Paycheck Protection Program Loan Approvals of over $150,000 in the Geosciences

The Paycheck Protection Program (PPP) was established to provide small businesses, eligible nonprofit organizations, veterans organizations, tribal businesses, and eligible self-employed or independent contractors with financial assistance to cover business operational expenses such as payroll, rent, utilities, and interest on mortgages.

As of July 2020, 13% of PPP loan approvals for businesses were for loans greater than $150,000 and comprised 72% of total PPP funding. Loan approval data indicates that 654,435 businesses were approved for PPP loans of over $150,000, and that these businesses were able to retain 31.2 million jobs. The number of jobs retained is a low estimate since approximately 6% of businesses in the loan dataset do not specify the number of jobs retained with the corresponding loan approval data.

Data from the U.S. Census Bureau's Small Business Pulse Survey showed the importance of PPP loans in helping businesses weather the economic impacts of the COVID-19 pandemic. Within the industry sectors where geoscientists most commonly work, 76% of small businesses in the mining, quarrying, and oil and gas extraction industry sector, and 69% of small businesses in the professional, scientific, and technical services industry sector had received financial assistance from the PPP by the end of June. These two industries comprised 14% of businesses receiving PPP loan approvals for over $150,000 as well as 10% of total estimated jobs retained.

Mining, quarrying, and oil and gas extraction

Within the mining, quarrying, and oil and gas extraction industry sector, 5,177 businesses received PPP loan approvals for over $150,000 and the estimated number of jobs retained was 220,420. Of the five primary subsectors within the mining, quarrying, and oil and gas extraction industry, 67% of PPP loan approvals went to businesses in the support activities for mining & oil and gas subsector, primarily to support those businesses involved with oil and gas operations support activities. Eighteen percent of PPP loan approvals within the mining, quarrying, and oil and gas extraction industry went to businesses in the nonmetallic mineral mining and quarrying subsector primarily to support those businesses involved with construction sand and gravel mining. In addition, 11% of PPP loan approvals within the mining, quarrying, and oil and gas extraction industry went to businesses in the oil and gas extraction subsector, primarily to support businesses involved with crude petroleum extraction.

Professional, scientific, and technical services

Within the professional, scientific, and technical services industry, PPP loan approval data for subsectors that are primarily geoscience-oriented can be split from other professional, scientific, and technical service subsectors. Geoscience subsectors accounted for 13,678 businesses with PPP loan approvals over $150,000 and 512,939 jobs retained. This equates to 16% of businesses with PPP loan approvals and...
Features

Peer Reviewed - Mining History
Historical Review of the Lovitt Gold Mine Wenatchee, Washington, USA
Graham L. Kelsey, CPG-11497, Roger D. Gill, Lorne Brown

Peer Reviewed - Mining History
Potash Discovery at McSweeny-McNutt #1 Commemorated by Roadside Marker
Peter Smith, CPG-11539

Peer Reviewed - Sustainable Mineral Production
Natural Resources and Sustainability: Geoethics Fundamentals and Reality
David M. Abbott, Jr., CPG-04570

Peer Reviewed - Sustainable Mineral Production
Lost Secrets of Carlin Gold Exploration
John Wood, CPG-10580

Peer Reviewed - Slope Stability
Apparent Cohesion and the Design of Slopes in Sand Quarries
Dr. ir. Robrecht Schmitz, CPG-11917, Dr. ir. Christian Schroeder

Web Sharks and Wright State Students
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Sri Lanka’s Miocene Jaffna Formation Fractured & Karstic Limestone Aquifer: the Sole Source of Drinking Water in the Jaffna Peninsula
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Peer Reviewed - Sustainable Mineral Production
The Retreat from Greenfields Mineral Exploration Was Ultimately Caused by the Growth in the Economic Importance of Open Pit Gold Mining
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American Institute of Professional Geologists (AIPG) is the only national organization that certifies the competence and ethical conduct of geological scientists in all branches of the science. It adheres to the principles of professional responsibility and public service, and is the ombudsman for the geological profession. It was founded in 1963 to promote the profession of geology and to provide certification for geologists to establish a standard of excellence for the profession. Since then, more than 10,000 individuals have demonstrated their commitment to the highest levels of competence and ethical conduct and been certified by AIPG.

The mission of the American Institute of Professional Geologists (AIPG) is to be an effective advocate for the profession of geology and to support its members through activities and programs that support continuing professional development and promote high standards of ethical conduct.
In this issue of TPG we have a group of six peer reviewed papers on various aspects of mining. David Abbott’s special contribution on sustainable mining, Larry Turner’s discussion of Greenfields vs Brownfields exploration, and John Wood’s paper on the ore controls of Carlin-type deposits are all linked by the topic of depletion. David questions the emphasis of the ninth of the Ten Fundamental Values of Geoethics, and takes the International Association for the Promotion of Geoethics (IAPG) somewhat to task because their discussion of ‘sustainability’ does not take into account that individual mineral deposits become depleted, or ‘mined out’. We then have to look for new deposits, with all kinds of consequences for the places where they are sought and may be found. David makes a point that I have not seen made before, and perhaps we are frightened to make it: that without a reliable supply of mineral resources, all of society will suffer. With a reliable supply of resources, the places where they are mined may suffer more than a little. There is a trade-off here that has been ignored: ‘society’ can’t have the resources it needs while the inhabitants of ‘locality X’ have a pristine environment; ‘locality X’ can only have a pristine environment at some cost to a very much larger number of people. Larry’s paper illustrates one reason why: we have focused on exploring for shallow deposits and now that slice of the earth is depleted over wide areas. We either have to go somewhere new, or go deeper, which will bring local problems. John’s paper describes one model that could allow us access to gold deposits at much deeper levels in very young volcanic or extensional terranes. These might be in areas valued for their scenery and recreational opportunities, and mining into rocks above 150°F would bring some real challenges and dangers.

Two additional papers though very different, discuss mining history, and both mention serendipitous discovery: they are Peter Smith’s paper on the commemoration of the Potash industry of New Mexico and Graham Kelsey and others’ paper on the history of the Lovitt Mine in central Washington.

Finally, there is Robrecht Schmidz and Christian Schroeder’s paper on slope stability in sand mines to satisfy the Geotechnical Engineers among us. Robrecht uses the word Geotechnics, a very European sounding word, but much less cumbersome than ‘Geotechnical Engineering’: he discusses the role of cohesion in maintaining slope stability.

We also have a wonderfully exotic report by Barney Popkin on his recent stay in the troubled city of Jaffna, Sri Lanka, to help them with their water problems.

This is my final issue of TPG as Editor: I have really enjoyed all the people I have met through the work: the AIPG leadership at all levels, the authors with whom I have corresponded, and especially the AIPG Staff in Denver, not least Dorothy Combs, as well as Sara Pearson, who besides all her other responsibilities in AIPG has been doing an incredible job on the layout of TPG for the last three years. It is now time to turn TPG over to Adam Heft, who I am, sure, will do a better job than I could ever do!

David makes a point that I have not seen made before, and perhaps we are frightened to make it: that without a reliable supply of mineral resources, all of society will suffer.
The Lovitt Gold Mine, Wenatchee, Washington, USA – Geological and Historical Review

Graham L Kelsey, BS, MS Geology, CPG-11497 (pictured left), Roger D. Gill, BS, MS Geology (pictured right), Lorne Brown, President and CEO of Lovitt Resources Incorporated (LRC)

Introduction

The Lovitt Mine, owned by Lovitt Resources Incorporated (LRC), consist of 614 acres of mineral rights and patented mineral claims. LRC also owns 100% interest in the MacBeth and Golden King patented claims. The patented claims contain the D-Reef gold horizon, which are the company’s current focus for exploration and development. The property is approximately 1 mile south of the city of Wenatchee, located at the intersection of US Highway 97 and US Highway 2 in central Washington state. The Lovitt Mine borders the southeast end of the former Cannon Gold Mine. Lovitt D-Reef is 0.20 miles northeast of the intersection of Methow Street and Squilchuck Canyon Road (Figure 1 and Figure 2). The climate is arid with hot summers and cold winters. The topography is hilly with occasional dissected plateaus. Elevations are from 900 feet to over 2000 feet. The property’s southern area includes steep hills and orchards along Squilchuck Canyon. The property’s northern area consists of steep hills and undeveloped rangeland. (Kelsey, G.L., 2019).

Early Mining History

The first geological record of the Wenatchee area was in 1855 by U.S. Army Major V. Carkeek with the Pacific Railroad exploration crew (Gill, R., 1984a; Gill, R. pers. comm. 2020; Power-Fardy, D., 2009; Woodhouse, P. et.al., 2002). Major Carkeek noted potential for gold in altered arkoses sandstone outcrops near Squilchuck Creek. This discovery was the original D-Reef location of the Lovitt Gold Mine. The Squilchuck Creek discovery was acquired by Frank Morris in 1884. Mr. Morris engaged Carkeek and staked the Golden King and MacBeth claims. In 1894, the partnership built a five-stamp mill and drifted on the claims at a four-ton per day rate, initiating the Gold King Mine. They netted $1,600 from 217 tons of ore, after 60 days of operation (Lovitt, 1954; Tot, L., 1986; Marr, 1990; Power-Fardy, D., 2009; Woodhouse, P. et.al., 2002). In 1895, the claims were acquired by Judge McIntosh, of Seattle, Washington. The Wenatchee Mining Company (WMC) purchased the Squilchuck Creek claims from Judge McIntosh in 1898. From 1910 to 1911, WMC extracted gold and silver from the property. From 1885 to 1911 27,433 tons of gold ore with grades between 0.380 gold ounce per ton and 1.08 gold ounce per ton was shipped to the Asarco smelter.
in Tacoma, Washington (Marr, 1990; Ott, L., 1986; Power-Fardy, D., 2009; Woodhouse, P. et al., 2002). The Macbeth and Golden King claims were dormant until purchased by J.J. Keegan in 1928. In 1934 Mr. Keegan patented the claims through Gold King Mining and Development Company. Between 1938 and 1942, Keegan held a contract with American Smelter and Refining Company (ASARCO) near Tacoma, Washington, which was dropped after shipping several tons. (Lovitt, 1954; Marr, 1990; Ott, L., 1986; Power-Fardy, D., 2009; Woodhouse, P. et al., 2002).

From 1943 to 1946, the Knob Hill Mining Company prospected the area. Knob Hill also shipped 6,200 tons of ore to the ASARCO smelter, but values were not sufficient for Knob Hill’s continued investment. (Lovitt, 1954; Marr, 1990; Ott, L., 1986; Power-Fardy, D., 2009; Woodhouse, P. et al., 2002). In 1948, the property attracted the attention of Wenatchee businessmen. They contacted Ed Lovitt, a Canadian mining engineer, to evaluate the mining potential of the D-Reef. Lovitt concluded the ore body could be economically mined by small, selective shrinkage stopping. In 1949 to 1950, Lovitt formed the Lovitt Mining Company (LMC) and the Wenatchee Mining Partnership (WMP). He raised financing to put the property into production, and purchased the J.J. Keegan properties (Woodhouse, P. et al., 2002). Lovitt sold shares to other investors but retained 51 percent interest. The Gold King Mine was subsequently renamed the Lovitt Mine. The Lovitt Mine became the leading underground gold producer in Washington state and ranked 11th nationally (Brown, L. and Gill, R., 2018; Lovitt, 1954; Marr, 1990; Moore, I.F., 1981; Ott, L., 1986; Power-Fardy, D., 2009; Woodhouse, P. et al., 2002). In 1951, Lovitt signed a $1 million option with the Anaconda Copper Mining Company of Butte, Montana for development of the property. Anaconda developed a 1250-foot level drift and performed core drilling around the D-Reef area. By 1953, they had exhausted the $1 million in work commitment without developing economic ore. In April 1953, Anaconda returned control back to Ed Lovitt. In 1958, Lovitt, his partner Vere McDowell, and the miners discovered a high-grade ore body on the 1250-foot level, dubbed Nellie’s Room. The zone was valued at over $1 million (Brown, L. and Gill, R., 2018; Gill, R., 1984a; Lovitt, 1954; Marr, 1990; Ott, L., 1986; Power-Fardy, D., 2009; Woodhouse, P. et al., 2002). In 1961, Day Mining Company of Wallace, Idaho formed a JV with Wenatchee Mining Partnership (WMP). Day Mining earned a 30% interest, while Lovitt, LMC and WMP retained 70%. A 300 ton per day float mill was constructed and from 1962 to 1967 sulfide concentrate and direct ore were shipped to the Asarco smelter in Tacoma, with some going to the Bunker Hill smelter in Kellogg, Idaho. The shipped gold and silver consisted of 410,482 gold ounces and 625,849 silver ounces from 1,036,572 tons of 0.396 ounce per ton gold and 0.60 ounce per ton silver. The mine was developed from 10 levels consisting of 7 miles of underground workings. The 1150-foot level served as the main haulage. A 32-degree inclined winze provided access from the 1150-foot haulage level to the 850, 950, and 1100-foot levels. A long section of the mine workings is shown on Figure 3. The workings were open stopped with mining focused on major cross-cutting quartz veins. The Lovitt Mine suspended operations in 1967 with gold price of $34 per ounce and was ranked as the 6th largest U.S. underground gold mine on its closure (Brown, L. and Gill, R., 2018; Burgoyne, A.A, 1996; Marr, 1990, Moore, I.F., 1981; Ott, L., 1986; Patton, T.C. and...
Later Exploration History

In the early 1970’s Cyprus Mines Corporation began exploration in the Wenatchee area. The work consisted of mapping, sampling, and geophysical surveys, with conventional rotary and diamond core drilling. Cyprus completed 18 diamond core holes totaling 9,300 feet and 44 conventional rotary holes totaling 16,620 feet (Gill, R., 1984a; Ott, L., 1986; Ott, L., Groody, D., Follis, E.L., and Siems, P.L., 1986; Power-Fardy, D., 2009; Woodhouse, P. et.al., 2002). In 1979 Cyprus Mines Corporation ceased development in the district, but retained some properties (Jewett, R., Robertson, D.B., and Callaghan, R., 1995).


Teck Resources evaluated the district in the mid-1980’s. The D-Reef was divided between United Mining Company (Moore, 1981) and Lovitt Mining Company (LMC). United Mining held 66% of the resource on their portion of the Golden King and MacBeth claims (Power-Fardy, D., 2009). Teck completed 19 drill holes on the Lovitt Mining property D-Reef (Power-Fardy, D., 2009).

In 1981, Gold Belt Mines Incorporated acquired an option on properties in the project area. Gold Belt then entered into a joint venture agreement with Asamera Minerals (U.S.) Incorporated to conduct further exploration west of Golden King (Power-Fardy, D., 2009).
the Lovitt Mine. However, GoldBelt, required additional financing to maintain its joint venture position. Breakwater Resources Limited provided that financing. Breakwater gained control of GoldBelt in 1982 and became a full partner (49%) with Asamera Minerals. (Jewett, R., Robertson, D.B., and Callaghan, R., 1995, Ott, 1986). In 1983, the Asamera-Breakwater joint venture initiated a development program, which became the Cannon Mine. By 1984, drilling identified 5,256,000 tons of 0.214 ounce per ton “reserves” (Burgoyne, A.A, 1996, Jewett, R., Robertson, D.B., and Callaghan, R., 1995; Ott, L., 1986, Power-Fardy, D., 2009, Price, B.J., 2007). Asamera subsequently leased the Lovitt Mine and Tenneco’s holdings in 1985. They performed a resource evaluation in March 1986, which indicated a potential of 2.23 million tons of 0.159 gold ounce per ton at 0.10 ounce per ton cut-off and 6.71 million tons of 0.085 gold ounce per ton at a 0.04 ounce per ton cut-off. The resource also estimated 0.860 million tons of 0.17 gold ounce per ton at a 0.10 gold ounce per ton cut-off and 1.88 million tons of 0.10 gold ounce per ton with a 0.04 gold ounce per ton cut-off for the LMC portion of the D-Reef (Burgoyne, A.A, 1996; Power-Fardy, D., 2009). In 1984, Grange Gold Corporation, which was incorporated in 1980, obtained 26.5% shareholding of Lovitt Mining Company (Brown, L. and Gill, R., 2018, Power-Fardy, D., 2009). From 1986 to 1990 Asamera also held a lease/purchase agreement to acquire 50% of the Lovitt Mining Company shares. They reopened the D-Reef 1250 level, rehabilitated, mapped, and sampled 7000 feet of underground workings, plus completed 39,000 feet of underground diamond drilling. They also completed 15,600 feet of reverse circulation drilling from the surface and performed metallurgical analyses of the D-Reef mineralization (Burgoyne, A.A, 1996, Power-Fardy, D., 2009). When the Cannon Mine closed in 1995, Gulf Minerals, Asamera’s parent company, liquidated Asamera. Grange Gold financed LMC’s purchase of the Asamera portion of the Macbeth and Golden King patented claims and the Chisel land and claims. This unified ownership of the Gold King and Macbeth property. After unifying the patented claims, Grange Gold owned only 57.8% of Lovitt Mining Company (LMC). Asamera gave their LMC shares to the minority shareholders upon their exit from the district. In 2002 LMC bought out the minority shareholders interest for $540,000 subject to a 5% net smelter royalty interest to former minority shareholders. The company changed its name to Lovitt Resources Incorporated (LRC). Lovitt Mining Company Incorporated, became a privately owned subsidiary of LRC (Brown, L. and Gill, R., 2018).

**Property Geology and Mineralization**

The Lovitt Mine stratigraphy and mineralization consists of a northwest trending belt of intercalated, arkosic sandstone, conglomerate, and siltstone with zones of carbonized leaves, twigs, and small logs in the sandstones of the early to middle Eocene Chumstick Formation (Figure 4). A black, carbonaceous mudstone horizon referred to as the Footwall Fissure (Lovitt and Skerl, 1958) with bedding-plane-parallel deformation marks the footwall to gold mineralization. The mudstone is approximately 50 feet thick. Arkosic sandstones adjacent to the mudstone are severely dislocated producing fractures amenable to the formation of auriferous silicified, stockworks, veins, and silica flooding. A coarse conglomerate borders the eastern flank of the stratigraphy. A perlitic rhyodacite and minor andesite were intruded along structures (Lovitt and Skerl, 1958). The Rooster Comb rhyodacite is a surface expression of the felsic intrusive. The late-stage, post-mineral rhyodacite and hornblende andesite described by Ott, 1986, cutting the Cannon Mine stratigraphy, the perlitic rhyolite Rooster Comb, the andesite dikes at the Lovitt Mine (Lovitt and Skerl, 1958), and the andesite intrusive (Gill, 1984a) might represent a late stage to barren “parental magma” intruded into the Chumstick Formation after its source magma expelled the final gold bearing fluids (Kelsey, G.L., 2019).

The mineralized sedimentary rocks and Footwall Fissure dip steeply to the southwest but flatten with depth. The Footwall Fissure shear zone has an overall undulating shape along strike and down dip. Its average trend is N50W and dip of 70 degrees southwest. The Footwall Fissure contains two fault zones with parallel strike. The distance between the two faults varies from 150 feet to a single zone. The thickness of each fault strand is 5-feet to 20-feet wide. The East Footwall Fissure strand separates mineralized arkosic sediments on the west side from un-mineralized conglomerate on the east side. The fault zone is characterized by broken unaltered arkosic pods, silicified arkose, and vein fragments in a black, sheared clayey gouge suggesting reverse displacement. The latest movement along the fault zone is interpreted as post-mineralization. (Burgoyne, A.A, 1996). Two populations of bedding orientations are reported adjacent to the Footwall Fissure zone. An overall N50W strike with southwest dip forms the majority bedding orientation. However, locally between the Footwall Fissure strands bedding display a NW strike and NE dips. The shear-sense implication of a reverse in bedding dip from SW to NE may represent some late-stage normal fault displacement on the Footwall Fissure structure.
The Foundation of the AIPG
Needs Your Support

The Foundation of the American Institute of Professional Geologists needs your support. Needless to say, 2020 has been a very different and surreal year for many of us. For several years, the Foundation has held a silent auction at the welcome reception of AIPG’s national annual meeting. The silent auction not only served as a fundraiser but is also an opportunity to promote the Foundation so that students and members know better what the Foundation has supported in the past few years. Since the annual meeting was postponed to October 2021, we were not able to hold the silent auction. This year we need to rely even more on the financial commitment from AIPG members and others who are able and interested in contributing to the Foundation. Every donation helps the Foundation to provide support toward building the future of geology. The Foundation supports a variety of programs of the AIPG: student scholarships, student and young professional workshops, educational programs aimed at practitioners, the public, and policy makers, and some special needs that may be requested by AIPG or other professional or educational organizations. The Foundation is proud to be able to serve AIPG and the geosciences by providing financial support for these programs. If you have any questions or comments about the Foundation, please contact me or any of the other Trustees of the Foundation for additional information.

Be sure to check the Foundation web page on the AIPG web site https://aipg.org/page/Foundation for information on awarded student scholarships and the list of donors. Your continued support is greatly appreciated. Thank you.

Barbara Murphy, RG, CPG
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The north-south trending, en-echelon faults are the second prominent structural feature of the Lovitt mine (Figure 4). Three main NS faults identified are the N-S Fault, the 49 Fault, and the Unnamed Fault. It should be noted that in the North Drift detailed underground sampling and mapping (Early Mining History-Nellies Room) show splays of the 49 Fault that appear to become conformable with the Footwall Fissure. This observation gives credence to Ott’s 1987 (Ott, et.al., 1987) model suggesting the intersection of the NS faults and the NW trending ore deposits and structures may have acted as a localization for hot springs activity. These en echelon faults have a N to N10W strike and vertical dip. They are interpreted as strike slip faults with late-stage reverse displacement (Burgoyne, A.A, 1996, Johnson, B., 1991).

Burgoyne, 1996 mentions four small-scale structures recorded from underground mapping at the Lovitt Mine. First, a low angle flat-laying reverse fault striking NW and dipping less than 30 degrees SW. The flat faults offset gold-bearing and barren veins. Second, NW striking, and steep SW bedding plane shears offset veins of all orientations. Third, high-angle NE trending faults offset all veins. Fourth, barren NE striking, SE dipping to NW dipping, and NW striking, SW dipping to NE dipping joints. A few north dipping joints are pyrite filled.

The D-Reef rocks are capped, stratigraphically by the 46.2 ±1.8 Ma Compton Tuff (Margolis, J., 1987). The arkosic stratigraphy east of the D-Reef dips to the northeast at 35 degrees to 50 degrees but increases from 70 degrees to 83 degrees adjacent to the D-Reef forming an overturned fold pattern at the Lovitt Mine. The core of this overturned fold is thought to be the Eagle Creek Fault structure responsible for the gold-bearing fluids pathway (Burgoyne, A.A, 1996). The Oligocene Wenatchee Formation unconformably overlies the Chumstick Formation. The Wenatchee Formation is composed of 1000 feet of fluvial and lacustrine sediments, including a conglomerate unit (upper member), quartz sandstone-shale units (lower member), minor tuffaceous units, and thin coal beds. District scale northeast verging fold and thrusting post-dates the Wenatchee Formation age (Margolis, 1989). (Figure 4).

The pervasive silicification of Chumstick Formation stratigraphy and intense jarosite-iron oxide staining of the D-Reef gold deposit defines an erosion-resistant outcropping ridge (Burgoyne, A.A, 1996). The occurrence of gold assays at D-Reef is spatially associated with quartz-adularia veins, breccias, and stockwork with quartz-adularia matrix flooding and calcite veins. This mineralization and alteration of the host rocks is pervasive and controlled by sedimentary permeability and joint plus fracture-induced porosity and permeability. A central core of silicification is enveloped by clay(-)-sericite alteration consisting of sericite, illite, and mixed illite-smectite. The sericite alteration intensity varies with degree of silicification. A propylitic halo consisting of pyrite, chlorite and illite surrounds the D-Reef alteration pattern with pyrite extending to
100 feet and chlorite continuing beyond the pyrite. (Burgoyne, A.A. 1996). The main metallic minerals include pyrite, arsenopyrite, chalcopyrite, electrum, native gold, marcasite, acanthite (silver sulfide), proustite (silver arsenic sulfide), pearcite (silver arsenic sulfide), naumannite (silver selenide), native silver, sphalerite, aquilarite (silver selenium sulphide) and pyrostilpnite (silver antimony sulfide).

References


About the Authors

Graham L. Kelsey graduated from Arizona State University with an MS geology 1979. Graham’s geological experience includes 45 years working in exploration, mining, and economic block modeling. He has worked for several companies in the western U.S., Alaska, Canada, Colombia, and Lao.

Roger D. Gill attended Western Washington University from 1971 to 1977 and received a BS (74) and MS (77) in geology. He worked as Senior Exploration Geologist for Asamera Minerals (US) Incorporated from February 1983 to December 1992.

Here’s an opportunity to tell us more about your experiences as students: what you are learning and researching, field experiences, graduate school pursuits, and transitioning from student to career professional. The Professional Geologist regularly publishes articles on these topics and geology education in the Classroom Earth feature. You are invited to share your perspectives for this feature. Please submit articles to the editor at aipg@aipg.org.
Potash Discovery at McSweeny-McNutt #1 Commenorated by Roadside Marker

Peter Smith, CPG-11539

The discovery of potash in Carlsbad NM will reach a 100-year anniversary in a few short years. Potash was discovered in Carlsbad in 1925 by V.H. McNutt, a geology graduate of the Missouri School of Mines and Metallurgy (now Missouri S&T). At the time, McNutt worked for the Snowden-McSweeny Oil Company, Fort Worth, Texas. He was looking for water in Artesia, north of Carlsbad, where he found oil. His search for oil then took him 23 miles east of Carlsbad, NM. Two oil drillers drilling on a permit held by McNutt drilled to a total depth of 4,416 feet. They found no oil or gas, but instead discovered a light pink to dark red salt. Analysis of the samples confirmed a high percentage of sylvite. This serendipitous discovery marked the beginning of a potash boom in the Permian Basin of southeast New Mexico.

Commercial potash occurs in the middle or McNutt Member of the Salado Formation (Upper Permian Ochoan Stage). The potash distribution in the Salado is asymmetrical, suggesting a reflux model related to a bar-restricted marine embayment with dense brine underflow toward the bar (Barker and Austin, 1993). New Mexico produced 83% of domestic potash and 27% of domestic consumption in 1992. Fertilizer used 95% of U.S. production; 5% was used in chemicals. The potash industry of New Mexico produces sylvite (KCI), langbeinite (K2SO42Mg(SO4)2) and artificial K2SO4. Sylve grade in New Mexico decreased from 20-25% K2O in the 1950s to about 14% in 1992. The average grade of langbeinite (first produced in 1940) remained constant at 8-10% K2O (Barker and Austin, 1993).

Potash in colonial America was made by leaching hardwood ashes in large iron pots. The first patent in the US was signed by George Washington in 1790 for the production of potash. Justin von Liebig’s mineral fertilizer theory, based on the principles of plant nutrition, reformed agriculture during the mid-1800’s, as he was the first to discover that potash salts in the soil were an essential plant food. Leading up to WWI, Germany held a virtual monopoly on potash salts and was the primary source of potash for the US. In 1915, Germany placed an embargo on potash. Potash was designated a strategic mineral in the US.

Based upon the samples collected from McSweeny-McNutt #1, McNutt immediately began acquiring land rights for exploration. His wife Amy was responsible for core storage. The Snowden-McSweeney Co. formed the American Potash Co. in 1926 but later changed its name to U.S. Potash. U.S. Potash began sinking the first shaft in 1929. However, after the stock market crash of October 1929, U.S. Potash was turned down for further financing by J.P. Morgan and was forced to sell half its stock to Pacific Coast Borax. The first shaft was then completed in 1931.

The 1930s saw many new potash mining companies in Carlsbad. U.S. Potash opened a second shaft in 1932. The Potash Company of America began production in 1934, the same year a moratorium was placed on new potash leases. The moratorium was lifted in 1944 at a time when US Potash doubled its production and supplied all potash for the Western Hemisphere and Great Britain. The boom in production continued well into the 1950s, which ultimately led to overproduction. In 1951, the Duval Sulphur and Potash Co. started production. In 1952, Southwest Potash Corp. began production and the Joy Continuous Mining (JCM) Machine was brought on-line. The National Potash Company started up in 1955 and U.S. Potash and Pacific Coast Borax merged in 1956. Overproduction, combined with higher grade ore and newer, more efficient mining equipment in Saskatoon, Canada ultimately led to the shutdown of US Borax operations in Carlsbad in 1967. The mine reopened in 1974 as Mississippi Potash and operates today as Intrepid Potash. Union Potash and Chemical Co., formed in 1936 and known through the years as International Minerals and Chemical Corp. (IMCC), is in operation today as Mosaic.
A roadside marker has been built to commemorate the historic significance of the discovery of potash in Carlsbad. The McSweeney-McNutt #1 Official Scenic Historic Marker was dedicated on March 16, 2019. The marker is located along US Route 62/180, east of Carlsbad, on the south side of highway at mile marker 58/59. The New Mexico Official Scenic Historic Marker program is a partnership with local residents and state agencies. Peter Smith with RESPEC and James Rutley with BLM submitted the application and background research to the New Mexico Historic Preservation Division, which administers the program. The Cultural Properties Review Committee reviews and approves marker text. The New Mexico Department of Transportation funds, installs, and maintains the markers. NMDOT District 2 prepared the site and coordinated the installation of the Potash Discovery Marker.

About the Author

Peter H. Smith, CPG, PG (NY) has over 30 years of field experience, including projects ranging from mining and hydrocarbon storage to geothermal and environmental investigations. He has worked on Federal Superfund sites in Niagara Falls, NY, a sinkhole investigation in Napoleonville LA, salt core logging in southern Veracruz, Mexico, and the Gold King Mine Spill in Silverton CO, to name a few. He is currently one of the key field personnel for Sandia technical support of the U.S. Department of Energy Waste Isolation Pilot Plant (WIPP).

Reference


Peter Smith, CPG-11539, Geologist, wins his Company’s Inspiration Award for 2019

The RESPEC Inspiration Award offers recognition to individuals for providing motivational inspiration to other individuals or teams to achieve excellence. The Inspiration category applies to a person who demonstrates exceptional creative and inventive thinking and, through his or her actions, leads others to the highest level of a special achievement.

Project Geologist Pete Smith was honored with an Inspiration Award for 2019. Peter has been supporting RESPEC operations in Carlsbad, New Mexico, for more than 7 years, despite being located in Rochester, New York. Peter has traveled and spent much time away from his home office to assist in whatever capacity was needed.

Peter’s inspiring professionalism has led to his progression from ad hoc support to a full-time employee on the Sandia contract. Pete has incorporated improvements into collecting field data and reporting video-logging results to the Waste Isolation Pilot Plant (WIPP) hydrology team. Pete also reorganized and improved the annual deliverable for this project, which is a Sandia milestone report that is archived in the WIPP Information Center.

Pete also collaborated with Jim Rutley, Geologist for the local BLM office, in leading the push to commemorate the First Potash Discovery Site with a Scenic Historic Marker at the first potash test well site, McSweeney-McNutt #1, in Eddy County, New Mexico. This site represents the start of a new industry in southeastern New Mexico and the end of the nation’s dependence on imported potash in 1925. Honoring the pioneering efforts of our forefathers in the mining industry is one of the ways that Pete has defined and exemplified RESPEC’s culture.
“I feel very strongly that AIPG must be run as a business and that every person on the executive committee should have a similar mindset; a bias for growth.”

**2021 National President-Elect**  
Matthew J. Rhoades, CPG-07837  
*Overland Park, Kansas*

“As Vice President I would assist AIPG’s Advisory Board in discovering each Section’s strengths and accomplishments and then help struggling Sections develop a simple action plan.”

**2021 National Vice President**  
Christine F. Lilek, CPG-10195  
*Juneau, Wisconsin*

“My vision for AIPG is to spark, encourage, challenge the upcoming generation of applied geology professionals to meet the world’s evolving challenges.”

**2021-22 National Treasurer**  
David T. Heidlauf, CPG-09365  
*Chicago, Illinois*

“...The Professional Geologist can and should be a way to engage and strengthen our membership; it is a forum to communicate complex concepts between our members and others, and help forge professional relationships that can last an entire career.”

**2021-22 National Editor**  
Adam W. Heft, CPG-10265  
*Holt, Michigan*

“I would like to see Student and Early Career Professional members become aware of and use the many resources that AIPG has to offer like the GOLI on-line learning courses offered in affiliation with the American Geosciences Institute.”

**2021 National Early Career Professional**  
Taylor Murray, ECP-0407  
*Scottsdale, Arizona*
Raymond W. Talkington
PhD., PG
Exeter, New Hampshire
Ben H. Parker
Distinguished Service Memorial Medal

Ray was born and raised in the Boston area, and spent some of his summers in both Colorado and Wyoming. One of his aunts, who was a High School Science teacher, introduced him to the world of rocks, fossils, and minerals at a very early age, and he has been studying and teaching about them ever since. He is President and Principal Hydrogeologist of Geosphere Environmental Management, Inc. in Exeter, New Hampshire. Prior to founding Geosphere in 1999, he was a Principal in Talkington Edson Environmental Management, LLC. He also worked with Ransom Environmental Consultants, Inc., Dufresne-Henry, Inc., and Falconbridge Limited, in Canada. He received his B.S. in Geology from the University of Massachusetts at Amherst and his M.S. in Geology and Geochemistry from the University of New Hampshire. He completed his Ph.D. in Geology and Geochemistry at Memorial University of Newfoundland, Canada in 1981.

Ray has been a Lecturer and an Adjunct Professor in the Earth Sciences Department at the University of New Hampshire in Durham, since 1997. He was an Assistant Professor of Geology at Stockton University in Pomona, New Jersey from 1982-1987, and a Post Doctoral Fellow in the Department of Geology at Carleton University in Ottawa from 1980-1982.

As a member of AIPG since 1990, Ray was President of AIPG in 2014. He was awarded the AIPG Presidential Certificate of Merit in 2019. He also actively participated in AIPG throughout his career as Editor of TPG, a Trustee and Chairman of the Foundation of AIPG, and as a member of the National Screening Committee. Ray has been a Distinguished Mentor for the Geological Society of America. Ray has been a member of the New England Water Work Association for 25 years and was the recipient of the David M. Erickson Groundwater Award for Commitment to the Technical Advancement of the Groundwater Profession (2018) by the NEWWA Groundwater Committee. He has also been the recipient of the Patriotic Employer Award by the National Committee for Employer Support of the Guard and Reserve. He has been developing and presenting seminars and short courses for both the New England Water Works Association and the New Hampshire Water Works Association since 1994. He saw a need to get geologists and geoscientists together to share thoughts and experiences. As a result, he was one of the original organizers and founders of the Geological Association of New Jersey and the Geological Society of New Hampshire.

Ray has more than 63 publications on geology and hydrogeology in professional journals, books, geology laboratory manuals, and technical publications. Because of his desire to mentor students and professional staff, many of his publications have been co-authored by students or co-workers. Many of his early publications are research-based and peer reviewed, while his later publications were focused on practical, real-world applications. Over the last several years, Ray has developed four webinars as part of the Geosciences Online Learning Initiative (GOLI) through AIPG and AGI, as well as the online Geology and the Environment course at the University of New Hampshire.

Ray has experienced the best of two disciplines over the last 45 years; as part of both the professional and academic worlds. Through these experiences, Ray continues to bring his “real world experience” into the classroom, and stays up to date on new and developing trends in the geosciences. The curiosity and excitement from seeing his first fish fossil and Wyoming Jade have not diminished over the years. Each time a new rock is picked up or a flowing artesian well is discovered, he becomes that boy exploring geology in Wyoming.
HONORS AND AWARDS

Adam W. Heft, PG  
CPG-10265  
Holt, Michigan

Martin Van Couvering Memorial Service to the Institute Award

It came as quite a surprise when I learned earlier this year that I was to be honored as the 2020 recipient of the Martin Van Couvering Memorial Award. When I look back at the list of those individuals who have received this award before me, I was struck by two things; first, that I know over half of them, and second, that I was considered to be worthy of becoming a part of this group.

Back when I first joined AIPG, I was working at a very small environmental consulting company. My supervisor, who was a hydrogeologist (but not a member of AIPG), encouraged me to join a professional organization and begin to develop my professional credentials and network. After I had applied and received my CPG, he told me that he hoped that I would be an active participant in the organization. I assured him I would be, and to that end, I attended my first annual meeting that year in Milwaukee.

I remember when I arrived at the meeting, I initially felt out of my league. A bit like a mouse among giants, truth to tell. But after a short time, I began meeting other professionals. They were all welcoming, and I was able to talk with several individuals, relax, and enjoy the meeting. After attending my second annual meeting, I knew a few more members, and began looking forward to future meetings where I could see them again. Since 2004, I’ve attended every annual meeting, and have become friends with many individuals from across the country.

I have been actively involved with Section activities almost since I first became a CPG. I served as an assistant editor for our Section’s newsletter until the previous Editor (Ty Black) stepped down in 2008; I’ve served as the Editor since that time. I’ve also served on several committees, including one as the Chairman of the 2007 Annual Meeting and another for our Section’s very successful Environmental Risk Management Workshops. My service has also been at the National level. I first served on the National Executive Committee in 2009 as an advisory board member, and in 2010 as Secretary. Then in 2016 I became President Elect. Now I’m standing for election as National Editor.

They say you only get out of something what you put in. This is generally true. I’ve put a lot of time into service to the Institute over the years. However, I feel that I have received more benefit from my service than I have put into it, and have enjoyed every bit of that time and effort. I’ve had the chance to meet many incredible members from all over the country, and even some from other countries. I’ve made friendships I would never otherwise have had. I consider myself the better for those friendships. I’ve been able to travel and see interesting geologic features, mines, and other points of interest that I don’t get to see in my typical environmental geology employment. And finally, active participation and public speaking at meetings has helped make me more confident.

I encourage our members, particularly those early in their career (though it’s never too late), to be active in your respective Sections. Attend an Annual Meeting or two if possible, and meet other professionals from elsewhere in the country and see some incredible geologic features on field trips. You won’t regret it!

I owe a debt of gratitude to many individuals for making it possible for me to receive this award. To my parents for encouragement to believe in myself even when times were hard. To Mark Henne for his strong encouragement to become an active member of AIPG. To Wendy, Cathy, Vickie, Dorothy, and Aaron at Headquarters for everything they do each day that makes our jobs within AIPG easier and more enjoyable – a BIG Thank You! For all of you that I have become friends with over the years; there are far too many of you to list, but may we have many more years of enjoyable Annual Meetings. And finally, but certainly not least, to my wonderful bride-to-be, Sara Pearson, for many things.

Career Achievements

I obtained a B.S. in Geology & Earth Science from Central Michigan University in 1990, and a M.S. in Geology from Michigan State University in 1993.

I began working as an environmental geologist as a field geologist and gas chromatograph operator for a mobile lab at Peterson Environmental Services, Inc. in 1993. I moved on to a small environmental consulting company, Fitzgerald Henne & Associates, Inc. in 1994 where I remained until 2008 when the environmental group joined Parsons Brinckerhoff, which later became WSP.

I joined AIPG in 1998 as a CPG. I served as general chairman of the successful 44th annual meeting and received the significant contribution to the Michigan Section award in 2007, and a Presidential Certificate of Merit in 2008. I first served on the National Executive Committee in 2009 as an advisory board member and in 2010-11 as Secretary. I received a Section Leadership award in 2014. I then served as National President in 2017.

Christine F. Lilek  
CPG-10195  
Juneau, Wisconsin

John T. Galey, Sr.,  
Memorial Public Service Award

Together: water and people working for positive change.

Water and rocks, but mainly water has been the focus of my life. Water has inspired and comforted me from childhood, through my career and now approaching retirement. In college, I believed that civil engineering would best connect me to water. Yet, immers-
ing myself in man-made materials and transport systems distanced me from my connection to water and I found myself attracted to the geosciences where I could study water in its “natural habitat”. A professional and personal focus that continues to feed mind, body and soul.

During my undergraduate hydrogeology studies at the University of Wisconsin – Milwaukee, I discovered that water movement in the natural world could cause both positive and negative changes. Some of the negative changes to Wisconsin’s groundwater were being intensified by human activities such as waste disposal, land spreading and high capacity well pumping.

In hopes of decreasing these negative changes to Wisconsin groundwater systems, I joined the Wisconsin Department of Natural Resources (WDNR) as a hydrogeologist after graduating from UW-Milwaukee’s Geology Department in 1981. My C.P.G. credentials and involvement with AIPG helped me interact and encourage water industry professionals to work together and try pilot projects in recycling, water reuse and innovative groundwater remediation. I had more energy in my 20s and 30s. In addition to working with WDNR and having a husband and 3 children, I was also appointed as the Village of Cottage Grove Water and Sewer Commission Director. Working with the Rural Water Association, we were able to develop and approve the first Conditional Land Use – Wellhead Protection Ordinance in Wisconsin.

Working with Water Industry representatives throughout the state, I came to respect the need for AIPG’s ethics and professional standards.

"Working with Water Industry representatives throughout the state, I came to respect the need for AIPG’s ethics and professional standards. Gathering participants for new projects could only be accomplished if these standards had been implemented in the past. We also needed to understand individual values and establish common ground. My 1995 Edgewood College graduate program of environmental ethics and stewardship classes, provided me with methods to bring people together from all walks of life to accomplish positive change.

I am especially proud of several of my diverse group accomplishments:

Our central Wisconsin municipality group in Portage and Marathon Counties received the 2012 La Follette Institute’s - Lloyd D. Gladfelter Award for Government Innovation for piloting a beneficial reuse project for street sweepings. After processing and testing, street swept inorganic solids were reused in road and sub foundation projects; saving tens of thousands of dollars for municipalities in landfill costs.

Our Wisconsin Section of AIPG has been able to educate and network hundreds of geoscience professionals and citizens during our events:

- Geology Days at Capitol (2010, 2019)
- Earth & Water Student Presentation Day (2013)
- PFAS Life Cycle Workshop (2019)
- PFAS: What’s Working Seminar (2020)
- Together: water and people working for positive change.

"I was a math major when I took my first geology course. Right then and there I knew, immediately, that I was home!

The AIPG has meant much to me over the years. It has given me the opportunity to interact and exchange ideas with some of the most outstanding professionals and geological scientists on the planet. I have developed solid friendships that I truly treasure. I find myself very blessed. I found the love of my life when I met my beautiful wife. I have a daughter and a son and five grandchildren who mean the world to me. I have had an extremely fulfilling and long career. And I have you. What else could anyone ask for?

Finally, I will admit to you that I am having much fun in writing the “Test Your Knowledge” column for the TPG. I try hard to make it informative and amusing for you. So, to all of you “dudes” and “dudettes”, many thanks for granting me this honor!"
Brandy M. Barnes  
MEM-3175  
Cary, North Carolina  

John Stewart Memorial Early Career Professional Award

In 2014, I founded an AIPG Student Chapter at Middle Tennessee State University and I never could have imagined the incredible journey it would start. Since graduating, I have been honored with AIPG leadership roles from state sections to the national board. I’ve had opportunities to host and coordinate events, volunteer on field trips and AIPG booths, and I’ve presented and mentored in several geoscience organizations. It has been a blast!

As for my AIPG friends and staff, I can never thank you enough. I am grateful for the calls and emails you’ve answered, the encouragement and advice over beers, and the dinners and laughs at meetings. You are special to me and have changed my life.

To AIPG members, David Wilshaw of Integrity Drilling and Geophysical Services, LLC, John Palmer and Mike Lawless of Draper Aden Associates, thank you for being amazing mentors and investing in me as a professional geologist. I have adored the opportunities within these two organizations, and I look forward to continued growth in the geotechnical, geophysical, and environmental industries.

Also, I want to thank my fiancé Brandon. You see me and encourage me to hold space for myself, the people I love, the things I cherish, and the courage to keep setting goals. Thank you for taking the time to understand why I love AIPG and supporting my professional career.

Finally, I would like to say that I am honored to receive the John Stewart Young Professional Award. John Stewart was a wonderful mentor and friend. I met John early in 2017 and instantly he took interest in my goals as a young professional. He was kind, thoughtful, and always willing to share his knowledge. I am thankful for my connection with John Stewart and the memories and advice he shared with me before his passing. He truly touched my heart and guided my professional goals.

Lately, I have been very interested in literature about leadership, courage, and vulnerability, which has led me to the research of Dr. Brene Brown. One of her books is inspired by a Teddy Roosevelt quote and I believe it speaks of our good friend John Stewart and his bravery to be a leader in AIPG, the geosciences, and his community.

“It is not the critic who counts; not the man who points out how the strong man stumbles, or where the doer of deeds could have done them better. The credit belongs to the man who is actually in the arena, whose face is marred by dust and sweat and blood; who strives valiantly; who errs, who falls, who comes short again and again, because there is no effort without error and shortcoming; but who does actually strive to do the deeds; who knows great enthusiasms, the great devotions; who spends himself in a worthy cause; who at the best knows in the end the triumph of high achievement, and who at the worst, if he fails, at least fails while daring greatly.”

Stephanie K. Jarvis  
SA-1495  
Boulder, Colorado  

John Stewart Memorial Early Career Professional Award

I was incredibly honored and surprised to learn I received the John Stewart Early Career Professional Award. Upon reading the letter, I spent some time reflecting on John and my interaction with him at the 2012 National Executive Committee Meeting. I had been invited to the meeting to share my thoughts on how AIPG could better reach students. Eight years later, I can still remember John’s enthusiasm and encouragement to stay involved. As an early graduate student, I was a bit in shock that my perspective was so valued by AIPG as to be invited to the meeting, but John made it clear to me that students and early career professionals were a top priority of AIPG and we should make our voices heard. He also insisted I pick something better out of the AIPG merch closet than a hat, and the fleece he gifted me that day has served me well.

My affiliation with AIPG began during my junior year of college, when I applied for and received the National Scholarship and incorrectly thought submitting an article to the TPG was a condition of the scholarship. That submission set off a series of events I could never have imagined: several years as the Student’s Voice columnist, a meeting at the following GSA in Denver, CO, with now great friend and mentor David Abbott, a job, a couple years on the Colorado Section board, and many meetings and fieldtrips. I vividly remember my dad’s response when I told him I had been asked to be a columnist for TPG—I was unsure at the time I could should take it on and he pointed out that I would be “incredibly stupid” to pass on an opportunity to make myself known to potential employers. While AIPG connections did lead me to a job, I’d say I’ve gotten so much more out of the organization than that.

I grew up in Shelby County, Kentucky and received a BA in Geology and Biology from The College of Wooster and a MS in Geology from Southern Illinois University. After my Masters, I worked as an environmental consultant for ERO Resources in Denver. During that time, I served for 2 years as the Secretary of the Colorado Section. After 2.5 years of consulting, my love of teaching took me back to graduate school and I am currently a PhD student at the University of Colorado Boulder.

The relationships I have developed within AIPG have made clear to me the importance of AIPG for students and early career geologists and have served as a source of inspiration to make the field of geology better for those members. I am incredibly grateful for the friendships, mentoring, and perspective on such a diverse field as ours offered by AIPG and am humbled by this recognition. I’d like to thank my dad for ever-practical advice, my mom for years of column editing, and David and Sue Abbott for giving me a home away from home.
Section Leadership Awards

Arizona

Richard Brose
CPG-07549
Flagstaff, Arizona

Richard has been exemplary in leading and guiding the Northern Arizona University (NAU) student chapter since about 2017.

Through his unselfish guidance, Richard has energized the students in the chapter to be active with field trips, regular meetings, and a significant water quality project that benefits the local community. Without his leadership, the NAU chapter would likely struggle, so this leadership award is very deserved.

Nomination by Doug Bartlett, CPG-09933.

Colorado

Graham Closs, Ph.D.
CPG-07288
Lakewood, Colorado

Graham is being nominated for his long-term service to the Colorado Section in multiple offices and (former) Colorado School of Mines Student Chapter.

He has served in multiple roles on the Colorado Section Executive Committee, including President-Elect, President, and Secretary. Graham’s Advisory Board Service as Chapter Faculty Sponsor over several years for the (former) Colorado School of Mines Student Chapter up until his retirement from UNC is greatly appreciated. He promotes student participation and activities in AIPG and has contributed to many other section activities.

Nomination by Douglas C. Peters, CPG-08274.

Ohio

Colin Flaherty
CPG-11465
Upper Arlington, Ohio

It is with great pleasure that I nominate Colin Flaherty for the 2020 AIPG Section Leadership Award. Colin has been involved with the Ohio Section of AIPG since 2014, and has since proven to be an exceptional leader and professional geologist. When he was recruited as a Member-At-Large, he hit the ground running assisting the Ohio Section...
Executive Committee with organizing Chapter dinner events, a Section night out at a professional baseball game, and in organizing that year’s Annual Section Meeting which was held at the Ohio State University Faculty Club. 2014 was also a big year as the Section worked to revise the out-of-date Section bylaws, for which Colin provided valuable input and a fresh perspective.

In 2015 Colin continued his efforts on behalf of the Section by assisting with securing guest speakers, organizing summer field trips to Ohio Caverns and to the Shale Hollow Nature Preserve, and assisting with other Section initiatives. In late 2015, Colin was elected to be the 2016 Secretary and continued expanded his efforts in 2016 in his new role. In 2016, not only did Colin fulfill his role as Ohio Section Secretary, he continued to assist in securing guest speakers and organizing Section events. In late 2016, Colin was elected for the 3-year term that includes President-Elect, President, and Past-President.

Starting in 2017, Colin increased his efforts for the Section and honed his leadership skills. 2017 was another good year for the Section with an array of dinner meetings with excellent guest speakers including Ohio EPA Deputy Director Laura Factor and the first iteration of the Section’s successful Vapor Intrusion Training Course. Colin was integral of all of 2017’s efforts. Colin also got his first taste of the inner working of AIPG National through his attendance of the 2017 Annual Meeting in Nashville.

In 2018, Colin led the Ohio Section to another successful year as President. Under Colin’s leadership, the Section conducted a successful technical field trip to the Serpent Mound Impact Structure in southern Ohio, a second Vapor Intrusion Short Course, student events, and dinner meetings. This year included the creation of a new student Chapter at Youngstown State University and the now annual tradition of holding the Section’s Fall Meeting in Northeast Ohio.

In the fall of 2018, Colin again attended the AIPG National Meeting in Colorado Springs as one of the Ohio Section’s representatives. While there he was floor-nominated and voted on to the Advisory Board for the 2019 National Executive Committee. As a result, Colin capped off his successful leadership of the Ohio Section with a new trajectory, involvement at the National Level in 2019 and beyond.

Through 2019, Colin continued to be directly involved with the Ohio Section as Past-President and, among other things, assisted in organizing the Section’s first “annual” golf-outing in June 2019. Following his first year of involvement on a National Level, Colin was elected to the Advisory Board again during the 2019 National Annual Meeting in Burlington, Vermont. Colin is continuing his contributions to the Ohio Section 2020 and is now recognized as one of our most valued and experienced members. He is an asset to both the Ohio and National Executive Committees and we truly value all of his efforts and contributions over the years and during the years to come.

On a professional front, Colin has continued to grow and excel as a Professional Geologist. When he first joined the Executive Committee in 2014, he was leading the Environmental Group at Terracon’s Columbus office.

After several years of continually growing that practice, Colin decided in 2019 to take a leap of faith and join SME USA to further develop the environmental practice in Columbus, Ohio. In his professional practice, Colin has continued to demonstrate and define the ability, knowledge, conviction, and morality of a Professional Geologist. With that it is my honor to nominate Colin for the Section Leadership Award.

Nomination by Brent Smith, CPG-11130.

Tales from the Field
My Year of Fun and Games

Episode 1: Experiences with the Zambian Army

John L. Berry, CPG-04032

In 1970 I was quietly doing my job evaluating the copper potential of the Bwana Mkubwa South Prospecting Area in Zambia when I got caught up in one of those situations in which everything happened at the same time and darned near everything went wrong. Bwana Mkubwa Mine had already begun operations, but the Mine Geologist was due for 5 months of long leave. At the same time the company was rushing the concentrating plant to completion (the ore was being railed 45 miles to the Rhokana concentrator in Kitwe in the meantime), and for this they needed 1 million gallons of water a day: I was on the spot so I could sub for the mine geologist and also sit the wells and the pumping tests. Then the Ndola Lime Company suddenly needed some exploration done. So of course I could do that, as well. To cover all these bases I was given the assistance of a new young geologist, Terence Faria. Terence was a Goanese Indian, a Roman Catholic and able to speak Portuguese as well as English and Konkani, the main Indian language of Goa. He was very anti-Indian because of the armed conquest of Goa by India in 1961.

Our Prospecting Area extended across the Gunnery Range of the Zambian Army’s Tug Argan Barracks. This barracks is, incidentally, named after a World War II battleground in Somalia where the Northern Rhodesia Regiment (among others) fought bravely for four days against an Italian force ten times its size. One of the Northern Rhodesians won the Victoria Cross, Britain’s highest military award for valor. The British lost the battle, but inflicted much heavier casualties on the Italians, who suffered 465 dead, 1,530 wounded and 34 missing versus 38 dead, 102 wounded, and 120 missing on the British side.

In order to ensure the safety of my prospecting crews, who were digging lines of prospect pits across the artillery range, I arranged to take along a Corporal, whose presence would guarantee that there’d be no shooting. Unfortunately, he was not given a two-way radio. So, at about 10:00 am one morning, mortar shells started landing near us. Fortunately, with

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Natural Resources and Sustainability: Geoethics Fundamentals and Reality

David M. Abbott, Jr., CPG-04570

Abstract

Ensuring sustainability of economic and social activities in order to assure future generations’ supply of energy and other natural resources is the ninth Fundamental Value of Geoethics (Di Capua, et al., 2017). Unfortunately, this statement fails to transparently and forthrightly acknowledge the depletability of individual natural resource deposits, thus inhibiting a fully integral and transparent discussion of this geoethics value statement’s goal of providing a sustainable supply of natural resources. The depletability of individual natural resource deposits is a fact of nature. Deposits are limited in overall size. This paper examines how the finite size of natural resource deposits and other factors can be realistically approached from a geoethical perspective. On one hand, developing a long-term mineral supply would encourage maximum extraction of a deposit’s valuable constituents by keeping the costs of production low, allowing for a lower cutoff grade. On the other hand, minimizing costs for environmental mitigation and social impact mitigation can result in unacceptable levels of adverse impacts for those living near the deposit. The costs for environmental and social impact mitigation increase the cut-off grade, the minimum grade that allows for profitable extraction. Dialog between the mining industry and the various environmental and social impact stakeholders is the key to finding the unique appropriate balance for each mineral deposit. The dialog among the various stakeholders about a particular deposit should recognize society’s need for mineral products as an important, socially desirable goal. Because individual natural resource deposits are depletable, natural resource supplies can only be sustained by finding new deposits, substitution of one product for another, recycling where possible, along with improvements in mining exploration, extraction, and processing technologies at both current and new mines.

Therefore, the ninth Geothics Value statement, Ensuring sustainability of economic and social activities in order to assure future generations’ supply of energy and other natural resources, should be changed to a more forthright and transparent statement. A suggested change is, Assuring supplies of natural resources for future generations requires recognition that individual natural resources deposits are depletable and that their identification, delineation, extraction, and processing have social and environmental consequences whose mitigation must be balanced with maximizing the recovery of the valuable minerals needed by society from each deposit. The term “energy” is deleted from the statement because oil and gas, coal, and uranium are adequately covered by “natural resources.”

Key words: geoethics, natural resources deposits, depletion, sustainability

For the first time since November 1995, no Professional Ethics & Practices column appears in this TPG issue. This peer-reviewed article addresses the 9th fundamental value of geoethics and takes the PE&P column’s place because its length is that of a typical PE&P column plus a typical TPG article. PE&P column 176 will appear in January 2021.
Introduction

The Geoethics concept arose from an idea conceived in April 2012 at the European Geosciences Union and developed at the 34th and 35th International Geological Congresses. The Cape Town Statement on Geoethics (Di Capua, et al., 2017) included a list of ten fundamental geoethical values (see side bar). The ninth fundamental value states, “Ensuring sustainability of economic and social activities in order to assure future generations’ supply of energy and other natural resources.” Unfortunately, this statement fails to transparently and forthrightly acknowledge the depletability of natural resource deposits thus inhibiting a fully integral and transparent discussion of this geoethics value statement’s goal of providing a sustainable supply of natural resources. The depletability of natural resource deposits is a fact of nature. Deposits are size limited. This same failure to forthrightly acknowledge and address the depletability of natural resource deposits is a major failing of International Association for the Promotion of Geoethics’ (IAPG’s) White Paper on Responsible Mining (Arvanitidis, et al., 2017). As Schendler (2009, p. 9) emphasizes, “The great flaw in the sustainable-business movement today is that few are willing to admit that achieving sustainability is difficult, and maybe impossible, without big changes in the way the world currently operates.”

A significant problem in discussing the sustainable development of natural resource deposits is a clear understanding of what “sustainable development” means. The widely cited UN Brundtland Commission 1987 report’s definition states, “Sustainable development is the kind of development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” Thus, there are no limits on the life of a “sustainable development” as commonly used and understood. The problem is that individual natural resource deposits are finite in size, are depletable, and any extraction of a particular deposit will eventually lead to its exhaustion. This paper examines how the finite size of natural resource deposits and other factors can be realistically approached from a geoethical perspective.

This paper will focus on solid mineral deposits that are extracted using mining methods. But other types of natural resource occurrences such as oil and gas reservoirs, geothermal energy systems, mineral extraction from brines (lithium for example), and the increasing number of “mined” water aquifers are depletable and the general concepts discussed apply to these other types of natural resource occurrences as well.

The development of geoethics

“Geoethics” was defined in 2012 at the 34th International Geological Congress in Brisbane, Australia from an idea conceived during the European Geosciences Union in the preceding April. The Cape Town Statement on Geoethics was published following the 35th International Geological Congress in Brisbane, Australia from an idea conceived in April 2012 at the European Geosciences Union and developed at the 34th and 35th International Geological Congresses. The Cape Town Statement on Geoethics (Di Capua, et al., 2017) included a list of ten fundamental geoethical values (see side bar).

1. The International Association for Promotion of Geoethics (IAPG) is supported by over 20 associated geoscience organizations, many of which are internationally recognized. Conspicuously absent from this list of associates are major, internationally recognized mining and petroleum organizations including the American Association of Petroleum Geologists, the Australasian Institute of Mining and Metallurgy (AusIMM), the Canadian Institute of Mining, Metallurgy, and Petroleum (CIM), the Institution of Mining and Metallurgy, the Society for Mining, Metallurgy, and Exploration (SME), and the South African Institute of Mining and Metallurgy. These mining organizations are very interested in the social licensing aspects of mining.

The Fundamental Values of Geoethics

1. Honesty, integrity, transparency and reliability of the geoscientist, including strict adherence to scientific methods.

2. Competence, including regular training and lifelong learning.

3. Sharing knowledge at all levels as a valuable activity, which implies communicating science and results, while taking into account intrinsic limitations such as probabilities and uncertainties.

4. Verifying the sources of information and data, and applying objective, unbiased peer-review processes to technical and scientific publications.

5. Working with a spirit of cooperation and reciprocity, which involves understanding and respect for different ideas and hypotheses.

6. Respecting natural processes and phenomena, where possible, when planning and implementing interventions in the environment.

7. Protecting geodiversity as an essential aspect of the development of life and biodiversity, cultural and social diversity, and the sustainable development of communities.

8. Enhancing geoheritage, which brings together scientific and cultural factors that have intrinsic social and economic value, to strengthen the sense of belonging of people for their environment.

9. Ensuring sustainability of economic and social activities in order to assure future generations’ supply of energy and other natural resources.

10. Promoting geo-education and outreach for all, to further sustainable economic development, geohazard prevention and mitigation, environmental protection, and increased societal resilience and well-being.
Congress in Cape Town, South Africa (Di Capua, et al., 2017). The Cape Town Statement defined geoethics as: “Geoethics consists of research and reflection on the values which underpin appropriate behaviours and practices, wherever human activities interact with the Earth system. Geoethics deals with the ethical, social and cultural implications of geoscience education, research and practice, and with the social role and responsibility of geoscientists in conducting their activities.” The Cape Town Statement on Geoethics stated that its purpose is, “Embracing geoethics is essential: to improve both the quality of professional work and the credibility of geoscientists, to foster excellence in geosciences, to assure sustainable benefits for communities, as well as to protect local and global environments; all with the aim of creating and maintaining the conditions for the healthy and prosperous development of future generations.”

The Cape Town Statement contains ten fundamental values of geoethics. The first six of these values are more or less standard parts of geoscience ethics codes advocating honesty, transparency, competence, verification of information and data, unbiased science, etc. New fundamental geoethics values are:

- Protecting geodiversity as an essential aspect of the development of life and biodiversity, cultural and social diversity, and the sustainable development of communities.
- Enhancing geoheritage, which brings together scientific and cultural factors that have intrinsic social and economic value, to strengthen the sense of belonging of people for their environment.
- Ensuring sustainability of economic and social activities in order to assure future generations’ supply of energy and other natural resources.
- Promoting geo-education and outreach for all, to further sustainable economic development, geohazard prevention and mitigation, environmental protection, and increased societal resilience and well-being.

As Bohle and DiCapua (2019) note, “The recent development of the concept ‘geoethics’ is a response by geoscientists to shape deeper engagement with their professional responsibilities and the wider societal relevance of geosciences. This introductory chapter outlines the development of geoethics to date, as a ‘virtue ethics’ focusing primarily on the role of the geoscientist, describes its meaning and function in relation to neighboring fields and explores how to situate geoethics in relation to a wider range of issues that require ethical consideration.” This widening of geoscience professional ethics can be expected to spread to the ethics codes of other professions.

The Preamble of the IAPG’s White Paper on Responsible Mining (Arvanitidis, et al., 2017) does point out other important characteristics of natural resource deposits:

- Modern societies are dependent on mineral-based products. Energy technology, information and communications technology, consumer electronics, infrastructure, logistics and food production all increasingly rely on an ever-widening array of minerals and metals. For example, production of a personal computer or a smartphone needs over 40 elements.
- Mineral and metal consumption strongly correlates with economic growth and urbanization. Three billion additional people will likely move to cities by 2050. Improved recycling, resource efficiency, better product design and new materials will reduce mineral and metal consumption per capita, but mining of primary resources will continue to play an important role in the future in building sustainable societies.
- Geology defines the occurrence of mineral deposits, so mining is geographically constrained, but the use of the products of mining in down-stream industries or as final products often takes place in continents and countries different from the location of the mine. Therefore, mining communities do not necessarily appreciate the importance of mineral production for the welfare of people living in other countries, particularly if there is no tangible sharing of those benefits.
- Mining cannot choose locations that are logistically, socially, environmentally, or politically optimal, appropriate, or ‘friendly’. This means that companies may have to deal with circumstances that could pose ethical challenges including the relationship with local communities, position in the landscape/environment, relationship with local and national governments, weak governance and associated increased risk of corruption and bribery. It is necessary to deal with these challenges in a responsible way.

How are these characteristics of mineral deposits and the demands for mineral products now and in the future going to be balanced? These are legitimate geoethical questions. However, as Grennan and Clifford (2017) point out, most proponents of sustainable resources ignore geology, ignore the fact of depletability, and the unequal but worldwide distribution of deposits including locations in countries with less stringent environmental laws and reputations for various forms of governmental corruption.

Figure 1 presents the 2020 edition of the Minerals Education Coalition’s “mineral baby.” The mineral baby predicts that every American born in 2020 will need an estimated 3.19 million pounds of mineral products during its lifetime. Abbott (2017) describes how the estimates shown in each year’s mineral baby are calculated along with graphs of some changes in the amount of particular mineral commodities over time. Although the mineral baby’s data is American, the mineral baby reflects the estimated minerals use of developed countries and the usage goals of under-developed countries. Certainly, modifications are needed to provide worldwide estimates of mineral usage requirements, but Figure 1 remains a useful estimate within its inherent limits. The Minerals Education...
SUSTAINABLE MINERAL PRODUCTION

Every American born will need...

3.19 million pounds of minerals, metals, and fuels in their lifetime
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Coalition encourages the widespread copying and distribution of each year’s mineral baby as long as the copyright and web address are retained.

Natural resource deposits are depletable

The concept of sustainable development has been, and still is, subject to criticism, including the question of what is to be sustained in sustainable development. “The production of mineral resources and fossil fuels would seem to be activities that cannot, by definition, be sustainable, but extractive industries provide necessary contributions to society” (Wessel, 2016). The depletability of natural resource deposits is a fact of nature. Deposits are limited in size. In addition to the limits on absolute deposit or occurrence size, various factors of geology, deposit delineation techniques, extraction and processing technologies, and extraction costs combine to prevent complete (100%) extraction of the contained valuable mineral(s) (the economically recoverable metal-bearing and other minerals) in a deposit. This is true regardless of whether the valuable resource comprises 100% of the core of a deposit, for example, a paper-grade marble or dimension stone granite, or a few parts per million (grams per tonne) in the case of gold and platinum group metal deposits. The mine life of a deposit depends on its size, the grade (i.e. the percentage of valuable mineral(s) in the deposit, the cut-off grade (the grade at which extraction becomes unprofitable), and the extraction rate. Some deposits are mined out within a few years while others may last decades.

Natural resource deposits are not uniformly distributed

Natural resource deposits are unevenly scattered around the world. Some areas are mineral rich, for example the southern part of the Katanga Province of the Democratic Republic of the Congo, which contains the majority of the world’s cobalt production and significant copper resources. The world’s major platinum group metal deposits are in South Africa, Russia, and Zimbabwe with much smaller occurrences in the Stillwater Complex of southcentral Montana and various parts of Ontario and Quebec. The world’s major iron deposits are in the older (~2+ billion-year-old) cratons of the globe. Major deposits of phosphates, a critical fertilizer (the P of N-K-P of fertilizer composition), occur in central Florida (increasingly depleted) and in a trend across northern Africa from Morocco to Saudi Arabia. The rare earth elements have traditionally come from either the Mountain Pass deposit in southern California or China. Rare earth element deposits are not so rare, but most are low grade and the most common rare earth element-containing mineral is monazite (Ce, La, Y, Th)(PO₄, SiO₄). Thorium (Th) is radioactive, creating an environmental hazard when processed for the rare earth elements. The La in monazite’s formula stands for the lanthanide series rare-earth elements, which, except for cerium, are very difficult to chemically separate and which make individual rare earth element oxides expensive to recover. Natural resource deposits occur where they are and not necessarily in areas deemed less environmentally sensitive or in less socially desirable locations.

Balancing resource recovery with environmental and social impact mitigation

The extraction of a natural resource deposit produces one or more holes in the ground of widely varying size. The clay pits of Hopi and other Native American potters may be fairly small as were the somewhat larger Native American flint quarries. In sharp contrast are the giant iron mines of northern Minnesota and Michigan or the porphyry copper mines including such giants as the Bingham Canyon Mine west of Salt Lake City, UT or the Chuquicamata Mine complex of northern Chile. In addition to the holes and piles of waste rock, mineral process-
ing techniques may add adverse environmental consequences, such as the use of mercury to recover gold by amalgamation, particularly by artisanal or small mining operations. The fact that many metal mines are within pyrite-rich rocks whose oxidation produces acid mine drainage is another variety of potentially adverse environmental consequence of mining. Small amounts of mercury-, arsenic-, and other toxic element-bearing minerals may be part of the suite of minerals comprising a particular deposit. These and other factors contribute to the potentially adverse environmental consequences from mining that should be addressed.

The social impacts resulting from the construction and operation of a mine can also be significant. Roads, public utilities, sewer and water lines, schools, town-size expansions or creation of new towns are examples. Frequently, the people already living near the mine site desire training that allows them to work at the mine. The social impacts vary considerably from project to project and must be dealt with on a project by project basis. As Bilham and Di Capua (2020) point out:

Living sustainably, prosperously and equitably on our crowded planet in the coming decades will depend on mining. However rapidly we increase recycling rates, improve resource efficiency and reduce demand for raw materials through new approaches to product design and use, we will continue to need to mine significant quantities of an ever-increasing range of elements. The mineral needs of the near future will be quite different from those of the recent past, given the urgent need to transition to low-carbon energy systems and to harness new, materially complex technologies to address a nexus of environmental, social and economic challenges, as articulated in the UN Sustainable Development Goals. Meeting these needs will mean mining in new places and communities—as well as in settings that bear the scars of unethical and unsustainable practices of the past—and will depend on the engagement and support of communities rightly seeking to assert their rights and defend their interests. It is therefore essential, from both a moral and practical standpoint, to mine responsibly, minimizing negative social and environmental impacts, maximizing benefits and legacies to affected communities, and including them as partners in a shared societal enterprise.

Bilham and Di Capua’s observations are from the Introduction to Jan Boon’s Relationships and the course of social events during mineral exploration: an applied sociology approach (2020). Boon discusses the various relationships between an exploration company and the various people and groups that are encountered in the course an exploration project. The nature of the relationships between the exploration company and these people and groups will determine whether and with what ease, or lack thereof, the exploration project’s technical aspects (geology, mine design, process testing, mineral resource and reserve delineation, etc.) can proceed to the development of an operating mine.

“Ore” is that part of a mineral deposit from which one or more valuable minerals can be legally extracted at a profit. That is, the revenues received from a mine’s operation must exceed the costs of mining and processing the contained minerals for sale. On one hand, developing a long-term mineral supply would encourage maximum extraction of a deposit’s valuable constituents by keeping the costs of production low thus allowing for a lower cutoff grade. But minimizing costs for things like environmental mitigation and social impact mitigation can result in unacceptable adverse impacts for those living near the deposit. The costs for environmental and social impact mitigation increase the cut-off grade, the minimum grade that allows for profitable extraction. A higher cut-off grade results in reducing the maximum recovery percentage of the valuable mineral(s) in a deposit. Mining industry mineral resource and mineral reserve classification systems such as the Society for Mining, Metallurgy, and Exploration’s SME Guide for Reporting Exploration Information, Mineral Resources, and Mineral Reserves (2017) or the Australasian JORC Code (2012) define critical terms and provide detailed guidance about the information required in order to determine that a mineral reserve (the economically extractable part of a mineral deposit) exists. This includes addressing the environmental and social licensing aspects of the deposit. Figure 2 presents the need to balance maximum resource recovery with minimizing the adverse social and environmental impacts of mining.

Who decides what the balance will be? The IAPG’s White Paper on Responsible Mining (Arvanitidis, et al., 2017) defines responsible mining: “Responsible mining demonstrably respects and protects the interests of all stakeholders, human health and the environment, and contributes discernibly and fairly to broad economic development of the producing country and to benefit local communities, while embracing best international practices and upholding the rule of law.” Doyle’s (2019) blog, “Responsible investing in natural resources” examines the environmental, social, and governance (ESG) issues for responsible mining investing. These papers imply the balancing summarized in Figure 2. The White Paper lists 15 best practices for responsible mining. These practices require identification of and dialog with relevant stakeholders including local and regional authorities, community members, employees, contractors, and non-government organizations. Dialog among the mining industry and these stakeholders is the key to finding the
appropriate balance for each mineral deposit shown in Figure 2. However, the discussion among the various stakeholders about a particular deposit should also recognize society’s need for mineral products including acceptance of some level of adverse impacts.

The alternative for reaching a balance between maximum extraction and minimized adverse resulting impacts is by regulation. Oreskes and Conway (2010) in their Chapter 3 on acid rain point out that had regulations on reducing acid-rain-causing emissions from coal-fired power plants been adopted sooner than they were, not only would mitigation have occurred sooner, the economic incentive to develop new, more efficient, and less costly mitigation technology would have occurred sooner as well. Enacting laws or regulations requires political power. Oreskes and Conway’s review of the acid rain saga and the associated political aspects of the issue provide a good case history.

Finding new deposits to replace depleted ones

Because natural resource deposits are depletable, natural resource supplies can only be sustained by finding new deposits. Even when substitutes for the use of a particular mineral product are found, deposits of the substitute minerals must be found. Grennan and Clifford (2017) observe, “Fundamental to a sustainable supply of raw materials for manufacturing industry is a mining industry; fundamental to a sustainable mining industry is a vibrant exploration industry; fundamental to a vibrant minerals exploration industry is geology. The real problems of the technical and financial risk attaching to mineral exploration, and the importance of geology, are rarely discussed. Grennan and Clifford (2017) point out:

There are two principal reasons why exploration tends to be ignored in all of this debate. Firstly, the high risk of no success—exploration success in Ireland is around 5,000 to 1. Most people, especially those in government service or in academia, rarely understand why anyone would undertake such risks. This is why there is a special section within the Stock Exchanges for such high-risk companies. Secondly, having succeeded in finding a viable deposit, the extent of the regulatory obstacles put in the way of development is enormous, and costly. They can be ameliorated, but the environmental lobby has totally captured the administrative system.

Mineral exploration and the risks involved are also impacted by the fact that the easily found deposits that occur on or near the surface have pretty much been found. The remaining deposits are further below the surface and harder to find. Wood (2018) observed that while the amounts spent on exploration have climbed significantly, the number of discoveries has declined. Wood attributes this to the continued focus on exploring for open-pit mining targets and suggests that exploration should refocus on targets requiring underground mining methods. Wood and Hedenquist (2019) describe the needed changes in exploration strategy. Moving to underground mining methods can change the environmental impacts but underground mining costs more on a per tonne basis that open pit mining.

Although changed exploration strategy is needed, it may or may not significantly reduce exploration risk. Grennan and Clifford (2017) cogently observe:

It has been argued that the best, and most efficient, way to find a deposit is to allow small exploration companies to flourish, whereby they can raise high risk finance and/or obtain exploration funding from major mining companies. Whilst it is undoubtedly true that exploration costs are rising, the real escalation in costs is in the post-discovery pre-development phase. Few geologists will argue against an increase in environmental and reporting standards, and inevitably the smaller company cannot sustain the costs and is typically taken over by the larger partner. The major company, through social and regulatory pressure accedes to the environmental/cultural/administrative lobby. This in turn leads to increased costs being imposed both directly and indirectly on the developer, which leads to lower profits, and thus lower tax payments, resulting in the self-fulfilling prophecy that such companies avoid paying tax. This does not have to be the case.

Alternatives to consider—substitutes and improved technologies

There are alternative routes to a sustainable supply of natural resources. Substitution of one mineral or metal for another is one alternative. Lead was formerly used as the primary white pigment in paint until this use was banned. TiO_2_, largely from the mineral ilmenite, FeTiO_3_, is the current most commonly used white pigment (reading ingredient labels reveals the widespread use of mineral products in a wide variety of products if you know chemical formulas of common minerals, for example, quartz, SiO_2_. Construction studs are available in wood or steel versions and some substitution between the two stud types does occur. Laminated wood beams have been used as substitutes for steel beams in buildings. Such substitutions will continue as the installed price for a particular metal or mineral product increases relative to the installed cost of the alternative, assuming job specifications are met. The relative amounts of platinum and palladium in automobile catalytic converters changes with the relative prices of the two metals.

New or improved technologies can make a huge difference. Agricola (1556, p. 217) noted that the second principal cause for mine closures was the quantity of water that flows in [that is, the inability to pump the water out or drive drainage tunnels]. The development of steam-engine driven pumps in the 18th century allowed the rejuvenation of the tin mines of Cornwall that had earlier supported the Bronze Age. Major improvements in the efficiency of mining equipment and techniques in the 20th century made possible dramatic improvements in open pit mining, which evolved from rail-based haulage to truck haulage. Similar improvements occurred in underground mines. Currently, the development of remote control, autonomous vehicles, and robotics technologies for mining equipment is expected to make significant technological advances in the coming years (Burgess-Limerick, 2020).

The extent to which substitutions and improved technologies will impact future mining and the timing of their adoption is unknown but significant impacts are expected.

Post mining uses of lands

Increasing attention is being paid to the post-mining uses of mined lands as shown by the following examples:

- Former aggregate mine pits (sand and gravel and crushed stone quarries) are being used for water storage.
- The ponds formed by aggregate mines are valuable features of new real estate development.
• Former underground limestone and salt mines are being used for records and other types of storage facilities.

• A large area of former smelter tailings in Colorado Springs, Colorado is being covered by new homes.

• Part of a former coal mine in western Colorado is now a mushroom farm.

• Aspen Skiing Company and Holy Cross Energy recently developed a methane-powered electric generation plant to capture the released methane from nearby gassy coal mines (https://www.aspentimes.com/news/how-aspen-skiing-co-became-a-power-company/). Methane is a potent greenhouse gas and its conversion to water and CO₂ is an environmentally desirable outcome.

Conclusion

Providing a continued supply of the natural resources that society continues to need requires recognition that individual natural resource deposits are depletable and limited in extent. Determining the extractable dimensions of a particular deposit depends on balancing resource recovery with the various capital and operating costs of exploring for, finding, and then building the extractive operation. This includes the costs associated with reducing the environmental impacts and obtaining the required social license to operate. As Schendler (2009, p. 238-239) points out, “The bottom line is that this [sustainability] job isn’t about the beauty, it’s about the mess. It’s not about the glory, it’s about the dogged pursuit of an enormously challenging goal. This book [Getting green done: hard truths from the front lines of the sustainability revolution] is testimony to the fact that the sustainable business movement isn’t gliding along rails. We’re slogging through the mud, struggling with difficult problems that have complex answers. There’s contradiction in the very fact of our existence, and uncertainty as to the outcome of our work. I am constantly asked: ‘Climate change is big these days. But what’s next?’ My latest response has been, ‘Honesty.’ The point is that unless we own up to the realities, we’re deluding ourselves, we’ll never be able to get down to solving the real problems.”

The ninth geoethics value statement, Ensuring sustainability of economic and social activities in order to assure future generations’ supply of energy and other natural resources, should be changed to a more forthright and transparent statement. A suggested change is, Assuring supplies of natural resources for future generations requires recognition that individual natural resources deposits are depletable and that their identification, delineation, extraction, and processing have social and environmental consequences whose mitigation must be balanced with maximizing the recovery of the valuable minerals needed by society from each deposit. The term “energy” is deleted from the statement because oil and gas, coal, and uranium are adequately covered by “natural resources.”

References


Minerals Education Coalition, 2019, Mineral baby: https://mineralseducationcoalition.org/mining-mineral-statistics. This figure may be freely reproduced as long as the copyright and source information are included.


In the modern era of 3D models, artificial intelligence, and database-centric exploration planning, sometimes obvious exploration vectors go unnoticed. Mineralogy and alteration zonation are often portrayed as alteration types 1, 2 and 3 without deep thought of geologic process, fluid flow or mineral depositional environments. Using 3D mineralogy models is often more enlightening than geochemistry. Having a rudimentary knowledge of geologic processes and a vision of where gold should deposit can reduce exploration costs and the timeline to discovery.

The various types of gold deposits have differing genetic origins of fluid chemistry, source rocks, host rocks, mineralogy and process of formation. Even similar deposits within the same district may have very different attributes due to changes in geologic parameters of formation. Irrespective of deposit type and structure, fluid-flow pathways are important controls of gold deposition. Host rock reactivity, fluid conditions, depth, pressure and temperature of formation can all be important controls on the solubility of gold and depositional environments. Most Carlin-like gold deposits occur as relatively small high-grade deposits occurring along folds and contacts with reactive rocks, bedded parallel faults and other structures where fluid flow may be impeded long enough to deposit gold. Brecia structures along larger faults may be mineralized where fluids experience a pressure drop entering an open structure. Flat structures and bedding can deflect ore-bearing fluids great distances from source areas, and barren altered rocks may extend several kilometers from a gold deposit, hindering any quick discovery.

During the 1980s, jasperoid bodies were considered closely associated with gold deposits in Nevada and Utah; many were extensively drilled, and a few gold deposits discovered. In later decades gold deposits were discovered more distal from jasperoid bodies, and complex alteration patterns were studied. Hydrothermal fluids that formed Carlin-like deposits consisted of more than 95% meteoric water (Hofstra, 1997) that circulated through many cubic kilometers of upper crustal rocks. The various types of gold deposits have differing genetic origins of fluid chemistry, source rocks, host rocks, mineralogy and process of formation. Even similar deposits within the same district may have very different attributes due to changes in geologic parameters of formation. Irrespective of deposit type and structure, fluid-flow pathways are important controls of gold deposition. Host rock reactivity, fluid conditions, depth, pressure and temperature of formation can all be important controls on the solubility of gold and depositional environments. Most Carlin-like gold deposits occur as relatively small high-grade deposits occurring along folds and contacts with reactive rocks, bedded parallel faults and other structures where fluid flow may be impeded long enough to deposit gold. Brecia structures along larger faults may be mineralized where fluids experience a pressure drop entering an open structure. Flat structures and bedding can deflect ore-bearing fluids great distances from source areas, and barren altered rocks may extend several kilometers from a gold deposit, hindering any quick discovery.

Marcasite is the best indicator mineral of fluid and depositional conditions in Carlin-like gold deposits. Marcasite precipitates in very restrictive depositional environments: pH <5, temperatures below 240°C, with abundant bisulfide molecules like H2S2 in solution (Murochick, 1992). Marcasite is unstable at prolonged temperatures above 160°C and tends to go back into solution or revert to pyrite (Nash et al., 1989). This explains a common sulfide texture of alternating bands of pyrite and vuggy pyrite that was formerly marcasite. In some deposits, marcasite is not present, but the banded and botry-
oidal textures of marcasite often remain visible to the trained eye, indicating that it was present. The highest gold grades are often in this pseudomorph zone. Pyrite generally forms gold colored euhedral cubic or rarely dodecahedral crystals, often complexly embayed, intergrown and banded. Marcasite is silvery or greenish in color and forms complex crystal structures, reniform or fibrous habits. It forms bands with pyrite and remnant textures are often visible after conversion to pyrite. In the absence of microscope and analytical identification of fine-grained sulfides, banded veins and areas that lack a pyrite habit could be remnant marcasite. In recent decades, areas of marcasite were targeted for exploration with mixed results. It must be remembered that, at least hypothetically, a large area of marcasite near favorable host rocks may be a kilometer up-gradient from a major gold deposit (Figure 1).

The exploration importance of marcasite and its pseudomorphs gives the explorer a general idea of the depths and temperatures of formation. The upper end of marcasite stability overlaps with the optimum temperature of gold deposition, around 240-220°C. Marcasite is unstable in much of the gold depositional environment, so the importance of recognizing pseudomorphs becomes readily apparent. Marcasite is only stable in lower temperature environments moderately distal from the optimum gold depositional conditions. Therefore, a small high-level gold deposit with abundant marcasite can be a good indication of a larger gold deposit at depth. It should be remembered that fluid pathways in this environment are rarely vertical, and a new discovery may be a kilometer down-gradient and lateral from a surface target (Figure 1). Favorable stratigraphy may only be mineralized near feeder structures and within fold or breccia structures that have trapped mineralizing fluids. Temperatures of deposition and mineralogy constraints will change with pressure and depth, so Figure 1 is only a general guide meant to give the exploration geologist a general idea of geologic process and a mineralogical vector orientation to a Carlin-like gold deposit.

References


About the Author

Apparent Cohesion and the Design of Slopes in Sand Quarries

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Abstract

This article discusses the background for the design, design-based monitoring (and the standards that allow this) of slopes in sand deposits in order to reach optimum extraction at sand extraction sites. We explain the benefits of taking the apparent cohesion into account when designing slopes. We provide a step by step overview detailing how the design should take place if the apparent cohesion is taken into account in the design of slopes in sand quarries.

Key words: Sand, slopes, monitoring, stability, apparent cohesion

Introduction

Sand is extracted in many operations world-wide. It can be mined above (dry operations) or below the water table (dredging operations). In deep “dry” quarries sand is extracted from a sequence of progressively deeper benches. This entails the creation of ‘temporary’ and ‘final’ slopes: the final slopes define the mine’s final shape, and need to be stable in perpetuity or until any backfilling is completed. The temporary slopes are the working faces at which daily extraction occurs. They are not as high and are not required to be stable for as long as the final slopes.

All of these slopes require a design, whether simple (based on experience) or more complex (using limit equilibrium methods and or numerical methods). The required detail of design depends on the local setting, local regulations and the geotechnical risk class.

The design is the basis for extraction and extraction is then followed by monitoring. Monitoring can also be simple (visual inspection) or complex (using inclinometers, piezometers, slope deformation monitoring).

The design aim for these slopes is part of the overall goal to determine the optimal extraction of the sand deposit. That is, the profitable extraction of as much sand as possible without compromising safety through an unacceptable risk of slope failure, and without the need for costly slope remediation (such as buttressing). The slope design, general layout of the different benches, final slope design and monitoring requirements should be described in the mine (or extraction) plan. For Sibelco’s quarries and mines the requirements for design and monitoring are based on Eurocode 7, as is explained in the two sections below.

Geotechnical design of mines and quarries and dredging operations

Is a detailed geotechnical assessment based on samples, sample analysis in the laboratory and numerical simulations required for every geotechnical problem? The answer is no. What needs to be done depends on the Geotechnical Category (Table 1) of the problem, as defined below, and as determined by a preliminary investigation.

For the geotechnical design of, for example, slopes, tunnels and caverns, Sibelco follows the principles of Eurocode 7 (implemented as e.g. British Standard EN 1997-1:2004 Eurocode 7: Geotechnical design) and uses the concept of the Geotechnical Category. Although not directly aimed at sand extraction, the design philosophy of Eurocode 7 is typical for processes used historically in mining, such as relying on monitoring using the observational method. Therefore, it is wise to cross-check the geotechnical aspects of mine or quarry design with the principles laid down in the Eurocode.

A preliminary classification of a structure according to Geotechnical Category should normally be performed prior to the geotechnical investigations.

The category should be checked and changed, if necessary, at each stage of the design and extraction process. For each category Eurocode 7 will provide information on the extent of site investigation required, the design type and degree of monitoring.

Depending on the nature of the design requirements, analytical, kinematic and numerical methods are used. We cooperate with universities to validate and introduce new con-
Geotechnical monitoring

Geotechnical monitoring is an essential part of geotechnical engineering and the actual doing is described in ASTM (American Society for Testing and Materials) standards and the philosophy e.g. in Eurocode 7.

Monitoring is used as a tool to:

- validate geotechnical design and trigger pre-defined courses of actions on time when accelerations in deformation or absolute values of deformation exceed trigger limits (limits defined in advance).
- analyze the behavior of geotechnical structures for which no design is available. In those cases the data generated by monitoring is the input for a subsequent geotechnical design.

Monitoring is not performed for its own sake. Monitoring is a part of the design process (key words: observational method). Therefore, the frequency of monitoring, the type of monitoring and the reactions to monitoring by operations are part of the same design and geotechnical management process.

The type of monitoring depends on the design, geotechnical category, mining method and geotechnical environment. Monitoring of slopes in hard rock operations is different from monitoring of slopes in clay quarries or monitoring of slopes under water in dredging operations. The parameters that are monitored in our mines and quarries (Figure 1) vary from local deformation monitoring on the object itself (e.g. over a single rock discontinuity), to large scale monitoring of deformations on the scale of a mine and quarry (e.g. using inSAR, Interferometric Synthetic Aperture Radar), to monitoring of stresses in hard rock operations. As is described in the text monitoring can be done to verify slope design but can also be used to deduce the rock mass properties to be used as input parameters for the design process itself.

The following overview (more details can be found in Schmitz (2020)) shows geotechnical monitoring done in house (only InSAR and fracking, and the installation of load cells and Lidar scans are hired-in). Geotechnical monitoring methods can be grouped as:

deformations/velocity/accelerations:
- deformation measured in surface mines with e.g. inclinometers (applied in Sibelco clay pits, hard rock open pit mines, quarry walls) or tachymeters or simple tell-tales (surface mines),
- satellite based radar interferometry (used to monitor surface mines, tailings facilities and subsidence above underground mines),
- Special dredging sensors have been developed to monitor the behavior of slopes under water.

stresses: absolute values and changes in mine and quarry morphology (topography):
- photogrammetry with drones provide topography (nearly all our quarries use drones),
- LIDAR drones have been used for a new surface mine development in a forested area,
- bathymetry for dredging operations, and 3D laser scanning to map geotechnical features in underground mines.
- **absolute values and changes in petrophysical properties**: Measurements of changes in dielectric constants, electric impedance / resistivity (used to determine if changes in moisture content, thus suction occur in sand layers)

- **rock mass, soil and structural elements**: This type of monitoring is traditional construction monitoring. Samples are taken e.g. during backfilling or buttressing to check if the specified density has been attained.

- **hydrogeological properties**: Changes in pore water content of porous media are part of the petrophysical monitoring described above. Monitoring of hydrogeological properties in terms of measuring the position of “free water” consists of i.e. measuring location and changes of the water table.

Water has an enormous (negative) impact on the stability of soils and rock. In “dry” quarry operations only slight changes in water pressure in the slopes determine if certain rock wedges are stable or not. Determining hydrogeological properties (e.g. borehole draw down tests with borehole pumps) and monitoring water level evolution is very important.

Monitoring of slopes is important during project realization (thus excavation of the slopes) to verify design and to check if specifications are met. Note that, depending on the geotechnical risk, monitoring might be required and will continue after the project has been realized (in a way such monitoring of e.g. final slopes in reclaimed areas might be considered as part of the asset management of a valuable recultivated terrain).

**Design and monitoring in sand operations**

In order to design and plan the monitoring of the slopes in a sand operation we need to predict the behavior of soils and rocks in response to extraction or loading. Geotechnical engineers require knowledge of the:

1) physical properties of the rocks and soils
2) the nature of the action (i.e. the size of the tunnel dug into it or the size of a slope)
3) the constitutive law - the model - that links the reaction to the action

For this geotechnical engineers require models: a ground model (including water described below) and mine model or mine plan (what actions will occur when) and a mechanical model (analytical or numerical). The summation of these models is the geotechnical model.

**The mine model or mine plan**

The actions such as overburden stripping and extraction of raw materials - causing the imbalance to the soils and rocks on a mine site - are described in the mine model or mine plan. The actions describe what will be done (at what scale) and when (time start - time end). Many geotechnical processes are time-dependent. A perfectly stable slope created in clay can be stable for months but not for years. In this example erosion (water) and a viscous behavior (creep) play a role. It is evident that mine planning and geotechnical engineering are interactive disciplines.

**The constitutive law**

The constitutive law is the link between the action (e.g. the mining) and the model consisting of soil and rock mechanical properties and defines thereby the resulting reaction.

An example of a very simple constitutive law is Hooke’s law of elasticity.

Perfectly elastic materials react linearly to forces (actions). A certain force will create a certain deformation. Hard rocks - without discontinuities - behave like elastic materials. In reality, rocks and soils undergo not only elastic but also plastic deformation.

Since the behavior of rock masses and soil masses is non-linear, different constitutive laws have been tested and are used in practice. The simplest law is the Mohr-Coulomb law. In this case the rock mass is characterized by its elastic properties (E-modulus, Poisson’s ratio) and its plastic properties: friction angle and cohesion. Some of these properties can be measured in the field, some need to be determined in the laboratory.

A model that combines the geotechnical properties of soils, rocks and discontinuity with the constitutive law is called a “Ground Model” or “Geotechnical Model”.

With an appropriate ground model (with the properties of the rock mass, the soil and the discontinuities and an appropri-
ate constitutive law) and the reaction forces (provided by the mine plan) the resulting reaction must be calculated.

**Sand slopes, behavior in practice**

As follows from the discussion above, in engineering practice for sand operations a constitutive model needs to be selected, properties need to be determined in the field and on samples in the lab for all relevant sand (and overburden) layers. In the process of determining the stability of slopes in sand it is important to exclude that the material (here sand) is susceptible to liquefaction by checking based on the criteria discussed by e.g. Bray and Sancio (2006). The following steps described in the text below are applicable only if the sand is not susceptible to liquefaction.

In practice the Mohr-Coulomb constitutive model is still accepted as the constitutive model to describe the behavior of sand close to surface and under normal loading conditions, as are found in civil engineering excavation or sand extraction. The basic parameters for the Mohr-Coulomb model that determine the shear strength of the sand are the friction angle and the cohesion. The friction originates from the interlocking and sliding of the grains when subjected to shear and normal stress (which is a function of normal stress applied to the sand) and cohesion. Cohesion in sands can originate from cementation if the sand is cemented or if there is a clayey component (or from “suction” as is described below). For the same friction angle stable slopes in sand with a cohesion set to 0 (i.e. not taking the cohesion into account for slope design) have much shallower angles at which they are stable than slopes with a small cohesion even if this cohesion only amounts to a few kPa. The authors have analyzed many (steep) slopes in sand without clay or cementation. So why were these slopes stable?

In case of pure (only sand with no significant amount of clay) non-cemented sands, cohesion is produced by “suction” (“capillary effects”) due to the moisture content of the sand. This effect of moisture content has been observed by nearly everyone, as a child when building sand-castles on a beach, or in professional life. The behavior of sand is different when it is completely dry, saturated or at a low water content such as in sands found in their natural state in sand pits and other excavations. At low water contents sand slopes can be stable at very steep angles (e.g. up to 55 degrees or even more). Completely dry, sand slopes have a maximum slope angle of 30 - 35 degrees, and under water stable slopes in sand can be as low as 10 - 5 degrees (all of these values represent ranges observed in the field, and are different for cut slopes in virgin terrain and built slopes).

This effect on the shear strength of the sand can be quantified by doing shear strength tests on sand in the lab and the measured cohesion is then called “apparent cohesion”. The theoretic field of study is called unsaturated soil mechanics. The apparent cohesion is zero when the soil is dry or totally water saturated. It can reach important values (up to tens of kPa or even more) at intermediate water contents. The relationship is established by laboratory tests and results in a “retention curve” that describes the dependency of the suction (and the apparent cohesion) on the moisture content.

Although the general effect of moisture content on sand has been well known (in a qualitative sense) for a long time and the effect is significant for the stability of slopes “the implementation of unsaturated soil mechanics into engineering practice has proven to be a challenge: new technologies and engineering protocols such as those proposed for unsaturated soil mechanics are sometimes difficult to incorporate into engineering practice” (Fredlund et al. 2012).

So why is this still a challenge? Most probably this is related to the fact that the moisture content has a significant effect on the apparent cohesion and that the moisture content is being regarded as a not stable parameter (it is called “apparent”). A parameter such as the apparent cohesion can easily change when changes in e.g. seasons occur (dry summer, wet winter). This is of course true. However for one particular sand extraction (quarry) site, in the same sand deposit (or sand layer), in the same climatic region (with quantifiable seasonal changes) and when considering that face slopes or working slopes (the temporary slopes where extraction occurs) are continuously created and “fresh”, the moisture content and apparent cohesion are variable but at the same time finite. In addition the use of design standards such as the Eurocode 7 allows the inclusion of monitoring as part of the design process. In this case monitoring, being thus part of the design process, should be focused on monitoring changes in water content, thus in apparent cohesion (whether directly by measuring suction or indirectly by measuring changes in moisture content).

Figure 2 and Table 2 on the following page provide the results of parametric analyses with various values of apparent cohesion for different values of the internal friction angle. At a friction angle of 35 degrees the overall factor of safety of the slope is larger than 1 (stable) if the apparent cohesion is 10 kPa or higher, whereas the overall factor of safety is lower than 1 (unstable) if the apparent cohesion is smaller than 10 kPa. In soil mechanics values of tens of 10 kPa are very small and used not to be considered relevant and were therefore not always considered in design.

**Sand slopes, design in practice**

With all of this in mind how does the actual “doing” take place in practice. This is described below for an existing sand operation:
Table 2

<table>
<thead>
<tr>
<th>φ (°)</th>
<th>c (kPa)</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
</tr>
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<tbody>
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<td>0.53</td>
<td>0.64</td>
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</tr>
<tr>
<td>5</td>
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<td>0.77</td>
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<tr>
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<td>1.00</td>
<td>1.12</td>
<td>1.24</td>
<td>1.40</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>1.14</td>
<td>1.24</td>
<td>1.35</td>
<td>1.48</td>
<td>1.63</td>
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<tr>
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<td>1.95</td>
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</tr>
<tr>
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<td>1.94</td>
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<td>2.18</td>
<td>2.33</td>
<td></td>
</tr>
<tr>
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</tr>
<tr>
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<td>2.89</td>
<td>3.00</td>
<td>3.13</td>
<td>3.27</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: The results of limit equilibrium calculations for the slope presented in figure 2 show (the line in red is the isoline for a global factor of safety equal to 1) that for a sand with a friction angle (φ) of 35°, an apparent cohesion (c) of about 7.5 kPa is enough to stay at the limit of stability.

A) Actual slope profiles need to be measured. For this today normally drones are used. With a drone a typical sand operation can be “flown” in 1 hour. Processing takes place during a few hours in the office and the next day information of slope profiles, angles etc. is available for study. Of course traditional measurements with hand held rangefinder (with azimuth and inclination) and inclinometers or tachymeter on a tripod can be used alternatively and still do a great job in the field. It is important to catch and analyze the entire slope morphology in sand pits including the steeper upper part of the slope, the mid-section and the toe of the slope and consider each morphological unit in further analyses.

B) Perform classical field mapping. Identify different layers, hydrogeological situation. Start creating a geotechnical model of the quarry (i.e. understand and take into account the geomorphology of the area at large (Fookes et al. 2015).

C) The information from (A) should then be used to do slope stability back calculations to determine which friction angle and cohesion value might fit to the existing slopes (taking into account the hydrological conditions).

D) Based on (B) and (C): set-up the sampling and in situ testing campaign and the lab program. Samples can only be collected in a good way if the lab program has been well defined. For example, in the case that there are gravel layers, a standard (10cm*10cm) shear box cannot be used. The grains will be too large. In that case an e.g. 50cm*50cm shear box must be used. This device requires however 300 kg of sample or even more for one test location only. It is evident that the collection of small samples (e.g. 5 kg) or larger samples (300 kg) requires different logistics.

E) Carry out the lab tests and determine the shear strength. Determine the (apparent) cohesion (e.g. by performing shear box tests at several moisture contents).

F) Use all of the above information for sensitivity analyses: What does it mean if the apparent cohesion is 1, 2, 5, 8, 10 and 15 kPa; how does the global factor of safety change?

G) Then design stable slopes (temporary and final slopes) and compare the stable slope angles with the required slope angles for a profitable operation of the sand pit.

H) Design the monitoring system. Decide on the basis of the sensitivity analyses of moisture content, the data from the field (moisture content in the field), and the slope angles if monitoring of changes in moisture content is required.

In a following contribution in TGP we will provide an example of these processes and show the devices Sibelco uses to monitor if changes in apparent cohesion take place in active sand extraction operations and the actions that then need to be taken.

Summary

This article discussed the background for the design, design-based monitoring (and the standards that allow to do this) in the light of optimum extraction of sand in sand extraction sites. We explained how the apparent cohesion affects the stability of slopes and under which conditions it can be used in the design of slopes in sand quarries (e.g. for temporary slopes). Then a step by step overview was provided that detailed how the design should take place taking the apparent cohesion into account in the design of slopes in sand quarries.

References


About the Authors

Robrecht Schmitz, has a MSc-Eng (Delft University of Technology) and a MSc in advanced studies and a PhD in applied Sciences (both Université de Liège). He has been working for 15 years in different mines in different positions and with different minerals. He is visiting lecturer at Delft University of Technology (since 2009). He is currently Global Leader Mining and Geotechnics with Sibelco. He is registered as CGeoel, CEng, CSI, CEnv, CMgr and CPG.

Christian Schroeder is a civil engineer and PhD. He has been a member of the academic staffs of the Université de Liège (ULg), Université Catholique de Louvain (UCL) and, from 2003, Université Libre de Bruxelles (ULB). Presently, he is invited Professor at the ULB and is the manager of CES Consult, the geotechnical consultancy company he founded in 2008.
In Memoriam

Jefferey T. Anagnostou, PE, CPG-07859
Livonia, Michigan
February 11, 2019

Member Since 1990

Jeff Anagnostou died on February 11th, 2019 on Livonia, Michigan. He had been a member of AIPG since 1990. He was 59 years old, and the principal and geotechnical engineer at Applied Geotechnical Services, Inc. He was educated at the University of Michigan, from which he held a B.S. in Earth Science and an M.S.E. in Geotechnical Engineering.

He was a volunteer for Hand-in Hand & Potter's Wheel Ministries in Northville, Michigan. Jeff is survived by his wife Shellie, children, Sarah, Nicholas (Abigail) and Kaitlyn and grandson, Myles.

Barry A. Schwartz, CPG-10421
Maspeth, New York
November 6, 1961—August 18, 2020

Member Since 1999

Barry A. Schwartz, 58, of Maspeth, New York, died August 18, 2020. He was born in Hyde Park, New York and was raised in Kew Gardens, New York.

He was a professional geologist in New York. Barry was also an active member of the Civil Patrol for more than 20 years. He co-owned Feathered and Friends Parrot Adoption Service for more than 15 years.

Barry was happily married to his wife, Gayle, for more than 16 years. He leaves behind his wife, Gayle; son, Peter; mother, Rochele; and sister, Jodi Engel.

Gerald “Jerry” Wayne Thorsen, CPG-01525
Port Townsend, Washington
February 25, 1933—May 6, 2009

Member Since 1967

Gerald “Jerry” Wayne Thorsen, 76, of Port Townsend, Washington, died May 6, 2009, of mantle cell lymphoma. He had been an AIPG Member Since 1967.

Jerry was born in Arlington, Washington, February 25, 1933 to Homer and Ildrie Thorsen. He graduated from Arlington High School in 1951 and received his BA in General Studies and MS in Geology from Washington State University.

He served in the U.S. Army Reserves where his specialties were map making and air photo interpretation.

During college and following graduation he was employed in mining and minerals exploration. In 1958 he moved to Olympia and joined what is now the Washington Division of Geology and Earth Resources, the state’s geological survey. His projects there included investigations of mineral deposits and abandoned mines, geothermal resources and geologic hazards, as well as mapping. He was the author of several volumes of the Department of Ecology’s Coastal Zone Atlas and co-authored a manual to help shoreline property owners minimize bluff erosion. One of his reports about earthquake hazards in Washington won a national award. He retired in 1988 and was a consultant, particularly in slope stability issues.

In the mid 80’s Jerry moved from Olympia to Port Townsend. He was a volunteer with the Port Townsend Marine Science Center, enjoyed sailing in Puget Sound and British Columbia waters, and was an accomplished carpenter and wood worker.

Jerry is survived by his wife, Katherine Milmine Reed; daughters, Peggy, Cathi (Marc) Capri, and Mary (Lenny).

Thank You, AIPG

Dear Amer. Institute of Professional Geologists,
I’m honored to have been chosen as the NAGT’s OEST Southwest Section Winner and want to thank you for the 1-year subscription to “Professional Geologist.” It’s opportunities like these that challenge me and fellow teachers to continue to learn and grow so we can invigorate our students to do the same. Thank you for supporting me and opening new doors. I can’t wait to dive in!

All the best,
Rachel Arbor
Weird Sharks & Wright State Students

Ryan Shell, SA-7165, Paige Wilms, SA-9748, Connor Motzko

Throughout history, as the world became more thoroughly explored, our understanding of “monsters” caused the total number of animals considered “monstrous” to drop. Sharks, however, always seem to remain on these subconscious lists. Their primitive two body plans, large sizes, and razor-sharp teeth all come together to create this image of a terrifying predator. As a student of paleontology, I have noticed that many of the features that make sharks interesting to the casual observer seem to magnify with geologic time. The strange, primitive body plans seen in modern sharks and rays (the elasmobranchs) appear stretched to their limit as we peer into the past. The large sizes seen today (in the White shark, for example) are dwarfed by the likes of the mega-toothed sharks of the earlier Cenozoic. Finally, their razor-sharp teeth, though ubiquitous, leave much less information for paleontologists to work from than the fossils of other vertebrate groups. In many ways, sharks are as mysterious to paleontologists as they are to beachgoers, albeit for different reasons.

My name is Ryan Shell. I am a PhD candidate at Wright State University. As you could guess, the bulk of my research deals with sharks in deep time (specifically the Permian Period of Texas and Kansas). I would like to introduce three ancient sharks: species that are not as well-known in popular culture as the Megalodon yet deserve more than a passing glance by museum visitors.

At Wright State University, it has been my privilege to join several paleontology field courses (and to plan a few as well) with a focus on sharks and other ancient marine predators. I wrote an article last year (Student Edition volume 50, issue 1) with David Peterman detailing some of these experiences and what they taught us. For this article, I would like to change course somewhat and discuss the ancient marine predators themselves. Two former students, Paige Wilms and Connor Motzko, are each weighing in on their favorite species.

Paige is doing her undergraduate research on a Pennsylvanian shark community in central Ohio. Following in the footsteps of a field course I helped to teach, Connor has been searching for the remains of Miocene and Cretaceous sharks in North Carolina.

Ryan’s Entry:

The trilobite that was a fish and the fish that was a trilobite.

The shark genus Janassa is an atypical shark in the modern sense (or rather, a chondrichthyan since it pre-dates the evolution of true sharks). In fact, I think it is atypical in almost every respect. Its flattened teeth, arranged into “tooth families” are unlike any modern shark teeth, and it is one of the rare few Paleozoic chondrichthyans to be preserved as a body fossil. I first encountered this genus when I recovered its fossil teeth from Permian sediments in southern Texas and eastern Kansas during my dissertation field work. The bizarre shape of the teeth, however, isn’t what keeps me talking about it. The history of how this animal was classified, as science the concept was invented, is almost poetic. A poetic comedy to be specific.

First, a lesson in tooth anatomy. There are two ‘faces’ of a shark tooth, these faces are where most of the anatomical information that we use to identify teeth and describe new species can be found. The labial, or lip-side, of the tooth is the surface that faces outward while the lingual, or tongue side, faces inward.

The lingual side of a Janassa tooth has most of the features useful to taxonomists. The crown of the tooth itself is usually shaped like a half-circle, and there is a washboard-like row of ridges (cristae) beneath the main cusp that is often as thick or thicker than the crown itself. Finally, there is the root which is fairly small and featureless (see the figure below). The three anatomical zones of this tooth, coupled with the fact that many Janassa fossils are only single teeth, combined to create a perfect storm in 1820 when Ernst Friedrich, Baron von Schlotheim discovered and described the type species (the species to which all other members of the genus are compared), Janassa bituminosa, as a trilobite.
In a way, at the very core of the trilobite definition, Schlotheim seems right. The remains of the animal he encountered in the Permian of Germany (or what was at the time the Duchy of Saxe-Gotha), had three very unique regions, and the middle region, the washboard of horizontal cristae, looked similar to the thoracic ridges of some trilobites. The problem then arises from every other part of the definition of a trilobite: that it had jointed segments, a hard shell not made from apatite (the mineral in bones and teeth), and a hypostome for eating. Another issue is that a trilobite head is not the featureless hemisphere of a Janassa crown. Trilobite heads have eyes, cranial sutures, glabella, and all kinds of other anatomical structures that combine to indicate that a trilobite fossil is what remains of a small arthropod, and that a tooth lacking these features is... a tooth.

The study of fossil animals, and of the earth in general, was still very new at this time. The idea that trilobites represented bottom-dwelling marine arthropods was a somewhat recent discovery when Schlotheim was alive, and the whole body of Janassa would not be described until 1899.

When Janassa bodies were finally found, especially in the Carboniferous Bear Gulch locality in the 1990s, they displayed a very flat animal. It had eyes on the top of its body, a mouth that faced downward -towards the sea bed- and large flat fins to propel it along. Janassa, it would seem, was a bottom dweller after all; one of the first vertebrates to ever take advantage of the sea floor in the same way that stingrays, skates, and flounders do today. Janassa may have been the first bottom dwelling “flat fish” in the literal sense of the word.

But this revelation isn’t what makes the story ironic. For that, we must look to Edward Lhwyd. In 1698 he published a landmark paper in British paleontology. In it he described several fossils he recovered from Wales in the UK, including the first published reference to trilobite fossils since the ancient Greeks and Romans. The concept that these strange stones were, with certainty, the remains of long dead animals was new and hotly debated in Lhwyd’s time. The idea that any animal could go extinct was also new (and generally thought to be false, heretical, or both) in his era. The combination of these two 17th century perspectives led Lhwyd to describe the first ever discovery of a trilobite (outside of the ancient Romans and Greeks) as the “Skeleton [sic] of some flat fish.” This means that the history of our early scientific understanding of Janassa is the mirror opposite of our understanding of trilobites: Lhwyd’s flat fish became an arthropod while Schlotheim’s arthropod became a flat fish.

**PAIGE’S ENTRY:**

**Cladoselache and its missing claspers.**

Cladoselache was a small shark that went extinct about 350 million years ago. It was about four feet in length, and the body plan of this species is very similar to modern sharks, with a few key differences. These ancient sharks had a terminal mouth and a very weak, flexible jaw joint. They also lacked a solid column of vertebra, a feature of modern-day sharks. Cladoselache also had scales only around its eyes, gills, and mouth. Modern sharks, on the other hand, have dermal scales over most of their bodies.

Some paleontologists suggest that Cladoselache had two primary tooth structures: either smooth teeth or teeth with several sharp cusps. The cusped teeth each have five needle-like points. These cusps improved the grip that the shark would have had on its prey. Cladoselache teeth lead researchers to believe that this species didn’t tear or chew their prey, but rather swallowed their prey whole. Many fossils found show that the shark would digest its prey tail first, leading researchers to believe that Cladoselache chased down its prey, biting the tail first. The diet of the Cladoselache consisted of ray-finned fishes, conodonts, small shrimp-like organisms, and possibly other smaller species of shark.

Some of best specimens of this species come from the Cleveland Shale, located on the southern shore of Lake Erie in Ohio. These specimens are so well preserved that many fossils have soft body parts intact, such as kidneys, muscles, and skin. There are a few hypotheses as to why this species is so well preserved. One is that the deeper water was anoxic and aided in preservation by slowing or preventing the decay of soft tissues. Another hypothesis is that Cladoselache’s blood was urea-rich and this, like the anoxic water conditions, helped prevent the decay as the shark was covered in sea floor sediment.

To me, the most fascinating characteristic about this species is the reproductive system. Modern male sharks have organs called claspers which transfer sperm to the female during mating.
None of the Cladoselache fossils that have been unearthed from the Cleveland Shale have claspers. This leads paleontologists to believe that either all of the fossils found are females, or that Cladoselache lacks this organ altogether. This would mean that female sharks occupied a different habitat than males, or that this shark did not reproduce the same way as all other sharks and rays, though more research would be needed to know for certain.

I first learned about this species when I was doing some additional reading for my undergraduate research project on the Portersville Shale in Athens, Ohio. My research focuses on the vertebrate species present in this locality, specifically the ancient sharks. What made this shark interesting to me is how well preserved the specimens are despite the lack of claspers.

**CONNOR’S ENTRY:**

**Water goblins.**

My favorite ancient shark is the genus Scapanorhynchus, which lived throughout the Cretaceous period and (probably) went extinct alongside dinosaurs during the K-T Boundary impact. The first fossil shark teeth I ever collected in the field were anterior and lateral Scapanorhynchus teeth from the Sardis Formation in Tennessee (see figure right, courtesy of the Cretaceous Research in Tennessee Facebook page).

My collection of Scapanorhynchus teeth has grown immensely and specimens range in size from a few millimeters to over 2 inches in length. I encountered them from central Tennessee to eastern North Carolina as a student in Ryan’s field courses at WSU.

Through collecting these teeth and observing their morphology, I learned that they have two different functions. The anterior teeth are long, slender, and allowed the shark to...
stab and grip onto its prey. The lateral and posterior teeth, however, are triangular with cutting edges that allowed the shark to slice the flesh of its prey, usually after catching it with its anterior teeth.

*Scapanorhynchus* is one of my favorite ancient sharks because it is the first shark that I have studied in the field, and because the morphology of its teeth explains the lifestyle of the animal so well. The body shape of *Scapanorhynchus* and its relatives, with a thin snout and freakishly protruding mouth, is also fascinating to me. The appearance of this terrifying looking group of sharks—called the goblin sharks today—leads many to believe they hail from deep sea environments, where other strange and monstrous fish dwell. However, body fossils of *Scapanorhynchus* from shallow water limestones in Lebanon make it apparent that this particular group of goblin shark evolved its alien appearance long before their modern cousins ventured into deeper water. While strange to our eyes, *Scapanorhynchus* must have been a regular sight in the shallow late Cretaceous waters of North America and the rest of the world.

**About the Authors**

Ryan Shell plans to graduate from Wright State University’s Environmental Science PhD program later this year (2020). He had previously earned a BS in geology from the University of Arkansas in 2013. Ryan primarily studies the biodiversity and ecology of ancient sharks. He will also begin geology teaching as an adjunct instructor for the University of Dayton in the fall of 2020.

Paige Wilms plans to finish her BS at Wright State’s Earth and Environmental Sciences department (EES) in the fall of 2021. She is also doing undergraduate research on a Paleozoic shark site in central Ohio that contains both *Janassa* and relatives of *Cladoselache*. She has also worked in the field with Ryan and Connor as part of WSU field courses. Later, Paige wants to pursue vertebrate paleontology at the graduate level. She is currently employed as a Teaching Assistant at Wright State University’s Earth and Environmental Sciences, and volunteers in the Paleontology lab at the Cincinnati Museum Center.

Connor Motzko graduated from WSU’s EES department in the spring 2020 with a BS. He first became interested in fossils when he was in middle school though the science olympiad. He met Ryan and Paige in WSU field courses such as Geology of the Appalachian Front, which was taught in the summer of 2019, and Atlantic Coast Paleoecology, which was taught in the spring of 2020.
On May 28, 1997, I packed up my sleeping bag, tent, hammer, hand lens, field clothing, and a long list of required equipment, tossed everything into the trunk of a 1987 Thunderbird, and set out for Lander, Wyoming. My destination: the University of Missouri’s E. B. Branson Field Laboratory, situated about 7 miles up Sinks Canyon, just southwest of Lander. I was nervous about camp. I was more than a little concerned that my aging T-Bird would not be up to the challenge of a 2200-mile round trip, having already logged more than 210,000 miles on the odometer. I stopped to stay the night with a friend in Lincoln, Nebraska and pressed on, covering just over 700 miles the second day. I met up with some classmates who were also attending the Branson Lab, and we camped just up Sinks Canyon, trying to acclimate to the elevation and chatting nervously about what to expect at FIELD CAMP. We seemed to say it that way, in all caps, as if it were larger than life. For us, it was a critical component of our undergraduate education. Our institution required a ‘C or better’ in field camp to graduate. This was our biggest test. The moment that we would take all of our classroom learning and all of our other field experiences and learn to use them to understand the processes that govern how the physical Earth works.

As we sat around the campfire that first night, it became clear that we were all worried about field camp. We attended a ‘directional state university’ and field camp represented a step up in the world. A quick look at the list of attendees revealed students from Cornell, and the University of Wisconsin, from Stanford, and the University of Minnesota. All of us were worried that we might not have the same quality of education as those from larger schools. One of my classmates, I’ll call him Jim, was extremely worried. He wasn’t always the best student, and he often eked out the bare minimum to get by. He was, quite frankly, intimidated.

We camped for another night, then made our way to the Branson Lab on Saturday morning. We were the first group to arrive; we got settled in, picked out our accommodations in the bunk house, and began to explore the campus. About an hour later, the first van loaded with students arrived. After we watched them disembark, Jim walked over to me, a broad smile on his face. “I’m going to be just fine,” he said. When I asked what had changed his perspective, he replied, “There were 13 students on that van. There were also 13 brand-new rock hammers.” He was right. In fact, of the 42 students that attended our camp, about 2/3 had never used their hammers on an outcrop. Our undergraduate program offered a field trip with every course and required a field trip for most. We had our noses on the outcrop from day one. It gave us a tremendous advantage when we could walk up to an outcrop with confidence and immediately begin to describe what we saw. For others, Field Camp was their opportunity to learn to ‘approach an outcrop.’ That ability is a critical component of our profession.

Sadly, the COVID pandemic resulted in the cancelation of nearly every field camp offered in the United States in the summer of 2020. I say ‘nearly’ because I have not been able to verify that every camp was closed, but I have also not been able to find a camp that remained open for in-person instruction. Many camps went to a virtual model, offering virtual field trips in lieu of on-the-outcrop instruction. While these virtual programs have value, they simply are not the equivalent of field studies. To be fair, the universities offering field camps were in a no-win situation and did the very best they could under unprecedented circumstances.

As a former field camp instructor, I appreciate the difficult choices that colleges and universities were forced to make. Still, I worry. I worry that some camps that often operate on the thinnest of margins will not reopen. I worry that schools, which already have begun to make field camp ‘optional’ will accelerate that move away from field-based geology education, to more virtual options. I worry that some schools will do the same with all field trips, moving completely away from field-based instruction. Times certainly change, and geology (and geologists) must change with them. However, there is no substitute for seeing rocks in the wild. As Alvis Lisenbee once told me, “the best geologists are the ones that have seen the most rocks.”

What can we do to ensure that seeing rocks in their natural habitat remains a core component of geoscience education? Speak up! Tell professors, students, administrators, tell everyone who will listen not only that field trips and field camps are important, but why. Tell them about the critical analytical and observational skills that are developed. Tell them about the importance of learning to take good field notes, and how those notes can sometimes become part of the legal record of a geological investigation. Tell them how these field experiences broaden the knowledge base of every geologist and how one critical field experience can expand the horizons not just of a geologist but of the team of which they are a part. Volunteer to assist with a field trip. Help universities get access to critical field sites when it is safe and appropriate to do so. Offer to develop and lead a field trip to sites that are critical to your specific field of geology. Show everyone, in word and deed, that hands-on, field-based learning opportunities remain a crucial component of geology education. Lend your voice and your experience to students and universities as they navigate these uncharted waters.

I wish you all the best this fall.

Aaron

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What a Year!

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I can honestly admit that I did not expect my year as president to go in this direction. It has been an interesting year to say the least. I have been working from home since March and while the transition was difficult at times, my work progressed as usual for the most part. Travel is a part of consulting, so I was already set up with a laptop, cloud-based access to work files, and the necessary equipment for the conference calls that fill up my calendar most days. However, all of us were not so lucky. Especially our headquarters staff. The Colorado stay-at-home order provided the staff a short amount of time to completely change their working environment from office-based to a mobile work force. This required an enormous amount of effort by the staff and they did not miss a beat, so we all owe our thanks and appreciation to Aaron Johnson, Wendy Davidson, Cathy Duran, Cristie Valero, Dorothy Combs, Mona Scott, Kathy Givlar, and Lauren Zeek. Thank you all for the work you do and for keeping AIPG running smoothly from home.

We held the first virtual Executive Committee meeting in June. Although the meeting was successful, we were planning to be in Minneapolis where I know the Minnesota Section had some great activities planned for us. I hope we get the opportunity to visit the Minnesota Section soon. The uncertainty of when states will open back up also led to the postponement of the annual meeting in Sacramento scheduled for October. There was some discussion about making this a virtual meeting, but we ultimately made the best choice for AIPG by postponing the meeting. The interaction with fellow members, interacting with students, and the field trips are integral to our annual meetings, and I will look forward to attending our 2021 annual meeting in Sacramento. Thanks to the California Section meeting committee for their hard work planning for the 2020 meeting – you are ahead of schedule for 2021!

In addition to our meeting postponement, I was scheduled to present at the GSA NE/SE Joint Section Meeting in Reston, Virginia at the Geoscience Careers for New Geoscience Graduates session chaired by AIPG members Ron Wallace and Mike Lawless. This was also cancelled, which was a disappointment as I always enjoy presenting to students eager to start their careers. It is always a great opportunity to recruit new students and early career professional members. Additional cancellations included the EFG spring meeting in Serbia and Geoscientists Canada 64th meeting, which I was able to attend virtually.

Our next executive committee meeting is scheduled for October 2020 and is typically an integral part of the annual meeting. The committee meeting includes opportunities for Section representatives to provide updates and we plan to continue to provide the Sections this opportunity in October. However, it will be virtual this year. Additionally, we will need to elect our 2021 Advisory Board representatives. The Advisory Board is a critical component of the Executive Committee as they provide routine communication between the Sections and the Executive Committee. This will be a challenging year for the elections, so if you are interested in running, please reach out to your Section Executive Committee and get on the ballot.

It has been a year of firsts for most of us. I transitioned to work from home in March and will do so through the end of 2020. Our office will undoubtedly be downsized with many choosing to stay at home permanently. My son started virtual school in August and the timeline for transitioning to inperson school is still being developed. The only thing constant in this life is change, so all we can do is embrace it.

I will admit this is not how I hoped my year as president would go, but everyone’s plans have changed this year. I was looking forward to representing AIPG at EFG and the GeoScientist Canada meeting. As many conferences have been cancelled this year, we will need to double our efforts next year to continue to recruit Student Members and Early Career Professionals as they will drive our membership growth in the coming years. I have said and truly embrace the idea that students and early career professionals should be receptive to the wealth of knowledge that professional members can convey, but also acknowledge that this is a two-way street. All of us should be open to other opinions. Professionals will inevitably disagree but should do it professionally. Disagreements should only be opportunities to improve. Disagreements should not be an attack on another person.

It has been an interesting year for us all. Furthermore, it has been a disappointing year for me due to the pandemic that has limited my ability to represent AIPG at various meetings. However, nothing has been more disappointing than the defamatory and derogatory letters and e-mails I have received from a few members this year directly aimed at myself and other members. I am not going into the specifics because senders deserve no notoriety. It is a supreme disappointment on a professional level to know that we have members in this organization that not only condone this behavior but promote it. I pride myself on my integrity and I know what I do is morally and ethically right. Unsolicited opinions from members that have never met me have no chance of changing that. If you plant ice, you’re going to harvest wind.

"The only thing constant in this life is change, so all we can do is embrace it."
1. **Pleurocoelus** describes a fossil:
   a) Pelecypod.
   b) Sauropod.
   c) Cephalopod.
   d) Who dreams up these weird names for fossils, dude? Why not something simple and descriptive, such as Clotilda the toothless clam, or Desmond the squashed-face dinosaur, or Mortimer the arm-weary mollusk…

2. “Hanging” lobes, knobs, bulges or lumps may form along bedding planes separating distinct sedimentary layers, where material from the overlying layer descends into the underlying bed. What term below describes these features?
   a) Load cast.
   b) Boudinage.
   c) Concretion.
   d) Not sure, man, but these “hanging bulges” sound as something ugly to run into…

3. Of the choices below, which one should NOT be expected to apply to clay-rich soils or argillaceous sediments as values of Atterberg limits and indices increase?
   a) Strength decreases.
   b) Permeability decreases.
   c) Potential volume change decreases.
   d) Hey hombre, who cares about the increasing limit of Atterberg’s index… just give me another tequila shot…

4. Which of these is a source of lithium?
   a) Cinnabar.
   b) Spodumene.
   c) Wolframite.
   d) Dude, do you know my pharmacist?

5. As geoscientists, it is sometimes helpful for us to comprehend the order of magnitude of the time frame involving various geological processes. Say that in our field work we encounter a horizontal, 100-meter thick basaltic sill with an olivine layer at its base. Think of an olivine crystal that solidifies at the top of the cooling sill. How long would it take for it to settle to the bottom? Is it a matter of minutes, hours, days, years? For simplicity, let us assume that the olivine crystal is nearly spherical with a density ($D_0$) of 3.8 gcm$^{-3}$ and a diameter ($d_0$) of 0.25 cm. Assume a Newtonian viscosity for the basaltic magma ($U_m$) at around 1200°C of $\approx$ 50 kgm$^{-1}$sec$^{-1}$ and a density ($D_m$) of $\approx$ 2,700 kgm$^{-3}$. Recall that the acceleration of gravity is 9.8 msec$^{-2}$. Ignore any turbulence or convection in the melt, or any crystal-crystal or bubble-bubble interaction, etc. Thus, to a first approximation, what is the time that it takes for our olivine crystal to settle to the bottom of the sill?
   a) A few hours.
   b) A few minutes.
   c) A few days.
   d) A few years.
   e) Dude, the day that I start thinking of little olivine spheres floating and sinking in magma, I’d say it is time to go PARTY!
Sri Lanka’s Miocene Jaffna Formation Fractured & Karstic Limestone Aquifer: the Sole Source of Drinking Water in the Jaffna Peninsula

Barney Paul Popkin

The tropical coastal aquifer is the sole source of drinking water for the 120,000 people of Jaffna City and the 615,000 residents of the 850-square kilometer Jaffna Peninsula in coastal Sri Lanka (Figure 1) and is poorly studied. It is thin, with low permeability, and limited storage capacity. It is overused, and rapidly degraded from manmade pollution and natural seawater intrusion. The aquifer is a shallow, generally flat, weathered and karstic limestone, whose few outcrops have mostly been removed to create more agricultural land.

Because it is relatively young, even though the climate is tropical there hasn’t been sufficient time to create the huge caverns found in many other carbonate aquifers. Because it is not heavily faulted, its fractures are not well connected and its primary and secondary hydraulic conductivities are low. The aquifer receives most of its natural recharge during the Maha monsoon of November to December, and some during the gentle Yala monsoon in May to September. It is otherwise over-pumped during the long dry seasons and saturated during the monsoons. It also receives significant recharge from household sewage and seawater. It is heavily polluted by agricultural chemicals, leachate from garbage, industrial waste disposal, and septic tank seepage. Because of rising sea levels and uncontrolled seawater intrusion, it is becoming more and more saline.

Although the aquifer receives about 20 percent of the regional rainfall as groundwater recharge, it has a small storage capacity and cannot meet agricultural, industrial, municipal, and household water demand (the relevant climatic, aquifer, and demand parameters are summarized in Table 1 at the end of the article). Consequently, although most households have shallow hand dug or drilled boreholes for washing, cooking, and cleaning, and the National Water Supply and Drainage Board supply public water at public roadside stations located throughout much of the City, householders import their drinking water as purified bottled water. Many of the over 80,000 domestic wells have been developed by blasting the aquifer to increase its local permeability and water-storage capacity. The water wells are typically approximately up to 10 meters deep.

To counter municipal water scarcity, it is planned to build a 35,000-cubic meters per day seawater desalination plant at Peaquochakadu, located 70 km southeast of Jaffna City’s Central Business District. Construction of this plant will be funded by an Asian Development Bank (ADB) loan. In addition, there are many small to very large schemes of constructed freshwater lagoons and surface water tanks for supplementing irrigation water. These engineering innovations are being undertaken to correct the municipal and irrigation freshwater deficits affecting the approximately 735,000 residents of Jaffna City and Peninsula.

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Answers:

1. The answer is choice “b” or “sauropod.”

**Pleurocoelus** was a small member of the sauropod family, which includes giants such as *brachiosaurus* and *diploicus*. These lizard-hipped dinosaurs were herbivorous.

2. The answer is choice “a” or “Load casts.” These sedimentary structures form during soft-sediment deformation shortly after burial and prior to lithification. They generate due to the differential loading caused by a denser layer of sediment being deposited on top of a softer, less dense, often saturated material capable of flowage. The “hanging” lobes, knobs, bulges and lumps form as columns of the denser strata sink into the underlying, softer, plastic layer.

“Boudinage” refers to cylindrical, lenticular or rectangular structures that develop from the stretching or extension of firm but flexible strata embedded in a yielding, less competent matrix.

Concretions, common in sedimentary rocks and soil, are hard and compact masses of mineral matter that form as mineral cement precipitates within the spaces between particles or clasts. They may be oval, quasi-spherical or have irregular shapes.

3. The answer is choice “c” or “Decreasing potential volume change.” In general, for clay-rich soils and sediments, as the Atterberg limits and indices increase:
   - Potential volume change increases.
   - Compressibility increases.
   - Organic content increases.
   - Strength decreases.
   - Permeability decreases.

Clays with high values of Atterberg limits and indices are typically of low strength, low permeability and high potential volume change.

4. The answer is choice “b” or “Spodumene” \([\text{Li,Al(SiO}_3\text{)}_2]\). Spodumene belongs to the pyroxene family with a hardness of 6.5-7.0 and perfect prismatic cleavage in two directions. Hiddenite (pale emerald green) and kunzite (pink to lilac) are gemstone varieties of spodumene.

Cinnabar \((\text{HgS})\) is a sulfide or mercury whereas wolframite \([(\text{Fe,Mn})\text{WO}_4]\) is an oxide of iron, manganese and tungsten.

5. The answer is choice “c” or “A few days.” The calculation follows. Recall that as we drop below ~ 1300°C crystallization will begin in a cooling magma. We are given:
   - \(U_m = 50 \text{ kg m}^{-1}\text{sec}^{-1}\) (i.e., 50 pascal-second or \(5 \times 10^4\) centipoise at 1200°C)
   - \(D_m = 2,700 \text{ kg m}^{-3}\) (at 1200°C)
   - \(D_o = 3.8 \text{ g cm}^{-3} = 3,800 \text{ kg m}^{-3}\)
   - \(d_o = 0.25 \text{ cm} = 0.0025 \text{ m}\)
   - \(g = 9.8 \text{ m sec}^{-2}\)

The settling velocity \((V_{set})\) may be approximated by using Stoke’s Law, where:

\[
V_{set} = \frac{(2/9) (g) (d_o)^2 (D_o - D_m)}{(U_m)}
\]

Substituting our numbers into (1) we obtain:

\[
V_{set} = \frac{(2/9) (9.8 \text{ m sec}^{-2}) (0.0025 \text{ m})^2 (3,800 \text{ kg m}^{-3} - 2,700 \text{ kg m}^{-3})}{(50 \text{ kg m}^{-1}\text{sec}^{-1})}
\]

\[
V_{set} = 2.99 \times 10^{-4} \text{ m sec}^{-1} = 9,443 \text{ myr}^{-1}
\]

For our 100-meter thick sill:

\[
T = \frac{(100 \text{ m} \times 1 \text{ yr})}{(9,443 \text{ m})} \times (365 \text{ days/yr}) = 3.9 \text{ days}
\]

From (4) and in our much over-simplified model, we see that it would take roughly 4 days for the crystal to settle down to the bottom of the cooling sill.

As stated in the question itself, this exercise is intended to simply provide us with an understanding of the order of magnitude of the geologic process versus what we might have intuitively conjectured. Be aware that the simplifying assumptions that we make can give rise to substantial differences in the potential answer. But, hopefully, this type of exercise gets us within the ballpark of reality and is better than just a simple guess or an arm-waving derived supposition.
Jaffna City or Town, also referred to as the Jaffna Municipal Council (JMC) extends 6 km east to west along the coast runs and 4 to 8.5 km inland. The Jaffna Lagoon and the Indian Ocean form the JMC’s southwest and south boundaries, respectively (Figure 4). The highest elevation is 10 meters above sea level. There are no rivers or perennially flowing gullies within the city.

The management of the aquifer is much criticized due to its anthropogenic pollution and natural seawater contamination.

As there is no piped sewage collection in Jaffna City, raw domestic and industrial sewage from buried, near-surface septic tanks easily leaks directly to the underlying aquifer, from where it flows into canals. The 32.6 km of main drains; 30.4 km of submain drains; 50 km of other drains, 43 stormwater detention ponds, and 8 sea-outlets also recharge the aquifer with untreated sewage (Figure 5).

However, there are “honey wagons” (Figure 6) which collect some wastewater for anaerobic treatment and land application at the Jaffna City solid waste management facility at Kallundai, 6.5 kilometers northwest of the Central Business District. The facility includes wastewater treatment, composting, plastic and glass recycling, and slaughter house and solid waste landfilling.

In addition, only half of Jaffna City enjoys garbage collection and disposal service, so much garbage is burned and/or thrown into the mentioned canals and ponds, a further addition to the pollution of the aquifer. All the canals and ponds are polluted with garbage, construction debris, and trash vegetation; and at least ten ponds have been filled in as designated garbage dumps.

Moreover, because the local tropical soils are low-fertility coarse regosols and calcareous latosols, they drain rapidly with infiltration rates exceeding 42 centimeters per hour. To make them commercially productive for paddy and vegetable crops, the soils must be over-irrigated, heavily fertilized and treated with pesticide. Thus, agricultural chemicals extensively pollute the Aquifer. Greenhouse agriculture is not an option because of its cost and unsuitability for rice and field vegetables.

Tidal fluctuations in sea level, especially during the dry seasons when groundwater levels are low, and climate-change induced rising sea levels, naturally contaminate the aquifer. The solution to seawater intrusion would be a network of fresh groundwater recharge wells along the coast, which would be expensive and is likely not feasible.

Finally, as for all limestone aquifers, the groundwater is naturally hard from dissolved calcium carbonate which promotes adverse gastrointestinal health effects.

In summary, groundwater typically contains agricultural chemicals such as pesticides and fertilizers, solid waste and its leachate, and septage and raw sewage. All the water wells contain hard water, nitrates, and coliform bacteria. More than 50 percent of the wells produce high salinity water. Unfortunately, this pollution and contamination is irreversible.

The objective of my work was to lead a local team of consultants in preparing a stormwater drainage master- and procurement plan to be implemented for up to four million dollars (Figure 7). Because of the high extent of urbanization, flat coastal topography, and inadequately cascading gravity-driven canal, pond and sea-outlet network, the recommended engineering option of a network of pump lift-stations and large-diameter pipelines to the sea would require investment of at least $500 million.
Figure 4 - Jaffna Peninsula showing Jaffna Lagoon, Elephant Pass, and extent of Jaffna City.

Figure 5 - Jaffna Peninsula Cascading Stormwater Drainage Canals, Ponds, and Sea Outlets.
Figure 6 - Left: My Tamil maid Kamsda and driver Shanker view the septic tank behind my bedroom/office of my house in Jaffna; Right: JMC “Honey Wagon.”

Figure 7 - First draft of Jaffna Town Priority Basins for Stormwater Drainage Management.
However, some flood reduction could be readily achieved by:
1. Cleaning and keeping clean the existing canal, pond, and outlet network;
2. Installing, operating and maintaining rooftop water capture and post-flood release (Fig. 8); and
3. Increasing the storage capacity of the aquifer by blasting and tunneling.

Running the project turned out to be complicated because the client required the team leader to live in and work from the Jaffna House, while the local technical team of part-time consultants lived and worked in the capital Colombo, 393 kilometers to the south.

An added complication was that Jaffna was at the epicenter of the 30 years long civil war between the minority Tamil-speaking Hindu population and the national government. The Civil War devastated Jaffna and left it as the poorest and most neglected region of the country. For example, there is no functional civil airport, and there is an extensive military presence.

The work encountered several technical challenges due to the lack of rainfall and runoff records appropriate for numerical modeling of stormwater drainage. This was overcome somewhat by information provided by community members on the 2014 and 2015 floods, by land and aerial surveys, and by satellite maps.

References
MG Consultants, 2019. Assessment of Environmental and Social Baseline Conditions of the Ponds in the Jaffna City Region.

![Figure 8 - Schematic of capture of rooftop rainwater to reduce flooding and flood peaks. Drs. Hemanthi and Shirani, and Mr. Van Doorn were senior consultants on the project in Sri Lanka.](image-url)
Table 1

<table>
<thead>
<tr>
<th>1. Selected Water Parameters</th>
<th>S.I. Units</th>
<th>U.S. Units</th>
</tr>
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<tbody>
<tr>
<td>Annual Rainfall</td>
<td>11 yea</td>
<td>2008-2018</td>
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<tr>
<td>Range:</td>
<td>869-1839 mm</td>
<td>34-73 in.</td>
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<td>Median</td>
<td>1369 mm</td>
<td>54 in.</td>
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<tr>
<td>Rain Days</td>
<td>4 yrs</td>
<td>2015-2018</td>
</tr>
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<td>Range</td>
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<td>Median</td>
<td>73 days</td>
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<td>Annual Flood Vols.</td>
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<td>2014</td>
<td>1,736,089 m$^3$</td>
<td>1407 ac-ft</td>
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<tr>
<td>2015</td>
<td>2,247,255 m$^3$</td>
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2. Annual Fresh Water Budget

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<th>S.I. Units</th>
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<tbody>
<tr>
<td>Rainfall</td>
<td>100%</td>
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<tr>
<td>Runoff</td>
<td>30%</td>
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<td>Evapotranspiration</td>
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<tr>
<td>Aquifer Recharge</td>
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3. Annual Fresh Water Use

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<th>S.I. Units</th>
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<tr>
<td>Total</td>
<td>100%</td>
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<tr>
<td>Agricultural</td>
<td>71%</td>
<td>49 MCM</td>
</tr>
<tr>
<td>Munic. &amp; Domestic</td>
<td>29%</td>
<td>20 MCM</td>
</tr>
</tbody>
</table>

Soil Infiltration Rate

| Sandy regosols & red/yellow calcic regosols | >42 cm/hr | >17 in/hr |

Limestone Aquifer Permeability

47 rising head field tests

<table>
<thead>
<tr>
<th>Range</th>
<th>$10^{-8}$ - $10^{-5}$ ms$^{-1}$</th>
<th>~0.0028-2.8 ft/day</th>
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</thead>
<tbody>
<tr>
<td>Median</td>
<td>$10^{-6}$ ms$^{-1}$</td>
<td>~0.28 ft/day</td>
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40 large-pond infiltration tests

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<tr>
<th>Range</th>
<th>~2.12 to 232 ft/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>~13.2 ft/day</td>
</tr>
</tbody>
</table>

Groundwater level

| 0-3 m | 0 -9.8 ft |

Aquifer thickness

| 20 - 30 m | 66 to 98 ft. |
Online Teaching vs. Classroom Teaching

Rasoul Sorkhabi, Ph.D., CPG-11981

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Teaching tools, methods and environments have changed through history. There was a time – tens of thousands of years ago – when our cave-dwelling ancestors gathered around a fire and shared stories or painted the art of hunting on the rock. Indeed, for millennia, school was as large as life; children learned from their parents and tribal members all the time. This schooling is still prevalent in indigenous tribes. With urban life and division of labor came schools where professional teachers taught children how to read, write, measure, calculate, and so forth. With increased specialization, higher education in colleges and universities became necessary. Plato reportedly had this sign inscribed at the door of his Academy: “Let no one who does not know geometry enter” – the first recorded instance of an entrance examination. Aristotle’s Lyceum was less informal: He used to walk while teaching – hence his philosophy came to be known as the Peripatetic (“walking”) school. Higher education schools were particularly developed in the Islamic civilization from the 8th through 12th centuries. It was in these schools that textbooks, rather than being skin parchments, clay tablets or cloths were paperbound manuscripts (originally invented in China), and professors wore “embroidered robes” (what we still do in graduation ceremonies), sat on their own “chairs,” and issued “licenses.” These traditions were adopted by emerging universities in Europe during the Renaissance. In all these different styles of education one thing was common: Teachers and students had to be together. Correspondence schools that emerged in the 19th century changed the rules of the game, but they never became mainstream even with the advent of radio and television in the 20th century. Face-to-face classroom education has been the predominant platform of education through the history of civilization – until 2020, the year of the Covid-19 pandemic, when online education became a forced option, a necessary evil or a modern savior (according to different perspectives).

Online education, like correspondence schooling, is a type of “distant education” but the major difference is that – thanks to the internet – teacher and students can be together at the same time but in difference places. Online education is not entirely new. Even before the pandemic, universities offered continued education courses on their websites, and college teachers used email, e-textbooks, video recordings (lectures and documentary films), and Canvas system even in classroom teaching. However, the 2020 pandemic has compelled universities to embrace online education more fully. This has raised questions and debates as to the pros and cons of real-life classroom versus virtual classroom teaching (or e-education for short), and whether a full-scale online education is able to or is going to replace the traditional classroom teaching. These questions and debates have both immediate and far-reaching implications.

Virtual Teaching: Vice or Virtue?

The main difference between real-life classroom and online teaching is the working environment. In classroom teaching the environment is physically specified and limited to a fixed number of participants who have to commute there. In e-education, teacher and students do not meet in the same physical place. This has several advantages. Firstly, it offers ease and convenience; you do not need to drive to the campus and struggle to find a place to park, and then walk to classroom, all of which consumes your time. You can sit in the comfort of your room and attend the class. Secondly, being a virtual environment, many students can take the course, or even, more than one teacher can teach the class.

Flexible time is also often mentioned as an advantage for online classes although this depends on how the teacher administers the class. In traditional classes, the teacher and students spend, say 80 minutes, together per class, and attendance usually carries some grade points. In online classes, the teacher may decide to record lectures and post them online. This will give flexible time for the student to watch the lectures at an appropriate time. However, if the teacher decides to convene the class at a specific time on a teleconference platform (such as BlueJeans Meetings, Cisco Webex, ezTalks Meeting, GoToMeeting, Lifesize, Skype for Business, and Zoom), then there is little difference between real-life and virtual classes. Also, if the teacher sets deadlines for assignments and project reports to be submitted, it will be similar to classroom education in which students do their homework, assignments and

1. Canvas is a web-based educational management system designed by Instructure, a company based in Salt Lake City, Utah (founded by two BYU graduate students, Brian Whitmer and Devlin Daley, in 2008). It is used by a large number of colleges and universities in the US, even for traditional classroom teaching. Teachers can upload lecture notes, assignments and other teaching materials, send messages to students, grade their work, and so forth. In 2019, Instructure announced that Thoma Bravo would acquire the company for $2 billion.
projects at home, and turn in their solutions and reports by a deadline.

As a matter of fact, a highly flexible (loose) schedule in online teaching may not be desirable. If for the sake of time flexibility, the teacher does not have fixed online meetings or does not set deadlines for assignments, projects and examinations, students will not learn well.

Today, many teachers use PowerPoint files (with slides of bullet points, key words and images) in their lectures. On the one hand this saves time for the class. However, I have also heard from some experienced teachers that the traditional way of writing on the whiteboard (yesterday’s blackboard) and explaining the subject step by step with interesting anecdotes and answering the students’ questions on the spot offers the “deepest” level of teaching and learning. In face-to-face talks and interactions between teacher and students there are subtle psychological elements that cannot be completely reproduced in online classes. Recorded lectures, even if well designed, can be too official and impersonal.

Online teaching will work best for abstract knowledge and for many courses in the humanities and social sciences, but it will not work for practical aspects such as those in chemistry, geology, medicine, and engineering. One example from geology: Mineral identification is a very practical procedure; it requires that students actually hold and observe mineral specimens and do various tests under the supervision of a teacher. If this is taught online, each student should be provided with a full set of minerals and the necessary testing equipment to perform mineral identification, ideally in a teleconference class. Geologic field trip is another example. There are many other practical aspects in science, engineering and medicine that are best learned and taught face to face.

Online teaching ideally requires a fully-designed syllabus and course materials at the beginning of the course, while traditional teaching can be more flexible in these regards. Classroom teachers need not prepare everything before the course begins; they will give live lectures and they can also steer the course depending on the learning level and interests of students.

Examinations taken online may also pose their own challenges. Currently, Canvas allows the teacher to post examinations (usually multiple-choice questions) and set a range of dates and a time limit for each exam. These exams can also be graded automatically. But for closed-book examinations requiring calculations and writing each student will need an approved proctor (or conducted in a proctored teleconference). However, presentations for projects or term papers can be recorded (on PowerPoint file, for example) by the student and submitted to the teacher.

**Overseas Students**

If online education becomes mainstream, will there be a need for student visas? Overseas students can take classes online, be graded online and then graduate after scoring the required credit hours. They do not need to travel and live in faraway cities like Oxford and San Francisco. Indeed, this issue came up in 2020 when President Trump’s administration wanted the overseas students (with legitimate student visas) to depart the USA if they did not enroll in in-person attending classes (and many students could not do that, especially on a short notice, because their colleges and universities were not offering in-person classes.) Although the administration softened the rule temporarily after a successful lawsuit by several major universities like Harvard, MIT, Stanford and Yale, the issue still remains unresolved and can be reactivated in the future.

It should be noted that foreign students not only pay relatively higher tuition fees but also spend large sums of money on housing, food, transportation, entertainment, and so forth. The same is also true for out of state students. Therefore, a full-scale online education can have adverse impacts on local economies where magnet universities are situated. Moreover, overseas (and out of state) students bring in cultural diversity and cross-cultural understanding, and act as grassroots ambassadors bringing various peoples closer to each other. All these are absent in online education.

*Continued on p. 60*
Modernization of Property Disclosures for Mining Registrants

Comments on the U.S. Security and Exchange Commission’s (SEC’s) proposal are available at https://www.sec.gov/comments/s7-10-16/s71016.htm

John Berry, CPG-04032, Editor
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Robert Font, Ph.D., CPG-03953

The two most basic tools used in petroleum exploration and production are well logs and seismic data. Their integration is essential to enhance the probability of success of exploratory and development ventures. In this module we concentrate on the subject of well logs. Although we always hope for success when we drill wells, we can learn valuable information from dry holes also. So, let’s see what we can ascertain from well logs.

Robert Font, Ph.D. is the instructor for this course. Robert is a Certified Professional and Petroleum Geologist and a Licensed Geologist in multiple states and earned his Ph.D. specializing in engineering geology and geomechanics, from Texas A and M University. He has 48 years of professional experience in both academia and industry. He is a former tenured Associate Professor at Baylor University, Project Supervisor and Area Geologist for Conoco, Inc., Executive Vice President at Strategic Petroleum Corporation and President of Geoscience Data Management, Inc.

To watch this webinar, go to:
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STUDENT EDITION COMING UP!
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The Foundation of the American Institute of Professional Geologists is appreciative of the many donations received during 2019, including monetary donations, donated gifts-in-kind for the silent auction, and funds collected from bid winners at the silent auction at the AIPG annual meeting in Burlington, Vermont. The silent auction generated interest in the Foundation and resulted in about $3600 in funds to the Foundation. We are very thankful for these contributions and the interest in the Foundation. The Foundation is proud to be able to serve AIPG and the geosciences by providing financial support for scholarship programs, student workshops, and other endeavors in support of AIPG and the geosciences. Be sure to check the web site www.aipg.org/foundation for additional information about the Foundation.

The Foundation is a 501(c)(3) organization. Contributions are tax deductible.

We thank all our donors for their generous support of the Foundation. All contributions, no matter the amount, are greatly appreciated. Thank you!

Barbara Murphy, CPG
Chairperson, Foundation of the AIPG

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The application of geology to the needs of the general public may be in many different forms. Recipients of this award have outstanding records of public service on the national, state, or local level well beyond their normal professional responsibilities.

JOHN STEWART MEMORIAL EARLY CAREER PROFESSIONAL AWARD

The John Stewart Memorial Early Career Professional Award was established by the Executive Committee in 2019 in posthumous honor of John Stewart, who graciously gave his time and experience to AIPG and in encouraging geologists in their early careers and professional growth. This award is to honor an Early Career Professional member who has demonstrated an ongoing commitment to the geologic profession and AIPG at the section and/or national level, and in particular, to mentoring and aiding in the advancement of Early Career Professional members in their early careers and within AIPG.

This award is to assure that active and ambitious Early Career Professional member geologists are honored as the future of AIPG.

OUTSTANDING ACHIEVEMENT AWARD MAJOR CONTRIBUTION TO THE PROFESSION

The Outstanding Achievement Award was established by the 1989 Executive Committee to honor a non-member of AIPG who is widely recognized as a major contributor to the profession of geology. The award is not necessarily given annually, but only when the Awards Committee recommends an outstanding candidate to the Executive Committee for their consideration.

In 2013, the Executive Committee voted to expand the scope of the award to include candidates engaged in all types of media that inform or enlighten the public on the roles of professional geologists and the geosciences in society. This award may be for work in any media that inform or enlighten the public on the roles of professional geologists and geosciences in society. This award may be for work in any media such as visual (television, film, webcasts), auditory (radio, podcasts) or printed (books, articles, websites). The work must have been completed within five years preceding the award nomination and the nominee may be an individual, a group, or a company.

Nominations may be made online, e-mail, or fax by January 15, 2021.

https://aipg.org/page/Awards
AIPG Section Leadership Award

(Annual submittal deadline is January 15th)

The AIPG Section Leadership Award was established by the Executive Committee in 2013 to recognize one or more of our members who have demonstrated a long-term commitment and have been long-term contributors to AIPG at the section level. AIPG has many sections where one or more individuals have demonstrated exceptional leadership for their section and in many instances kept the section together and moving forward. These individuals are commonly not known at the National level or by AIPG members outside of their sections; however, their contributions have been vital to their sections and they perform this work because of their commitment to our profession and AIPG. All active section members are eligible. It is not required to be a current or past section officer. The award will consist of a plaque (or similar) that will be presented to the awardees at the annual meeting of AIPG.

Based on the above criteria the Awards Committee may select multiple nominees for the award.

The AIPG Section Leadership Award is administered by the Executive Committee of AIPG. The selection of the winning member(s) will be decided by the AIPG Awards Committee. The deadline for submittal of nominees for the AIPG Section Leadership Award, to AIPG National Headquarters, is January 15th of each year. The nomination form for AIPG Section Leadership Award is presented below. The awardees will be announced in April so they may attend the annual meeting.

AIPG Section Leadership Award Nomination Form

https://aipg.org/sectionleadershipaward

Name of Candidate: __________________________________________ Section: __________________________
Address: __________________________________________________
Telephone Number: __________________________ Fax: __________________________ E-Mail: __________________________

Name of Person Making Nomination: __________________________ Section: __________________________
Address: __________________________________________________
Telephone Number: __________________________ Fax: __________________________ E-Mail: __________________________
Date: __________________________ Signature: __________________________

Supporting Statement (In brief here, but please attach a detailed letter of support) __________________________

Return to: AIPG
Awards Committee
1333 W. 120th Avenue, Suite 211
Westminster, Colorado 80234-2710
or E-mail to aipg@aipg.org

DEADLINE: Completed nominations must be received by January 15, 2021.
Introduction
A 2009 presentation by McCuaig, Guj, Hronsky, and Schodde1 pointed out that, starting in the late 1970s and early 1980s, the mining industry began retreating from greenfields mineral exploration work, and that by a few years after the last turn of the century, spending on brownfields exploration work strongly exceeded that used to conduct greenfields exploration. See Figure 1 on page 57.

Perhaps tellingly, this abandonment of greenfields exploration work occurred over the same time period that shallow bulk mineable gold deposits became the dominant exploration target in the western world. See Figure 2 on page 57.

The McCuaig et al. observations of 2009 were coupled with the warning that brownfields mineral exploration programs eventually and necessarily become much more expensive within any given mining district. See Figure 3 on page 58. McCuaig et al. further cautioned that brownfields exploration does not lead to the discovery of additional large, highest value ore deposits. Given these facts, the authors predicted that the mining industry would be forced by declining ore deposit discovery rates and declining ore quality to return to its original greenfields exploration paradigm over the following ten years.

Although the mining industry did not actually return to an emphasis on greenfields mineral exploration over the following ten years, the 2009 prediction of eventual ore deposit discovery scarcity turned out to be accurate. Since the early 2000s, in fact, Schodde2 had been already consistently reporting that world-wide mineral exploration expenditures were increas-ingly outpacing the number of deposits found. See Figure 4 on page 58 as a recent example of such a Schodde report. Schodde’s interpretation of the causes of the continuing and growing discovery failure later departed somewhat from that analysis of the primary cause by McCuaig, Guj, and Hronsky, his 2009 co-authors. As early as 20133, Schodde introduced several new (but derivative/secondary) factors as alternative explanations for the breakdown of the relationship between exploration expenditure and ore deposit discovery:

Over the last 40 years the absolute number varied directly with the overall level of exploration spend. However, this relationship appears to have broken down in recent years. Even after adjusting for the inherent delay in reporting recent discoveries, the industry has become very inefficient in the last 5-10 years. MinEx believes that one key driver is a major increase in input costs (for labour, drilling and admin costs) – which means that less work gets done in the field. If you don’t drill you won’t discover. Other key factors would be the increased challenges in exploring in remote areas and under deeper cover.

Is the Discovery Problem Caused by the Retreat from Greenfields Exploration or Not?
A closer analysis of the worldwide greenfields versus brownfields gold discovery data provided by Schodde in 2010 conclusively confirms the original 2009 analysis carried out by McCuaig, Guj, Hronsky, and Schodde. See Figure 5 on page 59.

2. For example, http://minexconsulting.com/recent-trends-and-outlook-for-global-exploration/
Figure 1: Australian Mineral Exploration Expenditure in constant 2006-07 Dollars separating greenfields from brownfields expenditure. Source: Geoscience Australia (based on ABS survey data deflated by CPI)

Figure 1 - From McCuaig, Guj, Hronsky, and Schodde (2009). Greenfields exploration was progressively abandoned beginning in the late 1970s and early 1980s. By the first few years of the 2000s, brownfields exploration predominated.

Figure 2. Gold exploration became dominant over the same time period that greenfields exploration began to be neglected in favor of brownfields exploration.
Figure 3. From McCuaig, Guj, Hronsky, and Schodde (2009). As the brownfields “search space” becomes depleted with continued mining and exploration, brownfields mineral exploration costs rise and average discovered deposit size grows smaller.

Figure 4. The disconnect between exploration expenditure and discovery – the case of gold.
The Probable Cause of the Slide off the Reliable Path to Discovery

So, why has the mining industry misconstrued its own exploration history and self-destructively abandoned the greenfields mineral exploration paradigm that supported it so well for so long?

The answer to this question is the probable anchoring effect of the post-1970s emphasis on finding bulk mineable gold deposits that could be mined using open pit methods. Reducing this sort of exploration down to its essentials, the approach was (and is) to simply find surface gold anomalies in greenfields or brownfields environments and then drill them. While an effective strategy for locating and defining shallow bulk mineable gold deposits, this elementary method of conducting mineral exploration does not work very effectively for any but the very shallowest of ore deposits.

Figure 5. World-wide gold mineralization discovery data for the period 1950-2009. These re-graphed data obtained from a 2010 Schodde presentation show clearly that greenfields gold exploration work has always been much more productive than exploration work conducted in brownfields environments. Green symbols and lines-of-best-fit correspond to historical greenfields exploration efforts, while brown symbols and lines-of-best-fit correspond to historical brownfields exploration efforts. Note that even during the post-1980 period when the greenfields exploration paradigm began to be very seriously neglected, more gold was still found by the relatively few geologists working greenfields.

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Tales from the Field, continued from p. 18

plenty of trees around, and with holes in the ground every 50 feet, everybody was able to escape unhurt, but badly shaken. One or two had suffered near misses from shrapnel. The next morning I went to the Lieutenant Colonel commanding the Battalion to request that we be given an officer. He did even better: He gave us his 2 I/C, a Major, and the major had a walkie-talkie.

We had begun this project just before the rains, so that all the reeds that we would usually have cut to thatch our wattle-and-daub huts had already been burned off. I had managed to scrounge quite a few corrugated iron sheets from the mine, but not nearly enough to roof all the buildings, so I myself had to spend the entire rainy season in a 6'x6'x7' high WWII-style British Army officer’s tent. This was an El Niño year, and instead of the usual roaring thunderstorm every afternoon at four o’clock, it seemed that year to drizzle almost continuously almost every day. There was a large village close to our camp, since there was no other surface water within ten miles. Of course, I got malaria even though I was taking the preventative Daraprim: I had regular attacks every six weeks, lasting for 24 hours of hell.

The nearest doctor was the army M.O. at Tug Argan, and I eventually decided that anything was better than suffering through the fever until it ended of its own accord, and drove over there. All the officers were in the Officers’ Mess, but the doctor kindly agreed to take time out to treat me: he gave me a huge pill – not one of the anti-malarials that I knew - and then gave me an enormous shot in the backside. The effect was almost miraculous. So much so that he invited me over to the mess for a drink. I discovered that after secondary school in Zambia he had been trained at Edinburgh, one of the most
THE CHANGING FACE OF UNIVERSITIES

Traditionally, universities hire professors both as teachers and researchers. Teaching and research go hand in hand; they reinforce each other. Research funds support graduate students too. A full-scale online education can create divides and wedges in the education and employment schemes of universities.

For instance, some brand universities may offer affordable undergraduate online courses and degrees, and since online classes can include a large number of students, this may hurt many other universities. Or a select number of “Star” teachers may be hired by several universities, and this would limit the employment of other teachers or fulltime teachers. These developments may eventually decouple the undergraduate and graduate studies in many non-brand universities, pushing these universities toward focused post-graduate education and research. Or the universities, in their struggle for survival, may not accept (or extremely limit) credits transferred from other universities.

Irrespective of how the future unfolds, one thing is certain: The online education successes and lessons that colleges and universities earned and learned in 2020, the year of Covid-19, will help them to operate during the possible future emergencies.

CONCLUDING REMARKS

Online teaching is entirely new, but it is a new trend and still an evolving process with various levels. At the one end of the spectrum, online teaching may be totally “passive”: Simply upload the syllabus and course materials, and let the student study on their own and finish the course. At the other end of the spectrum, online teaching may involve virtual classes, regular interactions between teacher and all students, and a strict timeline for assignments and exams. This “interactive” format is more preferable as far as learning outcome is concerned.

Most of us – teachers – learned the art of teaching in classroom and for classroom students. Naturally, it will take more time, and perhaps a whole new generation of teachers, to prefect the art of online teaching. Nevertheless, real-life, face-to-face teaching and learning will not go away because it will always have its own usefulness, need and demand, and it is also the best format for certain subjects involving practical learning skills. Universities, for their own survival, will not abandon real-life campus education, either. However, we will increasingly see hybrid (blended) online and real-life classes offered by all universities.

Online teaching makes high-quality education available to many people who are not able to attend a university because of time, distance or finance. This is all good for society and for education.

The popularity of online education may also motivate high IT companies to become involved in universities and higher education. Scott Galloway, who teaches marketing at NYU Stern School of Business, goes as far as saying that partnerships will emerge between IT tycoons like Google and Microsoft and elite universities like Harvard and Cambridge, and in this way, a handful of universities will monopolize higher education and destroy many brick-and-mortar universities. This sort of market speculation about the future of universities indicates that high-tech online education has added a new dimension to university life which, to a large extent, remains uncharted territory, but full of opportunities and challenges. Education in the 21st century will be different from that in the 20th century which was different from the one in the 19th century. Digital technologies are changing the face of education worldwide but the core components – good teachers, good textbooks (and other teaching materials), and attentive students – will still be critical requirements, and in some practical areas, nothing will replace face-to-face education that dates back to the beginning of the humanity itself.


Besides, it was politically impossible for the Zambian government to attack the forces of freedom movements that it had welcomed to the country.
The Great American Outdoors Act (S.3422) is a bipartisan bill with strong support from 59 Senate cosponsors.

The Great American Outdoors Act combines $1.9 billion per year for five years for deferred maintenance at the National Park Service (NPS), United States Forest Service (USFS), the Fish and Wildlife Service (FWS), the Bureau of Land Management (BLM), and the Bureau of Indian Education (BIE) schools and permanent annual funding of the Land and Water Conservation Fund (LWCF) at $900 million per year. The U.S. Senate Committee on Energy and Natural Resources reported legislation that formed the basis of the Great American Outdoors Act with strong bipartisan votes in 2019.

This bipartisan legislation will help improve access to public lands, including for hunting and fishing opportunities, which creates jobs and increases economic activity. The legislation also creates jobs by funding long overdue maintenance projects that will ensure our public lands remain an important contributor to a strong and growing outdoor recreation economy that will benefit states and local communities throughout the nation and ensure our federal lands are protected and preserved for future generations to enjoy.

**Section 1 – Short Title**

**Section 2 – National Parks and Public Lands Legacy Restoration Fund**

- Establishes a “National Park and Public Lands Legacy Restoration Fund” to be used to address deferred maintenance needs of the NPS (70%), USFS (15%), FWS (5%), BLM (5%), and BIE schools (5%).
- The Fund would receive funding equal to 50% of unobligated onshore and offshore energy revenues over 5 years (up to $1.9 billion annually / $9.5 billion total) to provide mandatory funding to:
  - Reduce by over half of the NPS’s $12 billion deferred maintenance backlog, which will address the high priority deferred maintenance projects in national parks across the country; and
  - Significantly reduce the more than $8 billion in deferred maintenance backlog across the USFS, FWS, BLM, and BIE.

**Section 3 – Permanent Full Funding of the LWCF**

- Provides annual, mandatory funding of the LWCF at its authorized $900 million level.
- Fixes the broken mechanism which has allowed over $22 billion since the creation of the LWCF to be diverted for non-LWCF purposes. *(S.3422 does not recover the $22 billion, simply fixes moving forward.)*
- The LWCF doesn’t use taxpayer dollars but rather is funded from a portion of royalties on offshore oil and gas development.
- Permanent reauthorization of LWCF passed the Senate by a vote of 92-8 last year and was signed into law by President Trump in the John D. Dingell, Jr., Conservation, Management, and Recreation Act.
Photography and geology go hand in hand. Geologists have opportunities that many never get in a lifetime to see some of the most wondrous places, witness some of the most amazing natural events, and explore the planet from its depths to the stars. We are challenging you to share these amazing experiences with everyone in a photograph that we will feature on the cover of the four 2021 issues of *The Professional Geologist*.

Challenge categories:

1. Amazing Vista - show off a stunning view of a geological feature.
3. Show me the Mentoring - sharing knowledge and learning from experienced geologists has proven to be a most effective way to transfer knowledge and build long-lasting relationships.
4. Why I am a Geologist - show us in a photograph what inspired you to become a geologist.

Entries must be original and taken by a member. Entry authorizes publication of the image in *The Professional Geologist* by AIPG with credit given to the photographer.

Challenge Rules:

Image requirements: digital, 300 dpi, 8.5”x11,” full color.

Members are allowed one entry per category with up to four submissions (one per category).

All images must be original and taken by the member.

Submit entries via email to aipg@aipg.org.

Entries must include:
- Name
- Member number
- Section
- Title of image
- Less than 200 word description of the image
- Names of any identifiable persons in the image and permission to publish their photo
- Year photo taken

Entry deadline: November 1, 2020.

Awards:

First place in each category:

Image published on the cover of *TPG* in 2021. Membership dues will be waived for winner for 2021. Membership fee equivalent will be donated to the Foundation of the AIPG in the winner’s name. Although student memberships are free, AIPG will donate $100 for a winning student entry to The Foundation of the AIPG.

Runners Up in each category:

Images will be published in the *TPG* in a special feature album. Runners up will receive AIPG gear of choice.