OKLAHOMA
GEOLOGY NOTES

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Deciphering An Acoustic Anomaly

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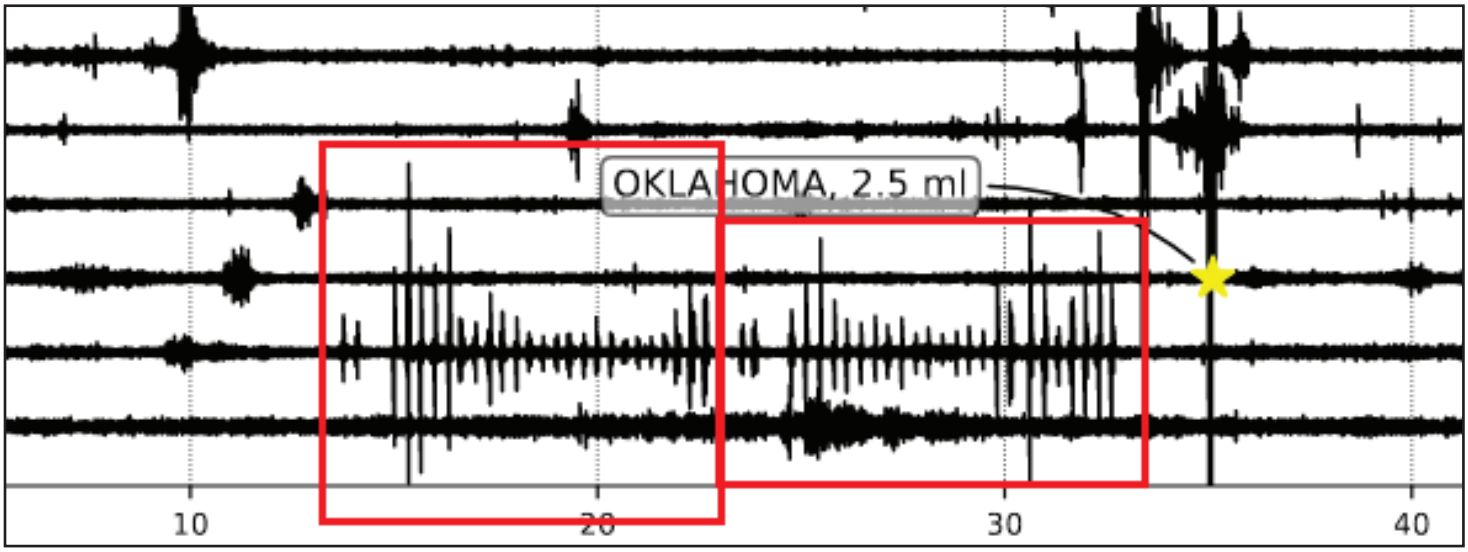

Also, OGS History Part 2: The Twin Territories

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OKLAHOMA GEOLOGICAL SURVEY

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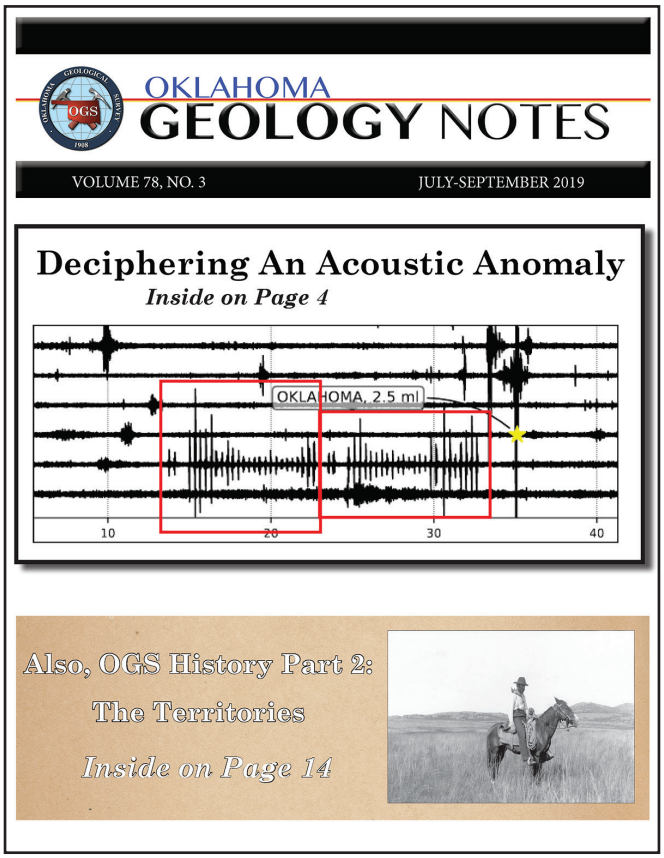


Man on the horse in the cover photo is Charles Gould when he was part of a US Geological Survey outfit northwest of Lawton. Comanche County, Oklahoma. 1901.

Dear readers,

This issue features an article by OGS Seismic Researcher Andrew Thiel, who details the story of how the seismic team began detecting unusual activity over the summer, and how the efforts to solve this mystery lead to some fascinating insights. This issue also includes Part 2 of our series on the OGS' history, and it begins with the establishment of the Oklahoma Territorial Survey and the arrival of Charles Newton Gould, who would come to be known as the Father of Oklahoma Geology.

Another thing I'd like to direct your attention toward is the Oklahoma Enhanced Oil Recovery workshop that the OGS is hosting this November. Details about sessions and registration can be found on page 4.

Kind Regards,

Ted Satterfield
OGS Editor

Oklahoma Enhanced Oil Recovery (EOR) Technical and Core Workshop

TECHNICAL SESSION (Thursday, November 14, 2019)

Purpose: **The Oklahoma Geological Survey (OGS) is developing a Technical Session and Core Workshop on enhanced oil recovery (EOR) with an emphasis on mostly tight sandstones, in particular, the Hoxbar Group of rocks in the southern Oklahoma and STACK/SCOOP/Merge areas in the Anadarko Basin of Oklahoma. The Pennsylvanian (Missourian) Hoxbar Group is economically important to the Oklahoma petroleum industry. In the Anadarko Basin the Hoxbar Group (e.g., Marchand sandstone) has been a prolific producer of oil and gas. Technical and engineering presentations will include sedimentology, reservoir quality, sequence stratigraphy, geochemistry, geomechanical rock properties and integrated depositional and diagenetic evaluation of the tight sandstones applied to EOR. Reservoir heterogeneity and mineralogy (as related to petrophysics) are important components used to evaluate EOR. The workshop is focused on the key learnings from both operators and researchers on tight sandstones and associated shales directly relating to EOR practices. The results of this work can be applied to other tight sandstones as an analog worldwide. The OGS is soliciting both sponsorships and presentations for this workshop.**

Where: **Moore Norman Technology Center - South Penn Campus, Oklahoma City, Oklahoma**

CORE WORKSHOP (Friday, November 15, 2019)

Purpose: **A half-day core workshop at the Oklahoma Petroleum Information Center (OPIC) will present cores from several key wells of the Hoxbar Group of rocks from Caddo, Grady, Stephens and Carter Counties. The Hoxbar cores (Medrano, Marchand, Culp Melton, and Cottage Grove Sandstones, Oolitic carbonate and the associated mudstones) will be viewed to compare the lithofacies changes regionally to examine their characteristics, and to see how the lithofacies (lithology) correlate to well logs.**

Where: **Oklahoma Petroleum Information Center, Norman, Oklahoma**

Technical Program Registration (Thursday 11/14/19)
Before October 11 (early-bird): $200
Beginning October 12 (normal): $300
Students: $75

Core Workshop Registration (add-on only, Friday 11/15/19)
$75 (limited seats available)

For further information about presentations, please contact Dr. Abbas Seyedolali (abseyed@ou.edu) or Mr. Ming Suriamin (huangcienming-1@ou.edu, 405-325-4437).

For further information about registration, sponsorship, or exhibit spaces, please contact Dr. Molly Yunker (yunker@ou.edu, 405-325-7313).

Hosted by the **OKLAHOMA GEOLOGICAL SURVEY**

Deciphering An Acoustic Anomaly

By

Andrew Thiel

Research Scientist, Oklahoma Geological Survey

On June 24, 2019, something interesting caught the attention of the OGS seismic team. Dr. Jacob Walter, State Seismologist, noticed a sequence of automatic detection picks that appeared on stations all over the state. Each automatic pick is essentially when the signal-to-noise ratio changes abruptly enough to trigger an automatic detection. This is intended to detect the phase arrivals of earthquakes, which it does quite well, but in this case, we were observing something different. An earthquake typically appears on a seismogram as a sudden excitement of the line being traced with time, followed a short time later by an even larger amplitude excitement, then gradually tapering off, eventually settling back to how the line appeared before the earthquake was detected. Each sudden change represents the arrival of different phases, which arrive at a station at different times because of how the seismic energy is conveyed through the earth. The "gradual settling down" is seen as a narrowing tail, called a coda. What we were seeing on June 24, however, was a series of brief pulses with no codas, each spaced precisely 20 seconds apart (Figure 1). Usually, something like this would be attributed to mechanical noise near a station, but it was being detected by stations all over the state, all at the same time. To be

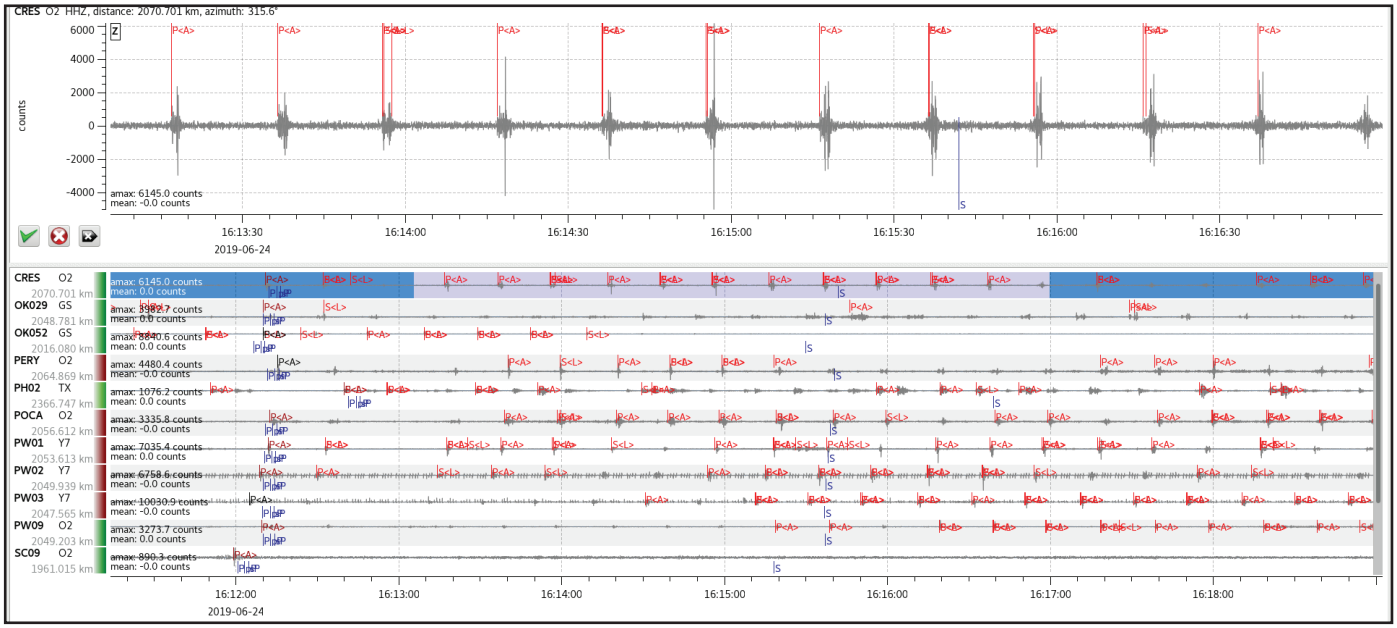


Figure 1: This shows the anomaly as it appeared on multiple stations, June 24, 2019.

observing something so widespread, but clearly not seismic, left us guessing as to a cause. Speculation was far reaching, from military aircraft, to a meteor shower or even something to do with pipeline infrastructure. We dubbed this signal "The Anomaly" (Figure 2).

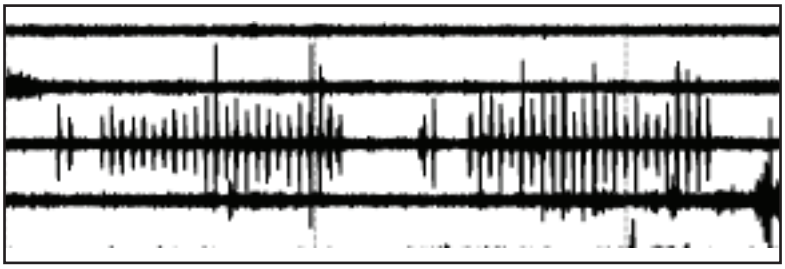


Figure 2: This image shows the anomaly pattern, twice. Two pulses followed by a gap, followed by 24 pulses.

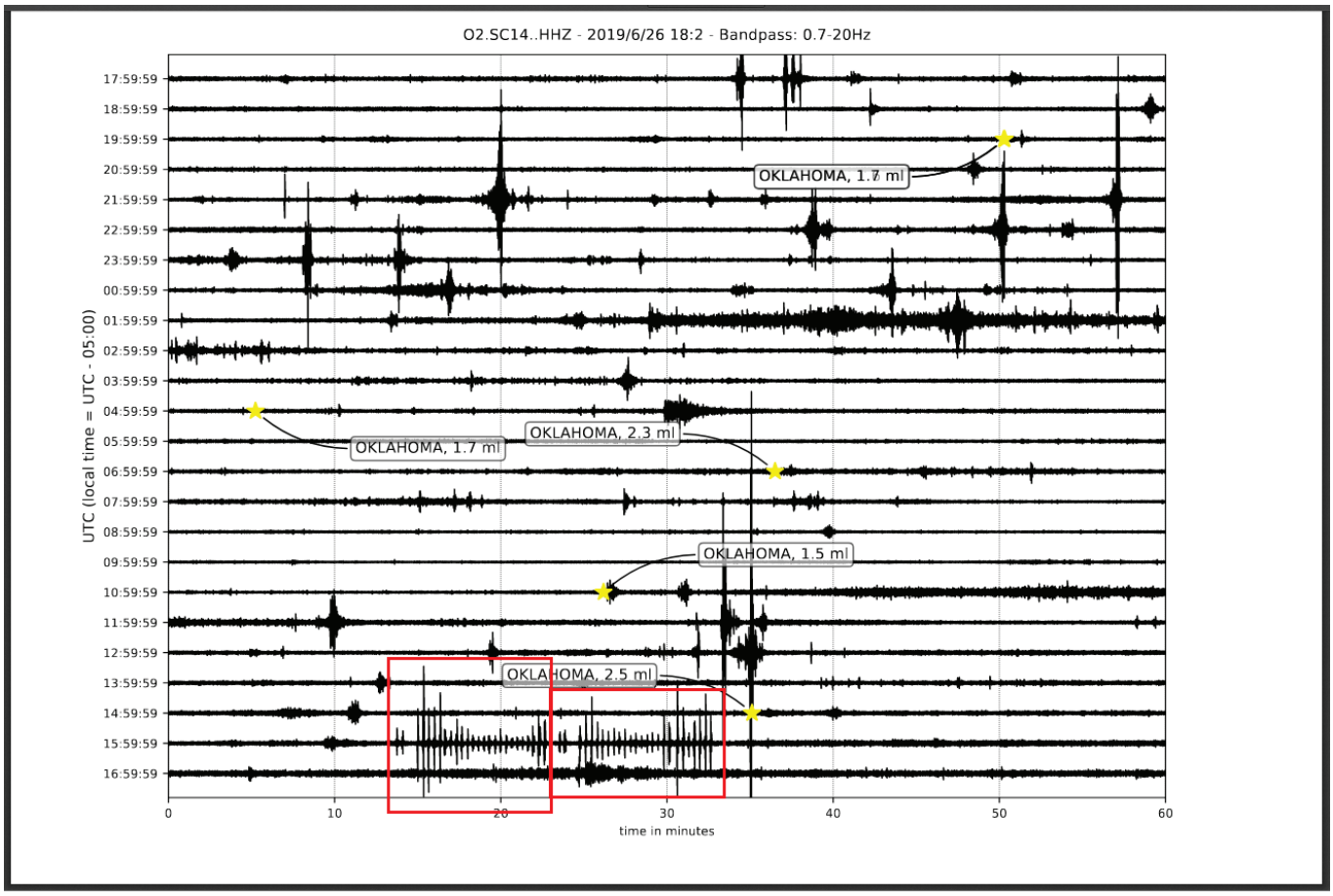
Initially, we attempted to locate a source for a single pulse. This approach failed to give even a remotely possible origin. Next we attempted using the first pulse to arrive at each station, which also failed to give any useful origin, but did present an interesting piece of information. The first arrival times for the stations that detected the signal — when added in sequence to a map — revealed that the signal was arriving at stations in an apparent "ping pong" manner. For example, the first pulse might be detected by a station near Tulsa (northeast OK), while the next station to pick up the first pulse was near Lawton (southwest OK), then the third back near Tulsa, etc.

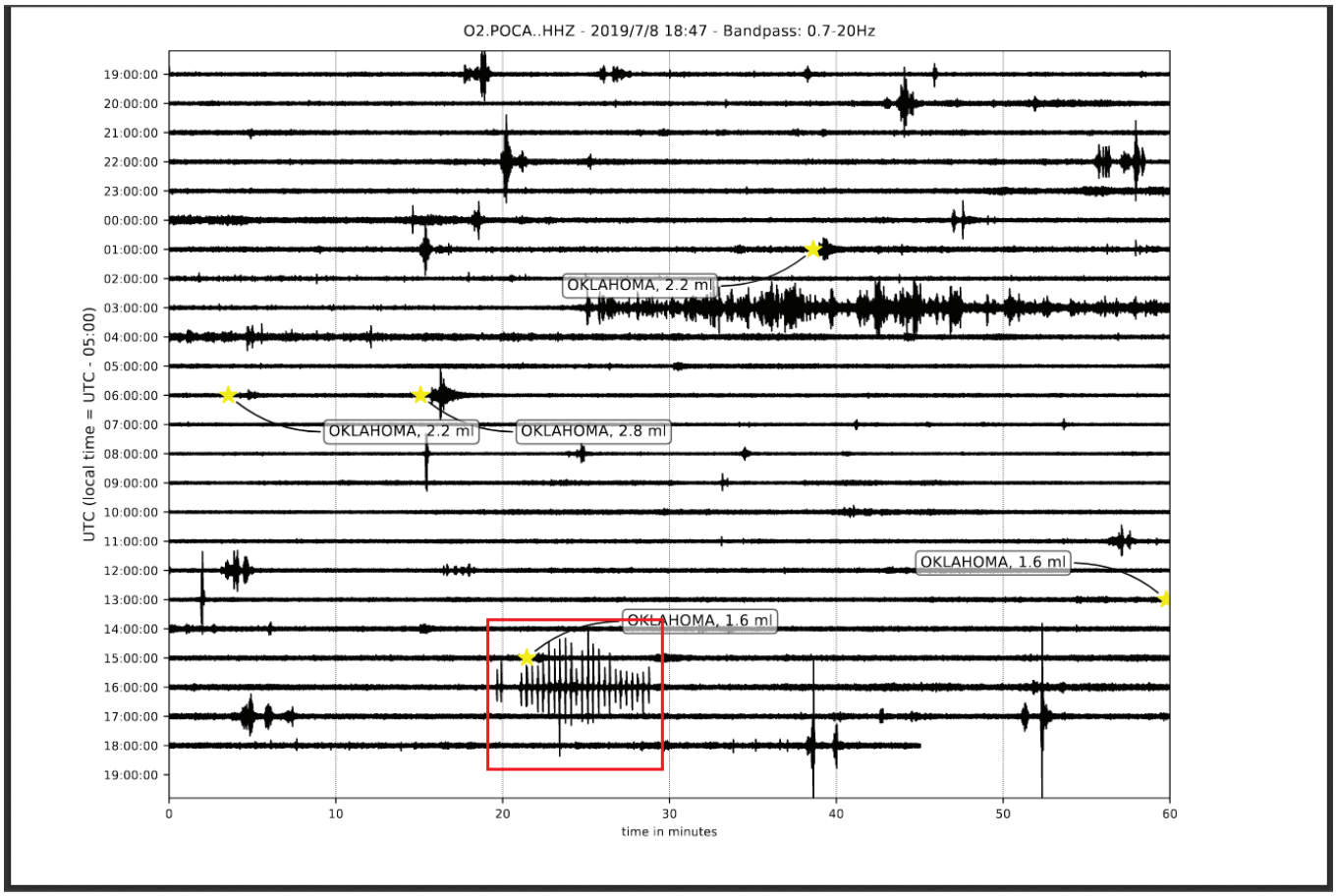
In subsequent days, the anomaly continued to show up around the same time each day (11:11 a.m. local), which led to checking past waveform data to see when else it might have been detected. Sure enough, on multiple days in the past, the anomaly had been detected. March 15th seemed to be the first instance, as during the three weeks preceding then the anomaly hadn't been detected. Curiously, the anomaly seemed to happen relatively less frequently (on fewer days) during March, but increased in frequency as time progressed. Similarly, the number of stations to detect the signal on days it occurred seemed to also increase as time progressed. Also of note was that the anomaly never seemed to occur on Sundays, and didn't occur over the 4th of July weekend. These last observations lent strong evidence to the source being related to direct human activity, rather than something automated.

The pattern of the anomaly was quite specific, with few deviations. It consisted of a pulse, then 20 seconds pause, then another pulse, then a longer pause of 40 seconds to several minutes, then an unbroken series of 24 pulses separated by 20 second pauses. This pattern usually happened twice, but sometimes only happened once (Figures 3 and 4). Relatively rare variations might be slightly longer or shorter pauses between some minority of the pulses, or skipped pulses, or a variation to the number of pulses in the sequence. Each individual pulse might have an approximate magnitude estimate equivalent to an earthquake of M1 to M2.2 (roughly approximated from random sampling).

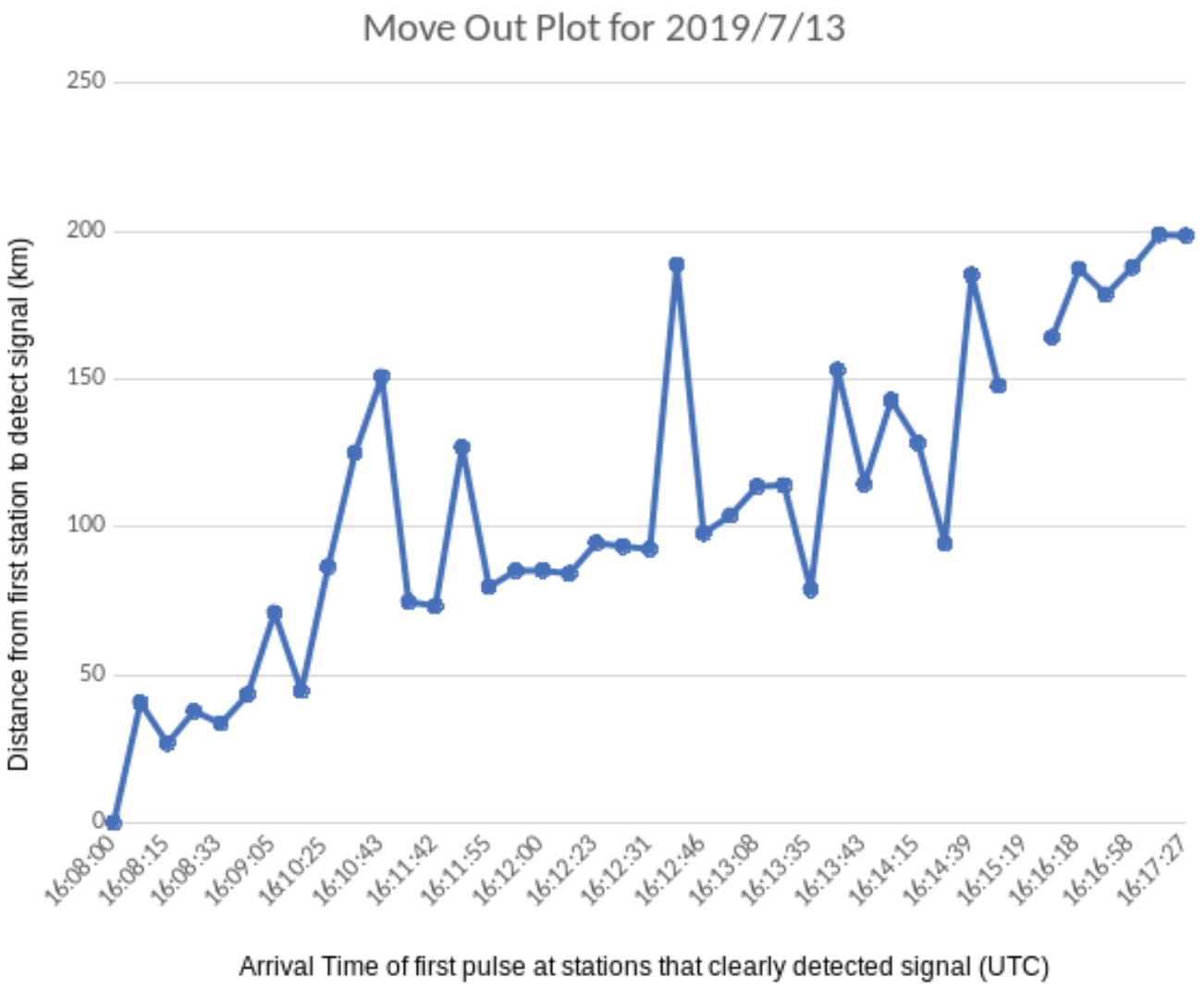
The anomaly was detected on a wide variety of sensor types (i.e., Streckeisen STS-2, Guralp CMG-6T, Guralp CMG-C3ESPC, Guralp CMG-3T, RaspberryShake, etc.). It was also detected on multiple networks, including ones we don't manage (i.e., Kansas, Texas, etc.) These factors allayed our concerns that the signal might be related to some bizarre form of equipment failure.

The anomaly became even more curious after pursuing another avenue of inquiry. Picking a day with a significant number of data points (41 stations had clearly detected the anomaly on July 13, 2019), we generated a move out plot. Move out plots are simple distance versus time plots where the slope shows velocity. Even with this many data points, we still couldn't determine the origin of the anomaly, other than that the overall trend seemed to suggest an origin to the southeast (with sensors near Lake Eufaula picking up the signal minutes before other stations more centrally located in the state, which was noted to happen in multiple records of the anomaly's occurrence). So, for a move out plot we instead used the "origin" as the first station that detected the anomaly that day. The plot might still be useful to determine velocity. And indeed, it did yield a velocity for the





TOP: **Figure 3:** Here the anomaly can be seen at station SC14, boxed in red. It repeated once in this instance, as it usually does (June 26, 2019). (Each horizontal line represents an hour.) BOTTOM: **Figure 4:** Here the anomaly can be seen at station POCA, boxed in red. It only occurred once that day (July 8, 2019). (Each horizontal line represents an hour.)



ABOVE: Figure 5: Move out plot for the anomaly on Saturday, July 13, 2019. Each data point represents a station, showing when it detected the first "pulse" of the anomaly, and how far away that station is from the first station to detect the anomaly that day. Note that the move out plot doesn't make a nice, straight line, as would be typical for point sources like earthquakes or blasts. RIGHT: **Figures 6 and 7:** Images from Google Earth of two barren locations within the McAlester Army Ammunition Plant. Each of these locations has approximately 28 apparent "blast pads" that are likely where munitions disposal detonations are performed.

anomaly on that day: approximately 370m/s. This is near the speed of sound in air. That suggested that the anomaly wasn't primarily moving as energy through the ground (vibrations move much faster through the earth than the air), but rather was moving through the air as acoustic energy (Figure 5).

Additional evidence that our seismic network was detecting something real came from the Oklahoma Corporation Commission (OCC), in the form of reports from citizens around the state who were hearing unexplained noises around 11:11 a.m. These noises were described as "bumps" or "mini explosions." The OCC sent personnel to investigate, and while they determined that the noises were not oilfield related, they didn't know their cause.

We also contacted Tinker AFB, Vance AFB, and Altus AFB to check if they knew anything about a potential source for these pulses. No answers were forthcoming, but those we spoke with at least sounded interested in the

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phenomenon.

By late July, we determined that there was sufficient data to confirm that our equipment wasn't somehow malfunctioning, and so decided to make our interest in the anomaly public. On July 25, an article presenting our observations was published in the OGS Field Blog (https://okgeosurvey.wordpress.com/2019/07/25/an-acoustic-anomaly/). A few days later, Dr. Walter posted a link to this article on his Twitter feed, which quickly changed the direction of our investigation.

That tweet caught the attention of Maya Wei-Haas, a reporter for National Geographic with an interest in Earth sciences. She contacted us expressing an interest in what we were observing, which quickly led to collaborating with her and her team. That collaboration continued over the next month, culminating in a National Geographic article (https://www.nationalgeographic.com/science/2019/09/strange-waves-rattled-entire-state-scientists-know-why/).

About ten days after being contacted by Maya, we were contacted by Dr. Joshua Carmichael of Los Alamos National Lab, whose research concerns seismic waveform detection, near-source wave physics and multiphenomenological explosion monitoring. He also expressed an interest in this phenomenon, and we began collaborating with him to seek out the possible source(s) and mechanism(s) by which this (apparently) acoustic energy was being transferred.

Around the time that Maya contacted us, we were looking into the possibility of explosives disposal at the McAlester Army Ammunition Plant as being the source of the anomaly. Dr. Walter remembered discussing the blasting there with Oklahoma residents from the McAlester area. Combined with the nuance that we weren't seeing the anomaly on Sundays, and that the overall move out plot trend suggested the signal originated somewhere in the southeast, all pointed to the army base there being a likely candidate as a source. It wasn't until a couple weeks later, though, that we managed to confirm with the army base that blasting did in fact occur most days (not Sundays) around 11:00 a.m., with the blasts staged at 20 second intervals. At the time of this writing, requests for further information, such as blast records, are still pending. The intervals between blasts are likely related to some maximum explosion yield permissible in a single detonation. From Google Earth, there are two barren locations within the army base that each have approximately 28 "pads" with apparent blast marks (Figures 6 and 7). This fits quite well with the acoustic pattern, as a blast sequence at each of these two locations could represent one of the typical 26 pulse patterns. The army would conceivably avoid setting off detonations at these two fields simultaneously, as that could risk surpassing the supposed maximum explosion yield limit. This could explain why most days the 26 pulse pattern occurs twice without the two sequences overlapping.

Knowing the source of the acoustic signal, the investigation shifted away from the mystery of "what could be causing this?", to a less dramatic but nevertheless interesting question of "how does this acoustic energy travel so far?" The average travel time from the move out plots reveal that the signal's energy is acoustic, not seismic. Indeed, there doesn't seem to be seismic energy associated with the signal. And yet, the signal is detectable as far away as Kansas and the Texas Panhandle.

A paper by Negraru et al (2010) describes a study in Nevada that gives insight into what could be happening here in Oklahoma. Essentially, sound energy — infrasound, to be precise — has been documented as traveling through the atmosphere and reflecting off of different atmospheric layers before returning to the Earth's surface. The speed of sound varies in these different layers, which directly affects the time it takes the sound energy to reach distant locations. As a hypothesis for what's happening in Oklahoma, this was supported when subsequent refinement of move out plots (using the McAlester army base as the origin) revealed different average travel time velocities for detection at different distances from the origin. This is indicative of sound waves moving through — and reflecting off of — different atmospheric

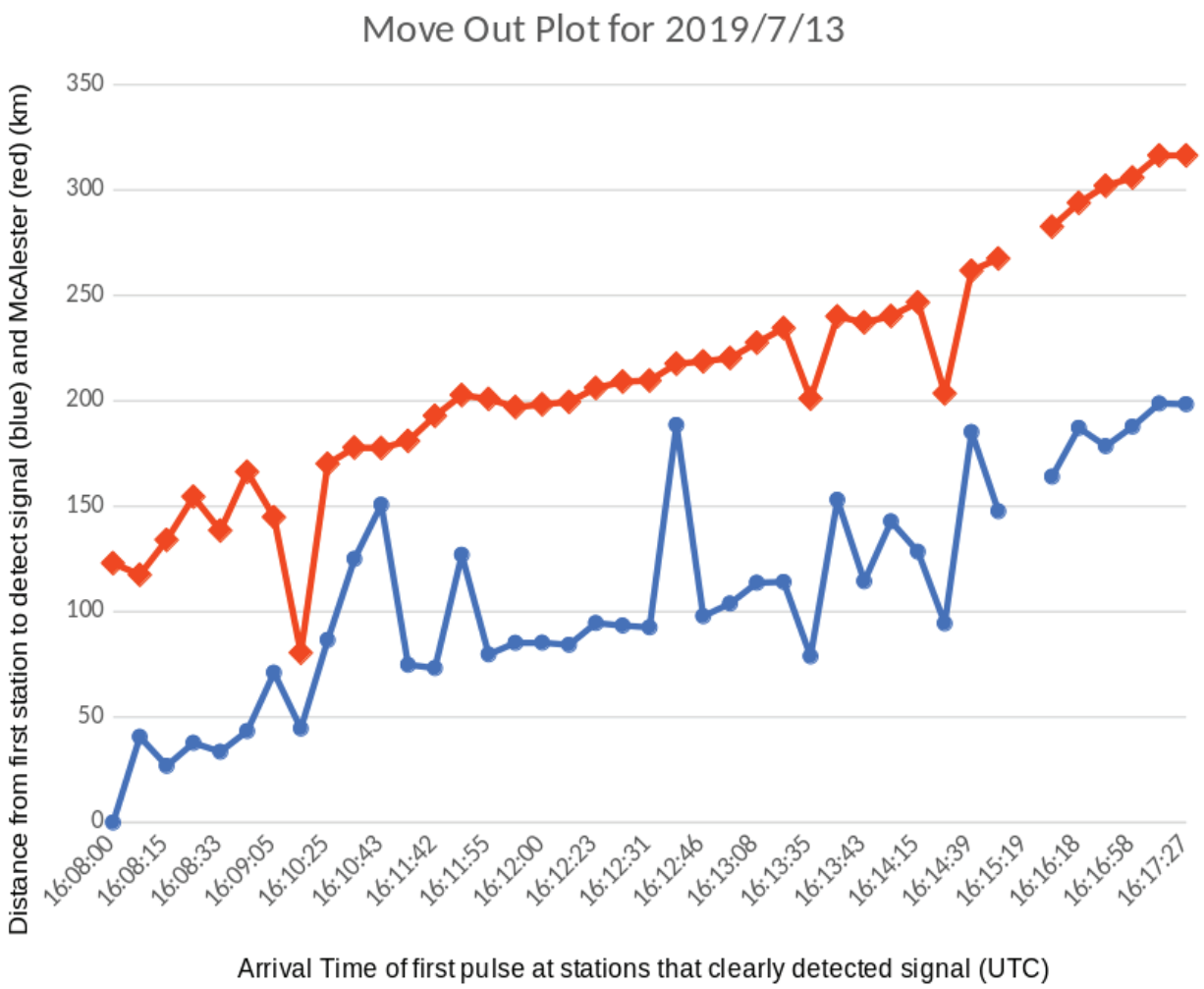


Figure 8: Move out plot for July 13, 2019, showing two plots. In blue: the origin used was the first station to detect the signal (as in the earlier plot for 7/13/2019). In red: McAlester Army Ammunition Base was used as the origin. Note that using the army base as the origin yielded a much cleaner result. Focusing on the later data set, note that two slopes are discernible, changing around 16:15:00. From ~150 km to 250 km from the origin, the average travel time velocity was 255 m/s. Beyond ~250 km from the origin, the average travel time velocity was 368 m/s. These varying velocities are indicative of the infrasound moving through and reflecting off of different atmospheric layers.

layers (Figure 8). Furthermore, varying atmospheric conditions, such as temperature and wind direction/speed, can also affect the speed of sound and how readily it can be conveyed. In addition to how infrasound from these blasts could be traveling so far, there is also the question of how so many of our sensors — most of which are not equipped to specifically detect infrasound — could be detecting this signal.

Knowing that the signal being detected by our sensors was of acoustic energy, it made sense that our earthquake analysis software had difficulty in locating an origin. Seiscomp3, the analysis software we utilize, is designed to locate origins of seismic energy, not acoustic. This is likely why the automatic detection picks didn't match the system's profile for what it determines might be an earthquake. In turn, this explains why it took so long for the anomaly to be noticed. Despite the large number of automatic picks made during detection of the anomaly, those picks didn't line up in any way that the system could recognize as being an earthquake, and so didn't flag the event (or the multiple pulses, individually) for review.

The "ping pong" like first arrival pattern we noted early on was merely a manifestation of how far away the source was from the receiving stations. With the source so far to the southeast, the order at which stations detected the signal

was sequentially farther away from McAlester (as would be expected, with hindsight). The two stations near Lake Eufaula that detected the signal minutes preceding other stations supplied significant perspective on the approximate origin of the anomaly.

Additionally, seasonal changes could explain why the anomaly was detected by relatively fewer stations in March and April, but by more stations in subsequent months. Varying atmospheric conditions — such as seasonally changing temperature and overall wind direction — could directly affect how well acoustic energy is conveyed, being more favorable during some seasons, less favorable during others. Considering that blasting at McAlester has been ongoing since before March 15, Dr. Walter confirmed (through random sampling) that the anomaly was indeed detected in 2018. Additionally, there is the possibility that the McAlester Army Ammunition Plant increased the frequency of blasting in the months following April.

At the time of this writing, we continue investigating this phenomenon with Dr. Carmichael, with intentions to publish our findings concerning the long distance conveyance of acoustic energy that seems to occur with such regularity in Oklahoma. To be clear, this is not the regularity of the blasting, but rather the regularity of the acoustic energy from those blasts traveling so far, so often. Considering the relatively large number of stations detecting this signal (up to 52 on a single day), and the years of continuous waveform data available for those stations, this data set has excellent potential to offer significant insight into how acoustic energy travels through the atmosphere.

REFERENCES

Negraru, Petru T., Paul Golden, and Eugene T. Herrin. “Infrasound propagation in the “Zone of Silence”.” Seismological Research Letters 81.4 (2010): 614-624.

About the Author

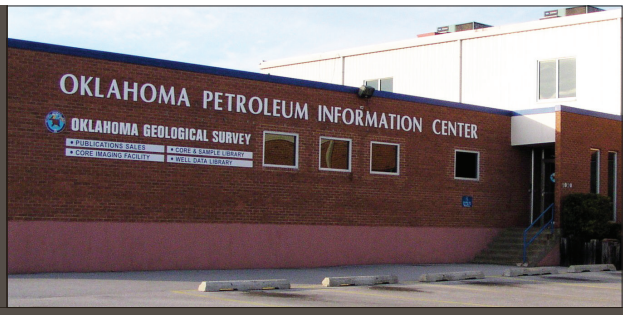
Andrew Thiel started working for the OGS in 2016 as a research associate with the seismic team. As a seismic data analyst, he locates earthquakes in the state of Oklahoma.

He received his M.S. in geology from the University of Oklahoma in 2012. His thesis research was focused on paleomagnetic analysis techniques.

While a graduate student at the University of Oklahoma, he was a teaching assistant for Introductory Geology, Sedimentary Petrology, Igneous and Metamorphic Petrology, Structural Geology, Introduction to Field Methods, and Fieldcamp: the five week geology capstone course in Colorado (twice). He also supervised the paleomagnetic research laboratory (operated by Dr. Elmore of the University of Oklahoma).

Between graduating and starting work at the OGS, he wrote and published a book on a physics hypothesis “On The Relation of Matter and Energy”. He coaches judo at Sooner Judo Club and competes in sailing regattas.

OKLAHOMA PETROLEUM INFORMATION CENTER



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Activities and Services

The Oklahoma Geological Survey's Oklahoma Petroleum Information Center (OPIC) is a 192,916 square-foot facility that houses approximately 500,000 boxes of core and cuttings from Oklahoma and elsewhere; an extensive repository of Oklahoma petroleum data; and the Geological Survey's publication sales office.

The OPIC facility is open Monday through Friday from 8AM to 5PM.

Core and Sample Facility

As Oklahoma seeks to maximize the recovery of oil and gas from new, existing, and shut-in wells, these data resources play an ever more important role.

In addition to being a valuable source of information for hydrocarbon exploration and production activities, OPIC's collections are used in many other ways. In particular, the use and appreciation of these materials is increasing because they are a major resource for groundwater studies, land-use change analyses, CO_2 sequestration research, archaeological investigation, and environmental studies.

Fee Schedule

For the most recent fee schedule available for all OPIC services, please go to the OGS website: www.ou.edu/ogs

Well Data Library

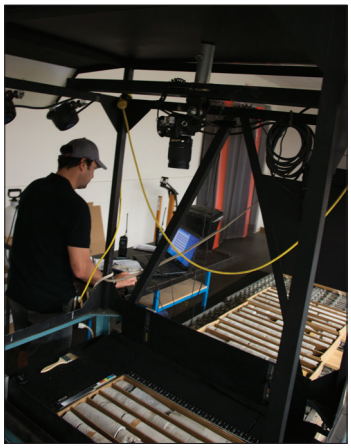
The OGS Well Data Library is the State's official repository for full-scale (5 inches to 100 feet) paper logs from more than 450,000 wells, with new logs added daily. In addition to hard copy logs, a backup collection of logs is available on microfiche as well.

Also in the collection are 126,000 strip logs dating from the 1890s which have been recently digitized. In addition, the library maintains a hard copy of 1002A completion reports from 1904 to the 1990s; multiple sets of scout tickets; completion cards for Oklahoma wells; and hard copies of aerial photos dating from 1934-1986 that are filed by county, township and range.

Publication Sales Office

The OGS Publication Sales Office is also located at OPIC. There you can purchase any USGS 7.5 minute quadrangle map of the state, a variety of other USGS maps and all inprint maps and publications produced by the OGS, representing nearly a century's worth of research and mapping.

OGS publications are used by hikers, campers, hunters, school and scout groups, those who enjoy outdoor activities. We have a resource room especially for K-12 teachers, which provides free access to rocks, minerals, fossils, and curricula for classroom use. OPIC is a resource for public officials planning highways and facilities, as well as those engaged in urban planning, water development, alternative energy, and other projects for economic development and civic improvement.



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OGS History Part 2: The Twin Territories

By

Ted Satterfield

Editor, Oklahoma Geological Survey

At the beginning of the 20th Century, the land that we call Oklahoma was still two separate territories: Oklahoma Territory (Western Oklahoma) and Indian Territory (Eastern and Southern Oklahoma). Discussions over statehood were well underway by the turn of the century and debates roared over whether the "Twin Territories" should join into one or whether they ought to pursue statehood separately (Gittenger, 1939, p. 236-258). Through a series of land runs and lotteries, Oklahoma Territory had opened to settlement starting in 1889 and into the first few years of the 20th Century. Indian Territory, however, began the century still undergoing the allotment process called for by the Dawes Commission that sought to place the land in the hands of individuals as opposed to entire tribes (Debo, 1940, p. 21-25). The United States Geological Survey (USGS) was tasked with appraising the lands in preparation for allotment.

In 1890 the USGS began a systematic study of the geology of Indian Territory. As mentioned in the previous installment, coal had been discovered in the Choctaw and Chickasaw Nations, and it was necessary to assess minerals in these lands to properly appraise the land for allotment (Dott, 1945, p. 194). The parties conducting these studies were first led by Robert T. Hill and were then followed by Joseph A. Taff. Territorial newspapers gave play-by-play accounts of where the survey parties were traveling and hints of what they were discovering along the way (e.g., Indian Chieftain, 1895; The Daily Ardmoreite, 1895).

Meanwhile, in Oklahoma Territory in 1890, the Territorial Governor George W. Steele signed a bill to establish three institutions of education, including a state university in Norman, but only if the residents of Cleveland County could come up with forty acres and $10,000 to construct a building. Two years later the university officially opened under the leadership of OU's first president David Ross Boyd (Harp, 2015, p. 4-7).

TERRITORIAL SURVEY

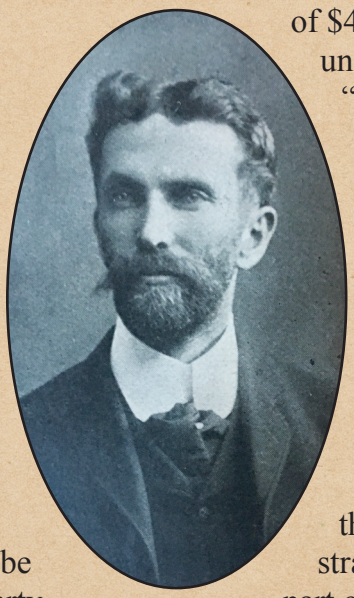
In 1898, President Boyd hired Albert Heald Van Vleet as biology professor, who immediately began working with the Board of Regents on a legislative bill to establish a territorial survey (Harp, 2015, p. 10). The language of the bill appears to have Van Vleet specifically in mind as it designates "the professor of biology and kindred sciences of the University of the Territory of Oklahoma" as the Territorial Geologist (Session Laws, 1899 p. 173-175). The bill passed the legislature, officially establishing a Department

ABOVE: "Territorial University at Norman." Oklahoma Terr., ca. 1897-98. BELOW: Photo of Charles Gould.

of Geology and Natural History, and naming Van Vleet as its director. He was appropriated the sum of $300 per year for maintenance of the Survey. After purchasing a wagon and assembling a team, Van Vleet had a "perfectly good Geological Survey ... Only one minor item was missing; namely, a geologist." (Gould, 1932).

CHARLES GOULD

Van Vleet was in need of a geologist but had no funds to pay for one. Van Vleet and President Boyd were discussing this dilemma when Boyd's private secretary said he had a friend doing graduate work at the University of Nebraska who might be willing to come accompany the field party over the summer as long as his expenses were covered (Gould, 1959). The friend was Charles Gould, who would eventually become the first director of the Oklahoma Geological Survey in 1908.



Gould traveled with the field party across Oklahoma Territory, and was offered the salary of $400 a year to teach geology at the university starting in September of 1900. "When I came, there was no geological equipment whatsoever, no collections, no books, not even a class room," (Gould, 1932, p. 200).

The following summer, in 1901, Gould spent the field season with a USGS party under the direction of Taff as they began on the eastern border of Indian Territory studying coal fields and slowly worked their way west where they eventually worked studying the stratigraphy and structure of the northern part of the Arbuckle Mountains. After this, they made their way into the Wichita Mountains in the recently opened Kiowa, Comanche, and Apache Reservation. A surge of white settlers had just entered this land, many of whom had been struck with gold fever.

ABOVE: A US Geological Survey outfit west of Lawton. Comanche County, Oklahoma Territory in 1901. BELOW: Photo of Frank McMaster.

Gold?

Stories of people finding gold in the Wichita Mountains date back to before the Louisiana Purchase. Members of Captain Marcy's expedition in the 1850s claimed to have found gold in the Wichitas and tales of the possibility of finding gold was something the Boomers used to recruit settlers, and many 89ers had gold on their minds when they chose to settle (Goble, 1980). In the late 1890s, the Native Americans who lived on the Kiowa, Comanche and Apache Reservation requested the assistance of federal troops as miners had invaded the reservation, causing tremendous damage to property in their efforts to mine for gold and silver. The Army removed unauthorized individuals from the reservation, but these actions did nothing to dampen their enthusiasm. In fact, many saw this as evidence that there were tremendous resources to be found and miners were being removed on behalf of powerful interests in the eastern United States (Morgan, 1973, p. 156-178).

Gould and Taff collected samples and sent them off for examination, which wound up showing nothing of value. Gould made it known that in his professional opinion, mining for gold and silver in the Wichitas was a waste of time and money and sent a letter expressing this to newspapers throughout the region. Years later, Gould said that he had not been prepared for the vicious response such a claim would provoke from those who had their hearts set on finding riches (Gould, 1959).

Gould was mocked in newspapers throughout the Territory, and in at least one instance was threatened with violence. This hostility was

The Campbell Mine on the north side of Mount Scott in the Wichita Mountains.

perhaps best expressed in a 1,300-word letter in the Daily Oklahoman written by 89er and editor/lawyer Frank McMaster. A small excerpt is shown below:

"A reading of an article in your issue of Saturday, by C.N. Gould, raises the query why Eastern Oklahoma breeds and pays a crop of scientists to continually belittle the western part of the territory. Possibly they must live, but they should live at the expense of some other locality or in some other pursuit. If they must be paid by the territory it would be better that their productions were used only for the benefit of the officials who have only a mission for wasting territorial funds on educational freaks. Even your space could do yourself more good as an editorial waste than in propagating geological guesses against our own territory. Supposing what he says is true, and no man knows if it is true, whom does he benefit by making it? His intention is to do the territory harm and it is scarcely a friendly act for a newspaper to aid him in doing it. If his labors result in a territorial injury it is no part the official duties of our educational asylums to contribute to their distribution. ... This report is untruthful but if true it is not such information as Oklahoma taxpayers seek. It bears every mark of a proposed raid in the interests of some scheme. Whatever reason the regents who favor such professors and the loyalties who support such regents will hear from the section on election days if we cannot be heard at other times," (McMaster, 1902).

McMaster would write several letters like this over the next few years, as would multiple other individuals who were caught up in the possibility of finding gold in the Wichitas. Eventually, the Territorial Survey would address the topic of gold, or the lack therefore, in the Wichitas in their biennial reports (Gould, 1904; Woodruff, 1904; Debarr, 1904). Gould would later write that he'd estimated over a million dollars had been wasted in search of gold in the Wichitas during that era (Gould, 1932).

Fortunately, efforts to harm and discredit Gould failed, and by 1904, the gold fever was dying down.

GOULD'S WORK

Gould's work in Oklahoma Territory was rewarded when his annual salary was tripled,

ABOVE: "Cleveland. The City of Oil Derricks." Panoramic view of an Oklahoma Territory town a year after the discovery of oil there. By Dick Man, 1905. NEXT PAGE: Indian Chieftain (Vinita, Indian Territory) on January 24, 1889 on page 3. This entry in the "Chelsea Notes" section of the paper is a casual reference to what is believed to be the first oil well drilled in Oklahoma.

going from $400 a year to $1,200 (Gould, 1959, p. 103). He was not only tasked with teaching classes and directing the University Geology Department, he was also asked to locate building materials for new university structures. In 1904, he was also asked to prepare and install an exhibit featuring Oklahoma minerals at the St. Louis World Fair, which, based on the frequency of its coverage in Territorial newspapers, was of great interest to those in the Oklahoma Territory (Gould, 1932, 1959).

Gould continued to make his famed covered wagon trips across both territories, and prepared reports of his findings. He also began taking students out into the Arbuckles a few times a year, as he believed it to be one of the best natural laboratories for students in the whole United States. In 1903, he began investigating underground water resources for the southern Great Plains on behalf of the federal government as part of the Reclamation Service. For this, he was given the title of resident hydrographer. In addition to this impressive list of tasks, Gould also managed to get married, have two children, complete his doctorate, and travel throughout the country to build relationships with famed geologists (Gould, 1959).

As mentioned earlier, Gould would go on to become the first director of the Oklahoma Geological Survey, and would even return to serve as director a second time. He would eventually be referred to as the "Father of Oklahoma Geology" (Ham, 1983). His influence on the state would be difficult to quantify, but, later in his life, he would reflect on this issue himself. Gould in 1933 would write that he had watched the state go from an annual income of $4 million from mineral products to $500 million in 1933. Of which, he asked, "May I be pardoned if I venture to say that in this development I have had some small part?" (Gould, 1933).

OIL IN OKLAHOMA

A very small entry in the "Chelsea Notes" section of the January 24, 1889 issue of the Indian Chieftain newspaper probably didn't grab much attention from readers. It reads "Ed Byrd is boring

ANOTHER LETTER.

—Chelsea is on a boom.

—The sun shines once more.

—The town is full of drummers.

—Dr. Garretson has moved to town.

—Ed Byrd is boring for oil, coal or something.

—Poole & Strange are wrestling cattle, hogs, hay and general merchandise.

—Charley Poole was around town to-day with his Mother Hubbard pants.

for oil, coal or something." If editors would have known its significance, it certainly would have instead been an enormous front page headline, as it is a reference to what is believed to be the first oil well ever drilled in Oklahoma (Franks, 2009; Forbes, 1939; Debo, 1949, p. 56).

Inhabitants of the Twin Territories would make note of the presence of oil and gas at least 70 years before anything remotely resembling an oil boom had occurred (Franks, 2009; Forbes, 1939). Efforts to extract oil for commercial purposes began well before Edward Byrd successfully drilled his well, but the efforts were hindered by transportation constraints as well as the complexities of securing drilling leases in Indian Territory. The allotment of tribal lands was an extraordinarily complicated endeavor and the discovery of oil did nothing but exacerbate the situation (Forbes, 1939).

Prior to statehood, few wells were drilled based on geologic data of any kind. Most were drilled on a hunch or based on the presence of oil on the surface (Forbes, 1939). Staff at the Territorial Survey attempted to discourage this type of "foolish experimenting" in The Second Biennial Report (Van Vleet, 1902, p. 11-12). Although not worded as strongly as their discouragement from mining for gold, they warned that money could be lost, especially in Oklahoma Territory where Van Vleet wrote, "there or no wells, as yet, that are known to furnish these products in paying quantities" (Van Vleet, 1902, p. 12).

This statement wouldn't stay accurate for very long. In 1904 the Twin Territories had almost 500 producing wells with an output of more than one million barrels of oil (Debo, 1949, p. 57). By 1907, it had a production of at least 43 million barrels, 26.2 % of the nation's output (Debo, 1949, p. 57-58).

Some suggest that petroleum is what "Brought Oklahoma to the Dance" in the years after statehood, as "an oil boom coming on the heels of Statehood provided the capital, the people, and the excitement literally to put the State on the map," (Enduring Partnership, 1997). Seeing as how the state of Oklahoma would eventually become

a national leader in oil production, the topic of oil follows the history of the OGS from before statehood until the present. It will recur throughout most, if not all, installments of this series. However, since the industry was in its infancy before statehood, we'll put a pin in this topic for now.

MARCH TOWARD STATEHOOD

An attempt by Indian Territory to establish itself as its own state of Sequoyah was essentially ignored by both the US Congress and President Theodore Roosevelt, since the decision had already been made that the Twin Territories should join into one state (Gittenger, 1939, p. 253-255). Many in Washington favored the establishment of two states, seeing the Twin Territories as potentially offsetting one another politically. Statehood being viewed as inevitable, the combining of the two territories into one state seemed most agreeable.

Democrats gained a ridiculous majority in the Constitutional Convention and representatives who had served in the unsuccessful Sequoyah Convention dominated every step of the way (Hurst, 1957, p. 1-5). This appeared to be a referendum on the federal appointments in both territories which had been made by Republican leaders in Washington.

This new majority, as well as the election of Democratic Governor Charles Haskell, spelled doom for many Territorial employees, notably the University which saw President Boyd and numerous faculty and staff (including the only janitor) lose their jobs (Harp, 2015, p. 17-20). The future of the OGS, however, wasn't harmed by these changes in personnel. Charles Gould knew many of those involved and was treated favorably not only during the Constitutional Convention, but also in the years following statehood (Gould, 1959). We'll address this in the next installment of this series.

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About the Author

Ted Satterfield became the OGS Editor in August 2015. A native Oklahoman, Ted has a diverse professional background. After receiving his master's in the Gaylord College at OU, he spent two years as a newspaper editor before switching to an academic career. For six years he was a mass communication faculty member at Northwestern Oklahoma State University, where he taught Intro to Mass communication, Photography, News Editing, and Media Convergence. He also acted as advisor to the student-media website. Ted is also an accomplished screenwriter and director, winning numerous awards, including the best short screenplay at the 2012 deadCENTER Film Festival. He and his wife, Melanie, co-wrote the stage play "Alcoholidays," which was produced in Oklahoma City in 2013, and ran through December 2015 at the Oklahoma City Civic Center. Ted is an active member of the Association of Earth Science Editors.

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