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This summer I had the opportunity to work as a geology intern for Cirque Resources, a small, privately-owned oil and gas exploration firm based in Denver, Colorado. Altogether Cirque owns mineral leases on over 1 million gross acres in the western United States, with land in the Denver-Julesburg, Hanna, Central Montana, Big Snowy, Powder River, Uinta, Sacramento, and Williston Basins. The company exclusively targets unconventional oil and gas plays throughout the west, including the famous Bakken Shale of the Williston Basin and the Niobrara Formation of the Denver Basin. Unconventional plays are increasingly taking center stage in America's recent push for bolstered domestic oil and gas production. Cirque is among several other companies like Noble Resources and EOG to pursue unconventional plays as a primary objective. However, the Cirque business model is unique compared to others, yet straightforward: acquire leases early-on, find a partner to dilute the risk and provide capital for drilling, drill test wells, and finally sell the acreage to larger companies who can handle production.

Throughout the internship I was exposed to the day-to-day interactions between the three main branches of an oil and gas exploration firm: geologists, landmen, and engineers. Any exploration and production firm must deftly intertwine these three components as they each represent crucial aspects—oil, land, and production. Geologists find the oil, landmen acquire the leases for the land, and the engineers struggle to get it out of the ground. The specific field of petroleum geology incorporates petrophysical wireline log data, historic production, core sample analyses, seismic imaging and many other tools in order to ascertain the potential for an oil prospect. Throughout my time at Cirque, I was able to learn about and experience first-hand each of these tools. I was also briefly introduced to the two other "branches" of the industry.

My primary task over the 8-week internship was to pick log tops for the Cretaceous Niobrara Formation in the northern Denver-Julesburg Basin using Geographix mapping software. Oil-bearing rocks are evaluated by petroleum geologists on several parameters that are measured by devices lowered into the drill hole itself, including porosity, oil and water saturation, gamma ray signature, and resistivity among others. Porosity is the measure of the percent pore space in the rock, which is often occupied by either water or hydrocarbons. Gamma ray signatures measure the radiation from a specific rock, and are useful for identifying potentially oil-bearing shaly layers that contain more uranium-bearing minerals than sandstones or limestones. Finally, resistivity measures the rock's reaction to electrical pulses. When drilling up to 12,000 ft. below earth's surface, water in the rock is often salty and therefore has very low resistivity as salt water conducts electricity. However, when oil (which does not conduct electricity) is present, spikes of higher resistivity will be recorded on the log. My goal was to find and investigate the spatial extent of these spikes of higher resistivity of the Niobrara Formation in the panhandle of Nebraska. In order to do this, I picked log tops on over 300 wells in Western Nebraska by examining cross sections, correlating zones of higher resistivity, and eventually creating maps from my findings. At the end of my internship, I compiled the data and maps as well as outside sources into a 15-minute presentation for the senior geologists of the company.

My other main task was to update Cirque's well database for Weld County, CO, on new wells drilled within the six months. Weld County is home to Colorado's largest gas field—the Wattenberg Field—which has to date produced 4.3 trillion cubic feet of gas, and is also home to several newly discovered oil fields with numerous recent drillings. These oil fields have become economical only through horizontal drilling techniques and hydraulic fracturing (i.e. "fracking") and contain an estimated ultimate recovery of over 14 million barrels of oil equivalent. The Colorado Oil and Gas Conservation Committee maintains an online database that contains essential information of new wells, although completion information (log data, geochemical

analyses) is not publically released until one year after initial production. In order to stay competitive in the cutthroat unconventional oil and gas market, companies have to continually investigate their competitor's drilling activity by using this public resource. I updated hundreds of new wells in 50 townships in Weld County, and created a map displaying the major companies' areas of interest and the locations of the newly drilled wells.

During three memorable days of my internship, I was able to accompany Cirque's senior geologists to view core samples from a few test wells. Core is an indispensable tool for petroleum geologists as it allows direct observation of the rocks themselves, something that is rare in a typical office setting. Through geochemical and petrophysical analyses, lab technicians are able to determine valuable information about the target rock like thermal maturity, vitrinite reflectance, porosity, and permeability. It was olafactorily rewarding to smell the oil in certain sections of the core, and also to feel it when I rubbed my thumb directly on the rock. I was also able to observe several interesting sedimentary structures and features including chicken-wire anhydrite, pyrite nodules in coal, ripples, fossils, storm deposits, and laminated algal beds. While I was at one of the core laboratories, I was given a private tour of their analytical areas to see first-hand how the tests are performed.

Another unique and gratifying part of my time at Cirque was sitting in on meetings and presentations to other companies. I was invited to several meetings with companies including Noble Energy, Microseismic Systems, Whiting Petroleum Corporation, and the Norwegian oil-giant Statoil. Each meeting involved a broad overview of Cirque's project in question, including thorough geologic considerations, engineering insights, and land issues. Not only did I get to witness a typical oil and gas trade in-action, but I was also able to meet the players involved and establish contacts outside of Cirque's small sphere. Observing these meetings helped me understand how the overall oil and gas industry operates, and also served as a distinctive introduction to companies that operate out of Denver, Houston, and even Oslo.

Since beginning the geology curriculum at Sewanee, I always knew that I wanted to enter the realm of economic geology—either hard rock mining or oil and gas—because natural resource extraction is, and always will be, a critical aspect of the economy. After my experiences this summer, I have recognized the immense career potential in the oil and gas industry, especially in unconventional domestic resources, and aspire to be a part of it one day. Nonetheless, I could not have enjoyed these experiences without funding from the Raoul Conservation Internship fund, and for that I am exceedingly grateful. Thank you.