Submission date: 6 February, 2020

Program/s in this review: Applied Geological Sciences MS

Specialized accrediting agency (if applicable): NA

Campuses where the program is delivered: Anchorage

Members of the program review committee:

- Simon Kattenhorn, Professor and Director, Anchorage
- LeeAnn Munk, Professor, Anchorage

1. Centrality of Program Mission and Supporting Role (700 words or less – 700 words)

Over 100 companies operating out of Anchorage and throughout Alaska hire employees with graduate level degrees in the geosciences, which is considered a high-impact, high-demand job area in Alaska. The MS Applied Geological Sciences (MSAGS) program at UAA began admitting students in the Spring 2018 semester and now contributes to those workforce needs in several key areas: petroleum, minerals and mining, and environmental consulting industries. Additionally, place-bound students who want to further their education to the MS level in geological sciences are able to do so in Anchorage, similar to place-bound BSGS students who have resulted in UAA having the largest undergraduate geological sciences cohort in the state of Alaska. Access to the MS program provides key opportunities for Anchorage-based geoscientists to have upward mobility in their places of employment. Accordingly, one-third of our current graduate student body are currently employed as geoscientists while working toward completion of the MSAGS degree.

The US Bureau of Labor Statistics predicts a 21% increase in job-growth in the geosciences in Alaska, compared to a national average of 13%. Anchorage, ranked the #3 location in the country for geoscience jobs, is thus well-positioned to see geoscience job growth in the 20% range. The UAA MSAGS program is key to providing the entry-level degree for higher-paying oil/gas, federal jobs, and 4-year universities for the largest population center in Alaska. The past experience of the department suggests that Anchorage-based students have little interest in attending UAF for a graduate level degree in geosciences for a variety of reasons, including being place-bound in Anchorage, needing to balance education and work, or because the UAF program does not offer the desired areas of emphasis. Only one graduate of the UAA BSGS program has attended UAF for a graduate degree (MS Chemistry), indicating that the UAA and UAF graduate programs serve different population cohorts and are thus both significant contributors to the state’s professional geoscientist workforce. The MSAGS program at UAA serves the Anchorage community by providing the skills and degree needed to obtain the highest-paying jobs in geosciences, as well as to broaden their employment opportunities.

Research conducted within the thesis option of the MSAGS program includes both pure and applied research relevant to Alaska and the world, including resource related issues and climate change impact issues. For example, several current projects are directly relevant to oil and gas exploration in either the North Slope or Cook Inlet regions of Alaska, whilst several others are focused on the effects of climate change across the state, considering the interplay between climate, boreal fires, glaciers, erosion, and coastal marine ecosystems.

MSAGS students are permitted to enroll in up to 6 credits of elective 400- or 600-level coursework in supporting disciplines such as English, Business, Project Management, and Geomatics. The Department of Geological Sciences at UAA has also been coordinating with the geosciences department at UAF to seek opportunities for instructional synergy and collaboration at the graduate level. Several UAA graduate students have enrolled in UAF courses through distance learning. We anticipate offering courses at each institution that will (1) attempt to avoid duplication of similar course offerings, where feasible; and (2) provide opportunities for graduate students at each MAU to enroll in courses at the other campus through the development of video-linked courses or graduate e-Learning.
The department engages in partnerships with outside agencies, businesses, and organizations through their participation in our Community Advisory Board, whose 18 members represent industry interests in oil/gas and mineral resources, environmental geoscience consultancies, geotechnical and engineering fields, federal agencies, and Alaska Native corporations. The department has many strong ties with the resource related industries in Alaska. These relationships have provided the department with $460K in industry donations since 2009. During the past 5 years, the department has received over $6.4 million in competitive research grants from federal agencies, industry, and research endowment programs, providing funding for 15 graduate students. We have received donated software programs from numerous companies to the order of more than $150 million (equivalent value) for use in our computational laboratory, permitting us to provide students with personalized training using the tools and scientific approaches needed in the modern workforce, thus making our students more competitive for high-demand jobs in Alaska.

2. Program Demand (including service to other programs), Efficiency, and Productivity (7 year trend; 1400 words or less – 1086 words)

Seven year degree and/or certificate awards trend: The MSAGS degree program was only initiated in Spring 2018 and is nominally a 2-year degree program. Hence, the earliest degree awards were only anticipated in FY 2020. Accordingly, 3 degrees were already awarded in FY 2020 (1 in Summer 2019 and 2 in Fall 2019). However, the youthfulness of the degree program explains why there were no degrees awarded in the 7-year window FY 2013-2019 and thus no trend data.

Credits Per Degree (Average Credits Earned): There are no data available for FY 2013-2019; however, the average number of credits per degree for the 3 degrees awarded in FY 2020 is 31.3 credits whereas the minimum number of required credits for the degree is 30 credits.

Seven year majors or program enrollment trend: Seven year enrollment trends are not available for this program; however, it is unclear why the FY 2019 IR data indicates a total enrollment of only 15 students (it should be 19) and no students for FY 2018 (note, the program began in Spring 2018 with 8 students enrolled; given that Spring 2018 falls within FY 2018, this data should be represented in the IR Reports). These data are confirmed by the daily enrollment trends in the MS Applied Geological Sciences program for successive semesters from Fall 2018 to Spring 2020, shown below:

<table>
<thead>
<tr>
<th>Semester</th>
<th>Enrollment</th>
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<tbody>
<tr>
<td>Fall 2018</td>
<td>15</td>
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<tr>
<td>Spring 2019</td>
<td>18</td>
</tr>
<tr>
<td>Fall 2019</td>
<td>19</td>
</tr>
<tr>
<td>Spring 2020</td>
<td>14</td>
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These enrollment trends since the inception of the MSAGS program in Spring 2018 indicate a **138% initial enrollment growth in 3 semesters**, with a recent decrease in response to graduating students and minor attrition.

Course pass rates: Although the MSAGS program only began in Spring 2018, graduate level courses were offered in the department during the past 7 years in support of the MS Interdisciplinary Studies program. Course pass rates in these courses have been consistently high, reaching 100% by FY 2020.

Internal demand: The 2020 program review data indicate that graduate level courses in Applied Geological Sciences have appealed to students in other graduate programs across the university over the past 7 years, but primarily the MS program in Interdisciplinary Studies which served as the default option for geology graduate students prior to the inception of the MS Applied Geological Sciences degree in Spring 2018.

Seven year Student Credit Hour (SCH) production trend: The MS program in Applied Geological Sciences has proven to be a UAA and CAS success story, with an **845% increase in SCH enrollments over the past 7 years.** With continued investment in the department faculty numbers, these SCH numbers have the potential to increase even further given the high demand for geologists in the state of Alaska.
SCH/FTEF: Other than a lull in 2014 that correlated with a faculty staffing shortage in the department, SCH/FTEF numbers in the Applied Geological Sciences graduate courses have been consistently high, averaging 160 and placing the program on par with English and Psychology.

Enrollment/Full Time Equivalent Faculty (FTEF): Enrollments in graduate level courses in geological sciences have generally increased over the past seven years, demonstrating the expected positive correlation with an increased number of graduate faculty between 2013 and 2018, and reflecting the general health, strength, and appeal of the program to graduate students in Alaska. These numbers have evolved to be consistently higher than the CAS average, implying program and departmental efficiency.

FTES/FTEF: FTES/FTEF has evolved into a stable trend since the inception of the MS Applied Geological Sciences degree program in Spring 2018. The ratio of Full Time Equivalent Students to Full Time Equivalent Faculty in Geological Sciences is now consistently higher than the CAS average for graduate programs.

Class Size (Average Class Size): Average class sizes in geological sciences graduate level courses increased significantly with the creation of the MS Applied Geological Sciences degree in Spring 2018, with average graduate level class sizes now significantly exceeding the CAS average, which has decreased in recent years. These data speak to the robustness and potential of the MS Applied Geological Sciences program.

Cost/SCH: The cost of supporting the graduate level courses in geological sciences has steadily decreased with the advent of the official MS degree program in Applied Geological Sciences in Spring 2018, and now approach the CAS averages for graduate degree programs.

Tuition Revenue/SCH: Applied Geological Sciences shows a slightly higher increase in tuition revenue relative to SCH as compared to the CAS averages. The general increase is presumably related to annual tuition increases; the reason for the slightly higher tuition revenue in Applied Geological Sciences is unknown but may relate to non-resident tuition revenue from a relatively higher percentage of non-resident students in the MSAGS program as compared to other CAS graduate programs.

External demand: The American Geosciences Institute (AGI) reports on the status of the Geoscience Workforce every Spring and is the most reliable data concerning geoscience employment. The most recent report was released in 2019 based on data collected in 2018. AGI states that the MS degree in the Geosciences is considered to be the “degree of employment,” although certain industries still employ BS graduates in geosciences but at lower salaries. In general, MS graduates in Geosciences earn $70-80 K per year compared to the $40-50 K of BS graduates. The higher salary is an attractant for BS graduates seeking to make more money to support their families. Additionally, the current external demand for the MSAGS program is very high based on the demands of both Alaska-based and US-wide industry. AGI projections highlight steady job growth in geosciences nationwide, and growth in all but one subspecialty.

Tuition revenue from graduate level courses in geological sciences is effective in covering the associated faculty costs of offering these courses. For example, data from the Spring 2019 semester indicate that the total tuition revenue exceeded faculty costs by $34,400 during that semester. Fees are not used to cover the cost of faculty as this is not the purpose of mandatory course/lab fees as per university policy.

Extramural funding is a significant contribution to supporting faculty salaries for non-instructional activities (i.e., sponsored research) and is also used for the purpose of course buyouts. The department faculty have been particularly successful in obtaining extramural funding to support student success (e.g., by providing research assistantships for graduate students), increase tuition revenue (graduate student tuition may be paid by grant funds), and for subsidizing faculty salaries. The department has received ~$6.4 million in research funding support over the past few years and which has provided financial support for 15 graduate students.
3. Program Quality, Improvement and Student Success (1500 words or less – 1328 words)

The MSAGS degree program at UAA currently has 19 admitted students (as of Spring 2020) and produced 3 graduates in the first 4 semesters of the program. An additional 2 students have defended their research theses and will graduate in Spring 2020. Although the program inception in Spring 2018 marked the first official MSAGS students, graduate courses have been offered in the department throughout the past 7 years in support of the MS INDS (Interdisciplinary Studies) program. With the approval and enthusiastic support of the MSAGS program by the Board of Regents in 2017, the inception of the MSAGS program has resulted in enrollments in graduate courses increasing by 845% since 2013, providing convincing evidence of the high need for such a graduate program at UAA. The program also benefited from a 138% increase in the number of graduate students from AY2018-2019 to AY2019-2020, resulting in attainment of the 5-year enrollment goal for this new program in only 1 year.

MSAGS is a cutting edge applied geological sciences program and was specifically designed to meet the high demand job market in Alaska and to support students involved in applied and basic research related to faculty research programs, including those related to oil and gas resources exploration across Alaska, climate change impacts in the Arctic, mineral resources, the sustainability of green energy via understanding lithium resource deposits, carbon sequestration, induced seismicity, and machine learning in geosciences. The program also offers opportunities for pure research in the field of planetary geosciences, with students already having produced award-winning research results.

The innovative MSAGS program design promotes student success in both thesis research-driven and non-thesis educational options, providing unique opportunities in Alaska for students to tailor the MS degree to their own interests and life situations. For example, one-third of the graduate student body are already currently employed as professional geoscientists and are enrolled in the MS program as part-time students in order to permit a realistic time frame and pathway to successful degree completion. Attainment of the MS degree will provide upward mobility opportunities for these students. The MSAGS curriculum is designed around highly applied courses that will uniquely prepare graduates to seamlessly transition into professional geoscience jobs in Alaska and elsewhere. For example, subsurface investigation courses are highly relevant to the oil and gas industry and are taught using industry relevant software. The department has received donations of >$150 million equivalent dollar value in high-end 3D visualization and modeling software and real-world data for instruction and research. The curriculum also includes a required course in scientific techniques and practices that emphasizes professional conduct and ethics.

The majority of the graduate courses are offered as classroom-based lecture courses; however, increased access to distance learning through video-conferencing or other eLearning options is a distinct future goal. Currently, we offer Environmental Geochemistry (GEOL A663) with distance delivery to UAF students and have the ability to live-stream any graduate course of our choosing using newly acquired Owl video-conferencing technology. These capabilities reflect important synergies and cooperation between the geoscience programs at UAA and UAF to maximize access to a diverse range of course content for the respective graduate student bodies at each MAU. Several UAA graduate students have also completed live-streamed courses through UAF (e.g., Basin Analysis and Introduction to X-Ray Spectrometry). The graduate level courses at UAA also incorporate important field-based transformative learning experiences into the instruction, with field trips to type localities or key locations around Alaska and elsewhere in the USA that provide students with critical insight into geological features and processes.

The MSAGS program has adopted three Program Objectives and five Student Learning Outcomes (SLOs) that are assessed annually, with the first assessment having been completed in 2019. The program objectives are to provide graduates with:

- Graduate-level technical knowledge within geological sciences.
- An ability to conceive and conduct graduate-level geological sciences research (thesis option only) and problem solving.
- An ability to effectively communicate and apply graduate-level geological sciences concepts and technical skills.

Attainment of these programmatic objectives are assessed based on performance in the five SLOs:
1. Use rigorous methods of scientific analysis.
2. Demonstrate mastery of graduate-level geological sciences theory.
3. Conduct advanced geological sciences research and/or demonstrate technical skill application.
4. Apply the scientific method to graduate-level problems in one or more focus areas of geological sciences.
5. Work effectively within the professional framework of geological sciences careers or be prepared for Ph.D. research programs.

Each of these SLOs are assessed to some degree during the annual assessment process through four assessment measures: direct course level assessment (CLA); exit surveys; thesis defenses or comprehensive examinations; and theses or projects. No clear concerns about the delivery or effectiveness of the program were raised by the 2019 assessment results.

The first cohort of graduate from the MSAGS program are all currently employed within their discipline. Other students whose degree completion is imminent have already been offered employment in the geosciences. Hence, the program is currently experiencing a 100% success rate in placement of our graduates into geoscience jobs. These successes by our graduates may be a direct outcome of the fact that students have opportunities to work on industry-funded projects as part of the degree program, providing them with direct exposure to potential future employers. Student success is also greatly enhanced through a culture of strong mentoring and academic advising for all enrolled students. Research mentors meet with their students regularly (every 1-2 weeks) and serve as primary academic advisors to guide students through the MSAGS program. Student success is also strongly assisted by the contributions of key support staff within the Division of Math and Natural Sciences in the College of Arts and Sciences, who provide administrative support related to admissions, course scheduling, enrollment, degree progress and completion, thesis submission, and graduation.

MSAGS students have demonstrated successes in obtaining summer internships and post-graduation full-time employment as well as acceptance into PhD programs. Examples of student successes include:

- One graduate student completed a summer internship with BP Alaska and continued after graduation to full-time employment with Chesapeake Energy (Oklahoma).
- Our students have received research grants or scholarships from the Pacific Section of the American Association of Petroleum Geologists (3 students), the Alaska Geological Society (4 students), the NASA Alaska Space Grant program (1 student), and ExxonMobil (1 student).
- One graduate student completed internships with Battelle (Ohio) and the US Geological Survey (Anchorage) before continuing after graduation to full-time employment with Hilcorp (Anchorage, AK).
- One student completed an internship with Pogo mine (Alaska) and currently works for the Alaska Department of Natural Resources (Anchorage, AK).
- One student is currently an intern at the Alaska Department of Natural Resources’ Geologic Materials Center (Anchorage, AK).
- One student completed internships and short-term employment with the US Department of Energy (Oregon) and Chemostrat as well as working on a STEPS student project with Halliburton (England, UK).
- One student completed internships and short-term employment with ExxonMobil (Texas) and Chemostrat.
- Our students have presented the results of their research at numerous national conferences, including the American Association of Petroleum Geologists (AAPG) annual meeting, the Geological Society of America (GSA) annual meeting, the American Geophysical Union (AGU) Fall meeting, the Lunar and Planetary Science Conference (LPSC), the Alaska Geological Society Spring Technical Conference (Anchorage), and the Alaska Miners Association (AMA).
- One student received a prestigious Dwornik Award from the Geological Society of America for his research and was singled out as having one of the noteworthy poster presentations at the 2019 GSA annual meeting.

Also of note, two teams of 5 graduate students each participated and represented UAA in the prestigious worldwide subsurface imaging competition, the Imperial Barrel Award, organized by the American Association of Petroleum Geologists (AAPG) in 2018 and 2019. Students worked on subsurface interpretation of a new area using massive
geologic and geophysical datasets over an 8-week period and presented their results in front of the judges with multiple years of industry experience. These students were mentored by experienced professionals from Shell and ConocoPhillips, Alaska.

4. **Program Duplication / Distinctiveness (300 words or less – 299 words)**

   Geoscience graduate programs are currently offered at UAA and UAF. Enrollment trends are strong at both campuses, reflecting their critical role in support of high-impact job areas in Alaska. The MSAGS program at UAA is unique in Alaska in that it is the only program to offer a non-thesis option (i.e., professional masters degree) to Alaska residents. Currently, 62% of the admitted students in the MSAGS program are local Alaskan residents who are place-bound and dependent on a UAA graduate program to attain their career goals. The remainder are non-resident students. The graduate program at UAF includes a PhD program and degrees in geophysics and geography that do not exist at UAA. Hence, the UAA and UAF programs are distinct in the state of Alaska and are not duplicative. There are also strong synergies between the two departments (see section 3) and distance-learning course offerings are provided by both programs that support the graduate student bodies at each MAU.

   Nationwide, the average number of geoscience degree programs per state is ~12. Only 6 states, including AK, have 4 or fewer geoscience programs. Resource-rich states have the highest number of geoscience programs, illustrating that multiple departments in energy- and mining-rich states are warranted to serve the industries in those states, and that as a resource-rich state AK has very few geoscience departments compared to our peers.

   The MSAGS program at UAA is also distinctive from the graduate programs at UAF because of the unique industry needs and the student body we serve in Anchorage. This distinctive role should not be considered a duplication or overlap due to the uniqueness of the program. Without this program, the largest city in Alaska would not have access to critical job skills (i.e., oil/gas, mining, environmental) that help sustain and build Alaska’s resource-based economy.

5. **Summary Analysis (500 words or less – 420 words)**

   The UAA MSAGS program is unique in its course offerings, which are focused around applied geoscience education and preparation for geoscience careers in disciplines such as environmental sciences, hydrogeology, applied geophysics, the minerals industry, and petroleum geosciences. The UAA Geological Sciences department thus provides critical opportunities for place-bound Alaskans in the Anchorage area and surrounds to obtain an **MS degree in a high-demand, high-impact job area** in the state of Alaska. The curriculum is innovative with an emphasis on applied geoscience skills and integrates transformative learning experiences with field-based instruction and access to state-of-the-art, industry-relevant computing software.

   Course enrollments have increased significantly over the past 7 years (**845% increase in student credit hours**) and the MSAGS program experienced a **138% increase in admitted students** between the first and second years after the inception of the program in Spring 2018. **The MSAGS program met its 5-year enrollment goal in only 1 year**, clearly demonstrating the critical need for this program in Anchorage and allowing UAA to be a key player in providing graduates needed to support one of the most critical workforces in a resource-dependent state.

   The department has benefited from strong community engagement and external financial support, with over a **quarter million dollars in industry contributions over the past 5 years** and over **$150 million equivalent dollar value in software donations** from numerous software developers.

   The MSAGS program’s graduates have been successful at gaining full-time employment, and have benefited from numerous research grants and scholarships, national awards, and internship experiences that speak to the quality of geoscience education offered by the MSAGS program at UAA. The department consists of only 5 tenure-track or tenured faculty who have worked hard to maximize their instructional efficiency while collectively bringing in **$6.4 million in research funds** over the past 5 years in support of departmental research projects. The faculty are
internationally recognized for their research accomplishments, having published in some of the best high-impact journals in the world. UAA Geological Sciences is also the only geoscience department in the world to have two active members of the editorial board for the world’s top-ranked geoscience journal, Geology. Students benefit immensely from learning geoscience from these prestigious researchers with past graduates consistently reporting back to the department regarding the high level of preparation they received for their geoscience careers or graduate programs. The future potential of the program is high but will clearly benefit from ongoing future investment in building capacity through more tenure-track faculty lines that will permit more course offerings and higher enrollments.