAL CITATION - DAVID MORROW

Submitted by Dr. Andrew Miall, Dr. Graham Davies and Mr. Kirk Osadetz.

David Morrow is an outstanding exemplar of the regional geologist, with a record of significant accomplishments in the mapping and interpretation of the Lower Paleozoic stratigraphy of the northern Cordillera, with a particular specialization in the Devonian System of the Yukon and Northwest Territories. In addition, his field work, modeling and theoretical studies have led to significant breakthroughs in our understanding of the process of regional dolomitization, a subject of first importance in the study of carbonate reservoirs worldwide.



2017 – 28th Annual CSPG Mixed Golf Tournament August 24th, 2018

Mark your calendars, and get ready for the 2018 CSPG Mixed Golf tournament on 24th August at Lynx Ridge Golf course. The four-golfer, best-ball tournament includes a round of golf, meals, plenty of hospitality and good times, and a chance to network with your colleagues and industry sponsors. This year we trust that we return to the typical August golf, where the course is at its finest, with the inviting fairways, smooth greens, spectacular mountains and the ever-beckoning water hazards and sand traps to capture errant golf shots.

This is a fun tournament, with balanced teams that allow all golfers to contribute to the team score, while having a great time enjoying the day and the fellowship of golfing as a team, and developing your network of geoscientists.

Please watch for further announcements, registration forms and information in the CSPG Reservoir, and make sure to register on-line at the CSPG website www.cspg.org. Register early to avoid disappointment!

We thank our previous sponsors from 2017 and look forward to the return of members, guests and sponsors to enjoy the event. A big thank you to our continuing committee members, Darin Brazel, Norm Hopkins, Jeff Boissoneault, Tiffiny Yaxley and co-chair Brenda Pearson.

You can address registration inquiries to David Middleton at 403-296-8844 (dmiddleton@suncor.com), or to Kristy Casebeer, CSPG Coordinator at 403-513-1233 (kristy.casebeer@cspg.org).

If you are interested in sponsoring the tournament this year, please contact

David at dmiddleton@suncor.com

David Middleton & Brenda Pearson
Co-Chairs CSPG Mixed Golf Tournament

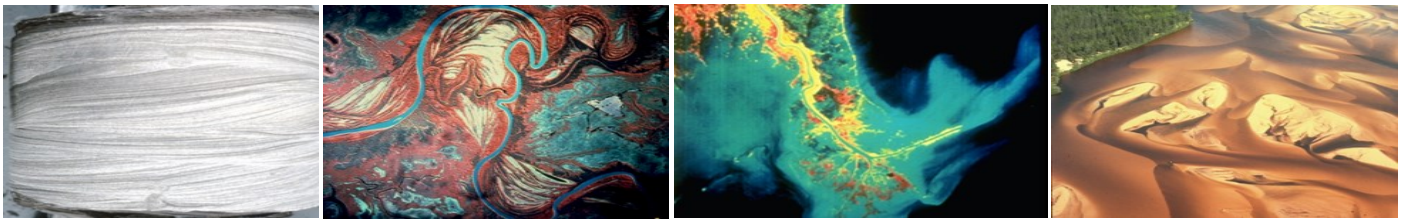
Clastic Exploration School

October 22-26, 2018, Calgary, Alberta

Instructors: David James, Jim Barclay & Andy Vogan

Member rate: $2500 **Non-Member rate: $2700**

Note from the Instructor(s): After a three + decade run, David decided to wind down the school at the close of the October 2017 CSPG class. But as famously stated "There are strange things done in the midnight sun" and that James is back could be one of them. That is because Jim and Andy, together with the CSPG unexpectedly stepped forward, and offered to continue the legacy of the class into the future. It is our hope, that with a cumulated exploration experience of the instructors boosted to well over 100 years, that the class will provide benefits to geoscientists, explorationists and to the CSPG for years to come.



Course Overview

This five-day school has been taught to Calgary, Houston and internationally based geologists and geophysicists for over 30 years and was initially designed as a mandatory course for all junior staff. Over the years it became apparent that more senior G/G (and Engineers) could gain great benefit from re-examining the advances made in facies modeling, traces fossils, sequence stratigraphy and seismic geomorphology. Using a combination of lectures followed by core examination, all clastic depositional settings from the Western Canadian basin that contain hydrocarbons are discussed.

Emphasis will be placed on core description, identifying sedimentary structures, recognizing reservoir facies, sequence boundaries, flooding surfaces and most importantly, thinking geologically. Delegates will be exposed to a vast amount of core (600+ boxes) over 5 days. The ultimate product is the establishment of a robust stratigraphically and facies based exploration model to guide a drilling program. Core correlation and field based exercises with data sets from the Alberta Basin and the international arena will be used to reinforce the concepts. The school concludes with a lecture on the controls of reservoir quality and how they relate to depositional setting and well productivity.

David James

Jim Barclay

Andy Vogan

For instructor biographies and more course information please go to

www.cspg.org