The Broader Impacts of Rope Rescue: Rescuing Fossils And Geologists

Presented by:

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Introduction:

All grants submitted to the National Science Foundation (NSF) are required to include information regarding the 'broader impacts' of the research proposed. The content of this section includes how the proposed work will improve education, the dissemination of what will be learned to the public, and improvement of underrepresented groups in the sciences, or helped by them. Generally, it describes how the research will benefit society. While technical rescue is not subject to the 'broader impacts' criterion, it is useful to consider how the concept may be applied to the discipline. At first glance it is obvious how technical rescue benefits society in tangible ways, however, rope rescue technicians can improve outreach, training, and practice by further engaging new portions of society. Described here will be the applications of single rope technique (SRT) and rope rescue techniques as an aid to scientific research with examples from the geologic sciences and paleontology. This will be followed by a discussion of the benefits to rope rescue technicians, rescue organizations, and the technical rescue community from outreach, teaching, and practice in the aid of scientific research. The examples used will focus on my personal experiences and the research encountered by the faculty and staff at Montana State University. While there are many such examples, I chose to use only those closest to me to demonstrate the need and frequency of use.

Uses of Single Rope Technique (SRT) in the Sciences:

Generally, there are three uses for SRT: fall protection, work positioning, and rope access. All three can be useful in performing geologic field work, and each will be discussed in turn with examples from geology and paleontology. However, first it is instructive to consider why each method would frequently be useful to a field geologist or paleontologist.

Often, geologists and paleontologists find themselves on or around exposed rock because their sciences require a clear view of the rock. Rocky terrain of interest to these scientists often contains steep or cliffy portions, which can be useful places to look for representative rock (for samples and description purposes) as well as fossils because large surface areas are exposed. Unfortunately this forces geologists to expose themselves to the steep or high angle environment, a hazard we, as geologists, are taught to accept and tolerate. These slopes and cliffs become our outdoor laboratory so we spend many hours, days, and even months of our lives walking, scrambling, or climbing over these obstacles. In most cases, no safety measures are used because they would reduce our efficiency in moving over the surfaces we are studying, however, in some cases it is useful to stay in one place to describe, drill, excavate, or otherwise deal with the rock. In those situations, safety measures would be useful and desirable because geologists can, and do, die during fieldwork.

Fall Protection:

Erosion is a friend to the geologist, as it provides them with fresh rock surfaces to study, however, it can also form treacherous slopes and cliffs next to features of interest. In these cases, it would be useful to have a method of arresting a fall when working near any high angle hazard. In these rocky environments anchors may be sparse or difficult to rig, requiring some practice and ingenuity, however, engineering and building fall protection around edges for use by a geologist would be no different than building the same systems for edge men during a 'normal' rope rescue.

An example of the need for such a system is an in situ fossil mysticete (baleen) whale located at the top of a southern California ocean bluff. Below the fossil is a 50-60 foot sheer cliff, and the bones extend from about 10 feet from the edge to the cliff face. To excavate this fossil would require extensive use of edge protection, and likely a combination of the next two techniques: work positioning and rope access. This fossil is of interest to one student in my present graduate program, however, until I spoke to him about using rope related techniques, had no idea how to excavate the skeleton safely.

Work Positioning:

Work positioning would be of use whenever a geologist or paleontologist would like to work on or below an edge requiring the rope to support their weight. Like fall protection systems, work positioning systems would be simple to design and build using the same techniques rope technicians use for personnel working a technical rescue.

Need for this type of rope assistance is startlingly frequent. When I entered my graduate program, I was approached by both my advisor and another graduate student wanting me to teach them how to safely describe a set of fossil footprints in China. The locality is on a steep slope that can be surmounted by careful climbing, however, to work safely, a rope was needed. I gave them a crash course in rope access and rope positioning methods; they went to China and described the fossils using what they had learned, and returned having accomplished work that other paleontologists could only discuss. Since learning these methods, both men stated that they could now excavate confidently on steeper slopes, and felt more comfortable looking for fossils in steeper terrain because they can secure themselves while both prospecting and collecting data. For the graduate student, this increased his thesis field area because the rock unit he works in weathers to overstepped slopes that he could not utilize because he was afraid of falls. During the upcoming field seasons, he plans to use work positioning and access systems to search for and excavate fossils in numerous locations other research groups working in the area cannot access.

Rope Access:

When terrain becomes too steep to scramble or climb up, a rope access system should be used because it can provide a means of accessing locations that would otherwise be impossible to reach, and do so safely. Historically, the geologist or paleontologist had two options: forgo research on cliff faces, or use whatever climbing technique he or she knew. In most cases, graduate students use the methods their advisors teach them or things they learn at the gym. Consequently, I have heard examples of rope techniques used in geology ranging from those taught to the 10th Mountain Division, to those used in sport rock climbing. Thus far, I have not spoken to or observed any geologist (or paleontologist) using the faster and safer working techniques of SRT, other than those I taught.

I have found dozens of examples of geologists and paleontologists using rope access techniques, however, I will only mention a few to give a flavor for the need of SRT and variety of other methods used. In the late 80’s and early 90’s a graduate student at Montana State University was studying the chemistry of an intrusion exposed in a cliff face in south western Montana. His advisor had been in the 10th Mountain Division, so the student used the methods his advisor taught him for both climbing and rappelling. At the time, the methods were outdated. However, the student was only interested in completing his thesis and obtaining employment. Consequently, he performed a brilliant study of solid state geochemistry that would not have been possible without rope access techniques, though his methods were not as safe as they could have been.

Similarly, in the early 90’s a paleontology student at the University of Washington was studying the invertebrate fossils in the San Juan Islands of Washington State. To access rock that had not been previously prospected, he had to rappel the cliffs on Sucia Island. He was able to recover many new and complete fossils, something he could not have accomplished by walking the bluffs or the shoreline. To accomplish his collecting, he used climbing methods he learned by taking climbing classes from the Mountaineers. Using standard sport climbing methods he felt less secure on the rope (his description), had a harder time working on the cliff faces, and ultimately had a difficult time completing the work he was tasked with, though the rope use did make his thesis possible.

When I asked the graduate students in my department who had used ropes in their research, I was sent a suite of photos by one student who is an avid big wall climber. He was tasked with taking porosity and permeability samples along a cliff face. This required rappelling to the desired locations, as well as suspending the heavy rock drill needed for large core samples. In this case, he used common big wall techniques (similar to SRT) and reported having fun drilling hundreds of cores. He attributed his positive experience to knowing how to easily and safely traverse the rope, as well as having the rigging knowledge to suspend the drill easily and move it around while on rope.

Lastly, a graduate student in my department is faced with describing the rock, and excavating and lowering the fossils off of a southern California beachside cliff. Not knowing anything about climbing, this student has been scrambling as high as he dares on the cliff, describing what he can, and only collecting those fossils that are small enough to take down in his pockets. When I gave a talk to our earth sciences department about using ropes to benefit research, it became clear that he could use training in rope access techniques to both describe the rocks (measure section) and excavate fossils. In addition, he could also use help raising fossils up the cliffs from where he collected them at the base, and in rigging a traverse line for when he takes data on the bone beds, which are a third to half way up the cliffs. This past summer we had planned to attempt these measures, however, scheduling became impossible after changes to both our research programs.

Uses of Rope Rescue Techniques in Paleontology:

As rope rescue technicians, we train to move an injured incapacitated person quickly, efficiently, and safely over rough terrain. Paleontologists frequently experience a similar problem, the need to move a heavy fragile fossil over rough terrain, somehow. Traditional fossil moving methods have included the use of tractors, forklifts, winches, and other heavy machinery when the fossil localities were accessible. As areas close to roads were cleaned of fossils, it forced collecting to occur in more remote areas. Consequently, heavy machinery often can no longer reach fossils where they have been discovered. To move large (heavy!) fossils, paleontologists have resorted to dragging them on old car hoods or doors (I have done this and it works!), physically lifting jackets (fossils wrapped in plaster and burlap) with a large group of people, or putting them on a ‘dino wheel’ (Museum of the Rockies), which is essentially equivalent to a wheel on a litter. However, these methods fail with some exceptionally large or fragile fossils, and another movement method is required. Presently, the method of choice is to use helicopters, which are both expensive, and dangerous to use around the cliffs that often correlate with large fossil localities. In dire circumstances, fossils are cut into pieces and taken out in smaller units, a result which is obviously undesirable.

A solution to this problem is to use the same rope rescue techniques we rope technicians all practice for moving people, as many jackets are found on or next to steep terrain or cliffs. Large jackets start at around 100 lbs and can be up to 1000 lbs. It is rare to exceed the 800 lb mark due to the problems with flipping fossil jackets, however they can be nearly 2000 lbs under the worst conditions, though fossils of this size are usually cut into pieces. This places the vast majority of large fossils squarely within the weight limits we train for (400-600 lbs). In addition, if fossils are heavier, it is certainly acceptable to reduce the safety factor during system design since the load is long since dead. Alternatively, a more elaborate and complicated system could be built if the fossil is extremely heavy and fragile, however, this is an incredibly rare occurrence (usually when very large, they are comparatively robust).

Designing systems to move fossils would be functionally identical to rescue systems with the exception that the load is not alive, and it would be appropriate and desirable to use old decommissioned equipment. Given that the forces involved could stress good/new ropes and hardware, it would be acceptable and preferable to use ropes and hardware that have been decommissioned.

The benefits to paleontology are immediate and numerous. First, the price of renting a helicopter to move a fossil can be prohibitive, which forces many paleontologists to wait years to remove fossils that have been jacketed, thus weakening the jacket, as well as the fossil. Second, helicopter usage can be dangerous, and placing fewer people in harm's way is desirable. Third, rope rescue techniques can be utilized under nearly all environmental conditions and in nearly all areas with steep terrain (there are exceptions in parks that do not allow some bolting or other modification to the landscape). This allows the paleontologists involved to plan for extraction in a concrete way that is presently not possible for many large fossils. Fourth, by being exposed to rope usage, paleontologists will learn methods that can help them with future field work via rope access and equipment or fossil movement.

Unfortunately I have no examples of rope rescue techniques used on fossils because in all the opportunities I have had to use them, the paleontologists in charge chose to use heavy machinery or brute force instead. However, a review of these scenarios is informative and illustrates the need for rope rescue expertise and proactive outreach.

During my master's degree research, I worked in a quarry on a steep slope in southern Utah. The slope was over 45 degrees (we did measure it), and the quarry yielded many animals (we still don't know how many there are since it is still being excavated), and many large plaster jackets. To move the fossils down the hill, we added extra layers to each jacket and dragged them down. When it became clear that the jackets would not survive the short trip down the hill to the road, we found an old car hood and used it to pull the fossils down the hill. The result was a significant breakage of the fossils (as they were repeatedly jarred during the decent), as well as the complete decimation of the rock slope. This movement could have been easily accomplished by a tracking line anchored at the top of the cliff and on a tripod on the valley floor or on the cliff across the valley. Using a tracking line, the jacket would not have experienced any of the impacts during the decent, and it could have been controlled easily from above, rather than placing personnel below it, as we did then. Ultimately, this is a prime example of when rope rescue techniques could have improved human safety, accomplished the task with minimal damage to the fossils, and would have required less work.

This past year, a fellow graduate student discovered a crocodile in her field area and asked for assistance removing it. The jacket weighed about 700-800 lbs and was at the base of an over steepened slope. After excavating and jacketing the articulated fossil, it was determined that the jacket would be winched out of the hole and up the slope. To accomplish this, the jacket was reinforced with many layers of plaster, burlap, and lumber and then a truck equipped with a small crane was driven out to the locality. The truck was driven over rough terrain until it was above the excavation, then the fossil was winched up the hill. During the winching, the ground was gouged significantly and the jacket torn to pieces, leaving plaster all over the area. The land owners were not pleased with the eye-sore created by dragging the jacket, and the damage to the fossil could be significant (the jacket has not been opened yet, so the damage caused is presently unknown). Moving this fossil could have been accomplished faster, with less damage and risk, using a tracking line. Because the ridge above the locality is steep and the locality is in a small valley, it would have been simple to lift the fossil from its resting place and sail it over the ground up to the road using a counterbalance or mechanical advantage system. This would have prevented the damage to the jacket, the landscape, and would not have endangered the vehicle by driving it off road over rough steep terrain. In this example, I had all my rigging equipment there, however the paleontologist in charge chose to use known methods rather than risk using methods he did not know or understand. Later this same paleontologist asked for rope access training, and has since purchased his own equipment, ropes, and plans on using SRT and rescue systems to facilitate his research in the future.

Benefits of Outreach to the Rope Rescue Technician:

Rope rescuers can receive tangible benefits from donating their time and service in the assistance of science, and particularly the fields of geology, and paleontology. First and foremost, outreach toward the sciences and paleontology can be fun. Often it can fulfill a childhood dream of becoming a paleontologist, by working on a crew helping move fossils. Similarly, interactions between rope rescuers and paleontologists will bring fun and interesting people in contact that will certainly lead to friendships.

Practically, there are two professional benefits to individual rescuers: first, the practicing of basic personal rope related skills, and second, the teaching of skills to others cements the skills in the teachers mind. All too often, personal rope skills are neglected in group practice, leaving the technician to study on their own. Having been a member of three different SAR agencies that utilized technical rescue skills, I have noticed in all three groups that individuals let their skills lapse, usually unintentionally. All practice helps retain information, and should be encouraged. Similarly, teaching forces the teacher to both know the information and know it in greater depth than the learner. By teaching others any rope related skills (SRT or rope rescue), the skills of the teacher will improve. Thus, by teaching and practicing rope related skills in the aid of the sciences, the personal safety of the rope rescue technician will improve during real rescues from increased familiarity with the material.

Similarly, the rigging problems faced by individual riggers in the transport of fossils will be entirely novel. The constraints, both physical (rock, trees, anchors, etc.), and self imposed (being gentle on the fossils), will be new and real. Thus, the rigger will gain experience working through rigging problems creatively, a skill that is nearly entirely ignored in many rescue agencies and rarely practiced. Practicing rigging creatively, performing system analysis, and intentionally engineering and building a system is the most advanced skill set in rope rescue and can only truly be gained by experience. Rigging to rescue fossils provides a fun and low stress environment and opportunity in which to practice this suite of skills.

Benefits of Outreach to the Rope Rescue Team:

Benefits to the rope rescue team are similar to those for individual rescuers. Rescue groups often have simulated rescue training events that are largely controlled and in places that are conducive to teaching and learning, leading to formulaic practices. Real rescues are not as accommodating, and rescuing fossils will certainly provide an opportunity for agencies to practice their rigging skills in a realistic setting with novel rigging problems, and without the stress of a human load. As mentioned above, the creative rigging and construction of rescue systems is rarely practiced, and rescuing fossils would provide an excellent opportunity to build, as a group, novel systems. Thus, these scenarios provide senior rigging personnel the opportunity to both instruct and direct junior members in the completion of a task they were not directly trained for. Such a practice will improve team communication skills as well as communal rigging, all with real world constraints.

Benefits of Outreach to the Rope Rescue Community:

Exposing scientists, of all kinds, to rope related skills could lead to an influx of bright, motivated people into rope rescue. More innovation, tempered with an understanding of physics, math, and statistics could lead to improvements in method development and testing. Arguably, the greatest benefit from rope rescue outreach to the sciences is the possible formation of partnerships between academia and the rescue community, which could improve component and system testing. Ultimately, greater scientific rigor in testing will lead to improved safety for all by demonstrating what works, and providing equipment and system tolerances for use during system engineering.

A real world example of this has been my discussions with the engineering faculty at Montana State University. I casually mentioned starting a testing program to a faculty member who responded favorably. He suggested such a testing program would be simple to accomplish, would be an excellent project for a PhD thesis, and would be appropriate for our location (in the heart of a climbing community). Another engineering faculty member is a member of an alpine SAR unit and runs their rope rescue training program, and his specialty is finite element analysis (modeling multipart systems by inputting component properties-perfect for rope rescue system analysis). Such fortuitous associations of rope inclined scientists and engineers could be found at other institutions and could be a significant and untapped resource for the rope rescue community.

Suggestions and Conclusions:

Hopefully, I have made the case that reaching out to scientists, particularly geologists and paleontologists, would be mutually beneficial for the people and institutions involved. To facilitate this exchange, it would be useful to contact earth science departments at the universities near you to offer your services. The bureaucracies at some institutions will make it hard to get through to the faculty and graduate students (at times). I recommend calling or e-mailing the departments on a routine basis to offer services and training. It may take time for them to respond. However, eventually someone will want training, and they will spread the word throughout their respective institutions. Attending geology related meetings would also be useful, both to meet people, and to describe what you have done to help their science. It will be appreciated and others will be interested in learning what you have to teach. I plan on giving a series of talks at meetings to both geologists and paleontologists to inform them what can be accomplished with rope rescue techniques. The talk that accompanied this article was the second in a series of four talks that will be given at academic meetings around the country.

The scientific community as a whole could use the knowledge of rope usage that the rescue community holds, particularly the geological community and paleontologists have a pressing need. The barriers to learning these skills are many, including the lack of time and incentives to learn because scientists are frequently busy merely attempting to retain employment or finish degree programs. Outreach from the rope rescue community would measurably improve the safety and efficiency of the field work many geologists and paleontologists undertake. Particularly, paleontologists encounter problems that are remarkably similar to the transport problems faced by technical rescue personnel. By helping geologists and paleontologists the rescue community would help more people and show the public what 'we do'. Teaching rope related skills to others would also disseminate rope skills more widely through the populous, thus increasing awareness and appreciation. These simple steps would increase technical rescue's benefit to society, which is both personally fulfilling and a civic responsibility to those with advanced skills.

Lastly, while scientists can learn much from us, we can learn from them. Research design within the rescue community is often not up to scientific standards, including few replicates, uncontrolled/poorly controlled conditions, or poorly described and reported tests. Often results are not published, and when they are, they can be difficult to find or access. The sciences demonstrate acceptable experimental techniques, as well as appropriate reporting and publication of experimental data in open and accessible journals. These comments are not meant as a condemnation of the research that takes place in the technical rescue community, but an admonition to do better. By utilizing the strengths of others we can improve our testing programs, thus helping us be safer in all we do. In addition, by adopting the research constructs of science, it may be possible to utilize untapped resources of both personnel and funding. By aggressively pursuing an academic research program it may be possible to receive federal funding for graduate study focused solely on rope rescue system testing. The result would be publicly available research utilizing data with large sample sizes, multiple replicates, under controlled conditions.

Ultimately, I am advocating improving the 'broader impacts' of rope rescue through outreach, teaching, and improved access to experimental data. By following a scientific model rope rescue will improve, and by the sciences adopting rope rescue techniques they will improve as well. Such a mutually beneficial relationship may take years to develop, however, working toward this goal will measurably improve personal safety for both communities. Consequently, I urge members of technical rescue groups around the country to consider offering their assistance to the scientific community, and I will work to persuade scientists (geologists and paleontologists) to seek your expertise.

NOTES