

Aota Technical, LLC
 Desert Eagle Operating, LLC
 Red Rocks 35-08A
Geologic Hazard Map
 Las Animas County
 NE¼SE¼ Sec.35, T29S R55W 6th P.M.
 Date: 1/29/24
 Figure No. Figure 6a

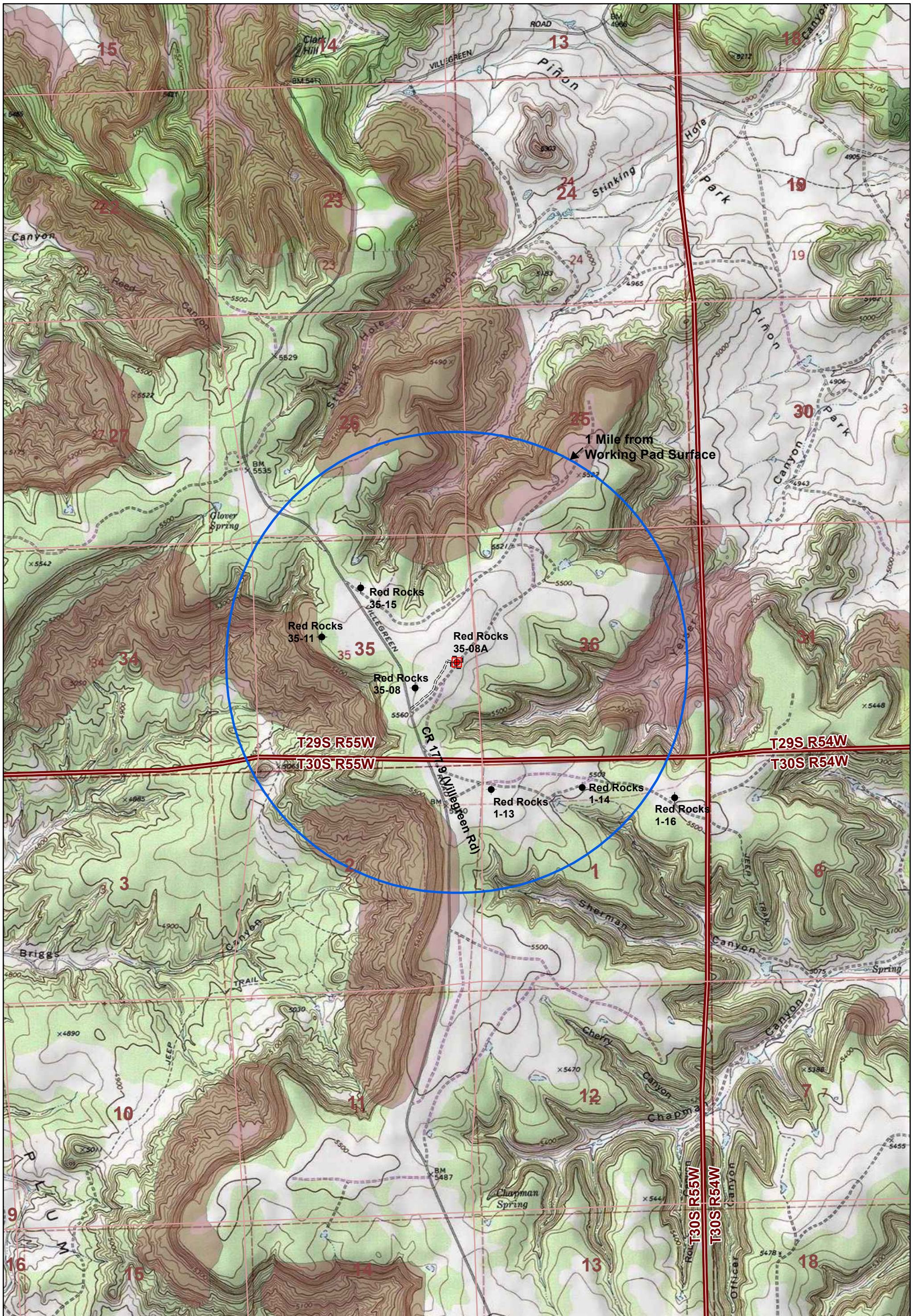
Legend

- Proposed Helium Gas Well
- Producing Helium Gas Well
- ==== Private Access Road
- Working Pad Surface
- Oil & Gas Location
- 1 mile from Working Pad Surface
- Colorado Geological Survey Landslide Area Data

Scale: 0, 625, 1,250, 2,500 Feet

North Arrow

Data Source: ECMC GIS Online, Colorado Geological Survey



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Legend

- Proposed Helium Gas Well
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- ==== Private Access Road
- Working Pad Surface
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N

 0 900 1,800 3,600
 Feet
 Data Source: ECMC GIS Online Colorado Geological Survey

Geologic Hazard Plan Lesser Impact Area Exemption Request


Red Rocks Oil & Gas Development Plan Amendment 2

SELF-CERTIFICATION

<p>I certify that I am a Professional Geologist, having met the educational requirements and professional work experience required by C.R.S. 23-41-208(1)(b). I have reviewed information pertaining to the Oil and Gas Locations and the surrounding area and have found no Geologic Hazard within a 1-mile radius which is so adverse to past, current, or foreseeable construction or land use as to constitute a significant hazard to public health, safety, or property.</p>	
	<p>2/2/24</p>
<p>_____</p> <p>Kurt Constenius, Ph.D. 8790 N. Shadow Mountain Drive Tucson, AZ 85704</p>	<p>_____</p> <p>Date</p>

(21) GEOLOGIC HAZARD PLAN LESSER IMPACT AREA EXEMPTION REQUEST

Requirement	Response
Exemption Requested	Rule 304.c.(21) Geologic Hazard Plan
Resource Concern	Geologic hazard to the Oil and Gas Locations
Exemption Circumstance	The impact to the resource is so minimal as to pose no concern.
Description	<p>A professional geologist has made the determination that the only geologic hazard within 1 mile of the Oil and Gas Locations is mapped landslide areas. The hazard posed by the areas is so minimal as to pose no concern.</p> <p>The professional geologist's self-certification statement is provided below. The individual's qualifications meet the statutory definition at C.R.S. 23-41-208(1)(b) as follows: Kurt Constenius is an exploration geologist and geophysicist with over 40 years of experience in oil, natural gas and helium exploration in the western U.S. and central Asia. He has a broad range of skills acquired in the pursuit of prospect generation. They range from design, acquisition, processing, and interpretation of 2D and 3D seismic data to wellsite and field geology. For the past 10 years, he has focused on helium exploration in Arizona, Colorado, Montana, and Utah. Dr. Constenius started his career as a geophysicist with Amoco Production Company, Denver, CO in 1981 working on exploration projects in the Wyoming-Utah thrust belt, followed by projects in the San Joaquin and Sacramento basins in California. In 1993, he enrolled in the Tectonics Program at the University of Arizona. He received his Ph.D in</p>

Requirement	Response
	<p>Geosciences in 1998. He worked as a geological and geophysical consultant for prospect generation and remained active in geologic mapping and research. Dr. Constenius is an adjunct professor at the University of Arizona.</p> <p style="text-align: center;">SELF-CERTIFICATION</p> <p>Included in the geological information I reviewed is COGCC GIS Online, Las Animas County Hazard Mitigation Plan (JEO Consulting Group, 2022), USGS regional geologic mapping, satellite imagery, topographic analysis (CalTopo), and a stratigraphic columnar section of the local area. The following geologic hazards, including their discussion in the Las Animas County Hazard Mitigation Plan, were evaluated for relevance to the proposed Oil and Gas Locations: avalanche; dam/levee failure; drought; earthquake; erosion and deposition; expansive soils; extreme heat; flood; hail; landslide, mud/debris flow, rockfall, subsidence (collectively, landslide); lightening; severe wind; tornadoes, wildfires, and winter storms. Of the potential hazards, landslides were determined to be relevant based on their mapped proximity within 1 mile of the Oil and Gas Locations and their relevance to new infrastructure.</p> <p>A geologic hazard finding from a landslide, and an associated Geologic Hazard Plan, is believed to be unnecessary for this location. A landslide, including the definition provided by Las Animas County, is considered to be the movement of slopes with debris, including slumps, rockslides, and soil creep. Risk areas typically are slopes greater than 30 percent and areas with a history of landslides. Mapped landslide areas in the vicinity of the Oil and Gas Locations correlate specifically to canyon areas that reside directly on the Dakota-Purgatoire cliff band and down canyon exposures of the Morrison Formation. Lithologically, the Morrison Formation is known to include a variety of swelling clays and shales that may increase the risk for unstable slopes and landslides in those areas. The stratigraphy is shown in Figure 1, below.</p> <p>Figure 1 illustrates the general lithologies of the Lower Cretaceous Dakota Sandstone/Purgatoire Formation. It is composed of massive sandstone, which is approximately 250 feet thick (highlighted in red). This unit comprises the mesa top along CR 177.9 and the surface geology of the Oil and Gas Locations. Below this is Morrison Formation (highlighted in green).</p> <p>The outcrops mapped as landslide areas or associated with the Morrison Formation are greater than 0.50 mile down canyon or are below the proposed Oil and Gas Locations. The proposed locations are not close to a mesa edge. The locations are sited on a thick mesa of stable Dakota Sandstone and relatively flat topography. Based on this evaluation, there is no risk of landslide affecting the Oil and Gas Locations.</p> <div style="display: flex; justify-content: space-between; align-items: flex-end; margin-top: 20px;"> <div data-bbox="548 1640 846 1745" style="text-align: center;">  </div> <div data-bbox="1166 1738 1240 1766" style="text-align: center;"> <p>2/2/24</p> </div> </div> <div style="display: flex; justify-content: space-between; margin-top: 10px;"> <div data-bbox="516 1801 789 1829" style="width: 45%;"> <p>_____</p> <p>Kurt Constenius, Ph.D.</p> </div> <div data-bbox="1187 1801 1240 1829" style="width: 45%;"> <p>_____</p> <p>Date</p> </div> </div>

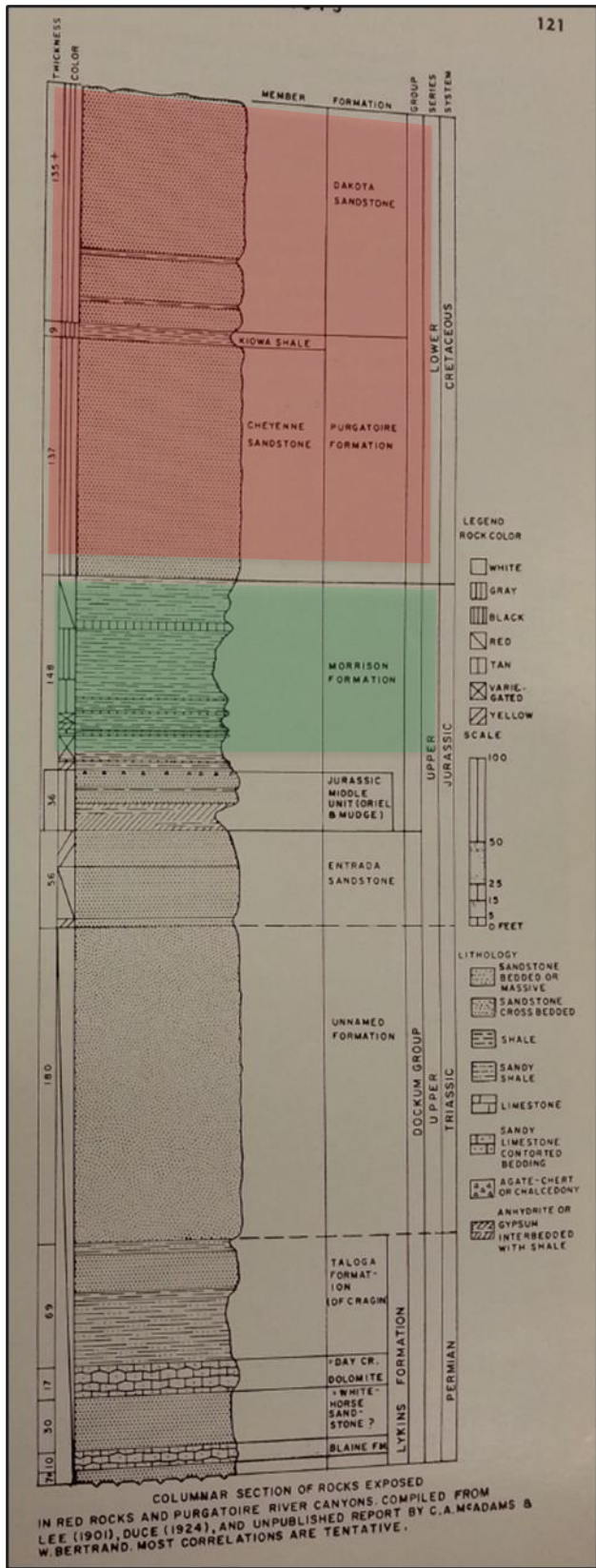


Figure 1. Stratigraphic Column in the Vicinity of Red Rocks and the Purgatoire River Canyon

Sources

CalTopo Slope Angle Shader: <https://caltopo.com/map.html#ll=37.48174,-103.54867&z=15&b=imagery&a=mba%2Csq> (Reviewed February 1, 2024).

ECMC GIS Online: https://cogccmap.state.co.us/cogcc_gis_online (Reviewed January 30, 2024).

Collapsible Soil:

<https://cologeosurvey.maps.arcgis.com/apps/webappviewer/index.html?id=a6f816b35fb64d3da096e84af661f070> (Reviewed January 30, 2024).

Colorado Landslide Inventory:

<https://cologeosurvey.maps.arcgis.com/apps/webappviewer/index.html?id=9dd73db7fbc34139abe51599396e2648> (Reviewed January 30, 2024).

Geologic and Structure Contour Map of the La Junta Quadrangle, Colorado and Kansas (Scott, 1968). USGS Miscellaneous Geologic Investigations Map I-560: https://ngmdb.usgs.gov/Prodesc/proddesc_9348.htm (Reviewed February 2, 2024).

Google Earth Pro Aerial Image. Image dated September 17, 2022: <https://earth.google.com> (Reviewed January 23, 2024).

Guide Book to the Geology of the Raton Basin, Colorado. Rocky Mountain Association of Geologists (McGinnis et. al, 1956). p.121. (Reviewed February 2, 2024).

Earthquake and Faults: <https://cgsarcimage.mines.edu/ON-001> (Reviewed January 30, 2024).

Hazards: <https://coloradahazardmapping.com/map#!/layers> (Reviewed January 30, 2024).

Historic Coal Mines:

<https://cologeosurvey.maps.arcgis.com/apps/webappviewer/index.html?id=1891e3149eda44af9dc8af81c4dc58a8> (Reviewed January 30, 2024).

Las Animas County Hazard Mitigation Plan (JEO Consulting Group, 2022):

https://www.jeo.com/sites/default/files/inline-files/01_Las%20Animas_Upfront_Updates%202.28.23.pdf (Reviewed February 1, 2024).

Radioactive Mineral Occurrences:

<https://cologeosurvey.maps.arcgis.com/apps/webappviewer/index.html?id=c5381e1335284d63bfa5d4b018b3372f> (Reviewed January 30, 2024).

KURT N. CONSTENIUS, Ph.D.

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(520) 991-2274 cell
kconstenius@comcast.net

SUMMARY

Geophysicist and structural geologist with over 40 years experience working in oil, gas and helium exploration, and conducting academic research. Experience mainly in structural terrains of the western U.S., characterized by fold-thrust belt, extensional basin, and wrench fault tectonics, developing projects and prospects ranging from oil and gas exploitation to frontier wildcat drilling. **Chief Geophysicist, Petro Matad Group exploring basins of the Gobi-Altai and Tamsag basin regions, Mongolia, from 2010-2019. From 2013 to present, geologist-geophysicist for Twin Bridges LLC, The Cobalt Group and Butler Petroleum working on helium exploitation and exploration projects in Arizona, Colorado, Montana and Utah.**

EDUCATION & WORK EXPERIENCE

I graduated with advanced honors (GPA 3.78) from Montana State University in June 1979 with a B.S. in Earth Science (Geology). I was awarded the Earth Science Department Honors Scholarship from 1976-1979. I received a **M.S. in geology** (GPA 3.65) from the University of Wyoming in December, 1981. The title of my master's thesis was "Stratigraphy, sedimentation and tectonic history of the Kishenehn basin, northwestern Montana.

I joined the exploration staff of **Amoco Production Company**, Denver, CO, in December, 1981, and worked for the company as a geophysicist until October, 1992. Thereafter, I was employed as a geophysical consultant for Amoco's thrust belt exploitation group (October, 1994 - December, 1999).

I enrolled in the Ph.D. tectonics program at the Department of Geosciences, University of Arizona in January, 1993. My **Ph.D. research** covered a variety of topics that included: Tectonic development of the Great Valley forearc, California; Late Paleogene collapse of the Sevier belt; Structure of the Deer Creek detachment fault system and evolution of Cottonwood core complex, Wasatch Mountains, Utah; and, Structural evolution of the Uinta salient and tectonomagmatic rejuvenation of the Cheyenne belt, north-central Utah.. I graduated in April, 1998 (GPA 3.91).

I've been a **Research Associate of the Carnegie Museum**, Pittsburgh, PA (1986-present). Appointed adjunct faculty member **University of Arizona**, January, 2017.

Oil & gas Industry experience and applied research I've conducted are:

Chief Geophysicist Petro Matad Ltd, Ulaan Bataar, Mongolia (2010-2019). Frontier exploration in Mongolia that involved large-scale 2D and 3D seismic acquisition (5400 km), deep core drilling and extensive field studies.

Exploration geologist and geophysicist Twin Bridges, Denver, Colorado (2013-present).

Exploration and exploitation of helium that involved prospect development, wellsite geology and seismic interpretation of high resolution 2D seismic in Pinta Dome and Navajo Springs fields, Arizona, and wildcat drilling in northern Montana, eastern Colorado and southeast Utah.

Geological & Geophysical consultant (1998-present). Geophysical interpretation of data from Arizona, California, Colorado, Montana, Oklahoma, Oregon, Utah and Washington. ***Employed by Anschutz Exploration Corp., Cirque Resources LP, Savant Resources LLC, Southwestern Production Co., Quicksilver Resources Inc., Delta Petroleum, Twin Bridges LLC, The Cobalt Group, Butler Petroleum and ExxonMobil Exploration Co.***

Utah Geological Survey - Geological Field Mapping (1999-2010). Field mapping and compilation (7.5 minute quadrangles) for the Provo 30' x 60' (1:100,000).

University of Arizona - Principal Investigator NSF project (2000-2002): 3-D Kinematic Evolution of the Charleston-Nebo thrust salient, Sevier Belt, Utah. Integration of seismic mapping, field studies and geochronology.

EGI, University of Utah - Geophysical-Geological consultant (1998-1999). Analysis of structural geology and petroleum system of central Utah fold-thrust belt.

Amoco - Geophysical consultant for Thrust Belt Exploitation Group (1994-1999). Structural interpretation of Whitney Canyon-Carter Creek field using 2-D and 3-D seismic reflection data. Designed and supervised acquisition and processing of Carter Creek 3-D survey.

Amoco - New Opportunities Group (1990-1992). Investigated and ranked basins and prospects in the western U.S. Geophysical prospect work on Sacramento Basin, CA, and Central Utah thrust belt, UT.

Amoco - San Joaquin Basin Analysis Project (1986-1990). Generated prospects using seismic sequence stratigraphy, facies analysis, and velocity inversion.

Amoco - Geophysical Technology Group (1985). Designed, acquired, and analyzed 3-D wave test, Columbia River Basin, WA. Coordinated high-resolution Vibroseis project, Hugoton Basin, KS.

Amoco - Wyoming-Utah Thrust Belt Exploitation Group (1981-1985). Acquisition, processing and interpretation of 3-D seismic data. Mapped drilling locations for drilling using finite difference modeling, depth migration and VSP data. Instructor on Amoco Structure seminar and field course, 1985.

ACTIVE RESEARCH PROJECTS AND ASSOCIATES

Late Jurassic-Early Cretaceous Evolution of the Western Canadian Foreland Basin and origin of the enigmatic basal Cadomin unconformity: Brian Horton and Matt Nix (U. Texas, Austin). Field and geochronologic research (U/Pb detrital zircon) applied to rocks of the Kootenay and lower Blairmore groups in the Fernie Basin, SE British Columbia.

Geochronology of the Purcell Lava and the age of the Belt Supergroup, NW Montana and SE British Columbia: Robert G. McGimsey (USGS), Mauricio Ibanez-Mejia (UAZ), Victor Valencia (WSU) and Matt Heizler (New Mexico Tech). *Field and geochronologic research (U/Pb baddeleyite, zircon and apatite; $^{40}\text{Ar}/^{39}\text{Ar}$ Hornblende and K-feldspar) testing the hypothesis that U/Pb zircon ages reported for the Purcell Lava (basalt) and also for the Moyie sills (gabbro) are in fact detrital zircons incorporated into mafic intrusions and flows, and that the age established for the Belt Supergroup is incorrect. GSA presentation June, 2017.*

Provenance and Depositional History of the Proterozoic Belt-Purcell Supergroup: Brian Horton and Jaime Hirtz (U. Texas, Austin), Victor Valencia (WSU) and Brian Pratt (U. Saskatchewan). *Field and geochronologic research (U/Pb detrital zircon) applied to rocks of the Belt-Purcell exposed in the Lewis thrust salient of NW Montana, SE British Columbia and SW Alberta.*

Sedimentary tectonics and structure of the Tsagaan Suvarga and Argalant basins, Gobi-Altai region, Mongolia: Mihai Ducea (U. Arizona), Brian Horton (U. Texas, Austin), Cari Johnson (U. Utah), and Matt Heizler (New Mexico Tech). *Applied research sponsored by Petro Matad LLC (Mongolia) using outcrop data and field relations to better understand basin histories and thermal conditions of undrilled frontier basins imaged on seismic and gravity data.*

Paleontology and basin studies, Kishenehn basin, NW Montana: Dale Greenwalt (Smithsonian Institution), Majie Fan (University Texas, Arlington) and Dave Dettman (U. Arizona). *Studies chronicle the extraordinary fauna of the Eocene-Oligocene Kishenehn Formation. Oxygen isotope study of fossil mollusks used to reveal sources of lake and river waters and paleoelevation of valley floor and surrounding mountains. GSA Bulletin 2021.*

Two-stage exhumation of mid-crustal rocks of the Cottonwood metamorphic core complex, central Wasatch Mountains, Utah: Matt Heizler (New Mexico Tech), Ken Dominik (University of Arizona), Matt Steele-MacInnis (University of Alberta). *Follow-up on my dissertation research using hornblende thermobarometry and Ar/Ar K-spar multidiffusion experiments and thermal models to describe extensional tectonics associated with exhumation of the Little Cottonwood stock. GSA Presentation May, 2018*

RECENT GRADUATE STUDENT SUPPORT

Matt Nix, University of Texas, Austin, TX (2019-2022): Shifts in deposition, sediment dispersal, and provenance for the Kootenay and Blairmore Groups: Implications for foreland basin dynamics in the Western Canada Sedimentary Basin. Advisor – B. Horton.

Jaime Hirtz, University of Texas, Austin, TX (2019-2021): Basin architecture, geochronology, and sediment provenance of the Belt-Purcell Supergroup: Implications for reconstructions of the Mesoproterozoic supercontinent Columbia. Advisor – B. Horton.

Edgardo Pujols, University of Texas, Austin, TX (2014-2017): (U-Th)/He and U-Pb double dating constraints on the interplay between thrust-fold and basin development, Sevier belt, central Utah. Advisor - D. Stockli.

Tsolmon Adiya, University of Utah, Salt Lake City, UT (2015-2017): Microbial-caddisfly bioherm association from the Lower Cretaceous Shinekhudag Formation, Mongolia: Earliest record of plant armoring in fossil caddisfly cases. Advisor – C. Johnson.

Tony Jijina, University of Wyoming, Laramie, WY (2015-2017): The paleobotany and paleoecology of the “Herren Formation” of north central Oregon, USA. Advisor – E. Curran.

Chelsea Mackaman-Lofland, University of Texas, Austin, TX (2015-2020): Kinematic evolution of the La Ramada fold-thrust belt, south-central Andes (32°-32.5° S). Advisor – B. Horton.

RECENT PUBLICATIONS

Spencer, Jon E., Constenius, K.N., Dettman, D.L., and Domanik, K.J., 2021, Implications of seasonal varves in the lower Pliocene Bouse Formation, lower Colorado River Valley, and implications for Colorado Plateau uplift: *Geosphere*, DOI: 10.1130/GES02419.1

Fan, M., Constenius, K.N., Phillips, R.F., and Dettman, D.L. 2021, Late Paleogene paleotopographic evolution of the northern Cordilleran orogenic front: Implications for demise of the orogen: *Geological Society of America Bulletin*, DOI: 10.1130/B35919.1

Pujols, E.J., Stockli, D.F., Constenius, K.N., and Horton, B.K., 2020, Thermochronological and geochronological constraints on Late Cretaceous unroofing and proximal sedimentation in the Sevier orogenic belt, Utah: *Tectonics*, DOI: 10.1029/2019TC005794.

Mackaman-Lofland, C., Horton, B.K., Fuentes, F., Constenius, K.N., Ketcham, R.A., Capaldi, T.N., Stockli, D.F., Ammirati, J., Alvarado, P., and Orozco, P., 2019, Andean mountain building and foreland basin evolution during thin- and thick-skinned Neogene deformation (32-33°S): *Tectonics*, DOI: 10.1029/2019TC005838.

Jijina, A.P., Curran, E.D., and Constenius, K., 2019, The paleobotany and paleoecology of the Eocene Herren Beds of north-central Oregon, USA: *Palaios*, v. 34, p. 424-436. central Oregon, USA: *Palaios*, v. 34, p. 424-436.

Mackaman-Lofland, C., Horton, B.K., Fuentes, F., Constenius, K.N., and Stockli, D.F., 2019, Mesozoic to Cenozoic retroarc basin evolution during changes in tectonic regime, southern Central Andes (31-33°S): Insights from zircon U-Pb geochronology: *Journal of South American Earth Sciences*, v. 89, p. 299-318.

Dawson, M.R., and Constenius, K.N., 2018, Mammalian fauna of the middle Eocene Kishenehn Formation, Middle Fork of the Flathead River, Montana: *Annals of the Carnegie Museum*, v. 85, p. 15-49.

Fan, M., Constenius, K.N., and Dettman, D.L., 2017, Prolonged high relief in the northern Cordilleran orogenic front during middle and late Eocene extension based on stable isotope paleoaltimetry: *Earth and Planetary Science Letters*, v. 457, p. 376-384.

Wavrek, D.A., Slack, M.N., and Constenius, K.N., 2017, Stinky bubbles in the Diamond Fork Canyon (Utah): A curious case of whodunit?: *Utah Geological Association Publication 46, Geology*

and Resources of the Wasatch: Back to Front, eds., Lund, W.R., Emerman, S.H., Wang, W, and Zanazzi, A., p. 1-16.

PUBLICATIONS

- Condor, J., Butler, R.F., DeCelles, P.G., and Constenius, K., 2003, Paleomagnetic determination of vertical-axis rotations within the Charleston-Nebo salient, Utah: *Geology*, v. 31, p. 1113-1116.
- Constenius, K.N., 1981, Stratigraphy, sedimentation, and tectonic history of the Kishenehn Basin, northwestern Montana: University of Wyoming, unpublished Masters thesis, 116 p.
- Constenius, K.N., 1982, Relationship between the Kishenehn Basin and the Flathead listric normal fault system and Lewis thrust salient, in Powers, R. B., ed., *Geologic Studies of the Cordilleran Thrust Belt*: Rocky Mountain Association of Geologists, p. 817–830
- Constenius, K.N., 1988, Structural configuration of the Kishenehn Basin delineated by geophysical methods, northwestern Montana and southeastern British Columbia: *Mountain Geologist*, v. 25, p. 13-28.
- Constenius, K.N., 1996, Late Paleogene extensional collapse of the Cordilleran foreland fold and thrust belt: *Geological Society of America Bulletin*, v. 108, p. 20-39.
- Constenius, K.N., 1998, Extensional tectonics of the Cordilleran fold-thrust belt and the Jurassic-Cretaceous Great Valley forearc basin: University of Arizona, unpublished Ph.D. dissertation, 116 p.
- Constenius, K.N., and Dawson, M.R., 2008, *Blickomylus* (Atriodyctyla, Camelidae, Stenomylinae) and the age of the Moroni Formation, central Utah: *Journal of Vertebrate Paleontology*, v. 28, p. 1228-1231.
- Constenius, K.N., and Dyni, J.R., 1983, Lacustrine oil shales and stratigraphy of part of the Kishenehn Basin, northwestern Montana: *Mineral and Energy Resources, Colorado School of Mines*, v. 26, no. 4, 16 p.
- Constenius, K.N., Clark, D.L., King, J.K., and Ehler, J.B., 2011, Interim geologic map of the Provo 30' x 60' quadrangle, Utah, Wasatch and Salt Lake Counties, Utah: Utah Geological Survey Open-File Report 586DM, 42 p., 2 plates, scale 1:62,500.
- Constenius, K.N., Dawson, M.R., Pierce, H.G., Walter, R.C., and Wilson, M.V.H., 1989, Reconnaissance paleontologic study of the Kishenehn Formation, northwestern Montana and southeastern British Columbia: *Montana Geological Society 1989 Field Conference Guidebook*, p. 189-203.
- Constenius, K.N., Esser, R.P., and Layer, P.W., 2003, Extensional collapse of the Charleston-Nebo salient and its relationship to space-time variations in Cordilleran orogenic belt tectonism and continental stratigraphy: in *Cenozoic systems of the Rocky Mountain region*, Reynolds, R.G. and Flores, R. M., eds., *Rocky Mountain Section, Society of Economic Paleontologists and Mineralogists*, p. 303-353.
- Constenius, K.N., Johnson, R.A., Dickinson, W.R., and Williams, T. A., 2000, Tectonic evolution of the Jurassic-Cretaceous Great Valley forearc, California: Implications for the Franciscan thrust-wedge hypothesis: *Geological Society of America Bulletin*, v. 112, p. 1703-1723.

- Constenius, K., Schelling, D., and Collister, J., 1999, Structural geology and petroleum systems of the central Utah fold-thrust belt : EGI Technical Report 99-5-20953, 175 p.
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