SPECIAL REPORT
Glaciers and Mining Series

Los Azules – Minera Andes
(McEwen Mining of Canada)

Risks and Impacts to Rock Glaciers and Periglacial Environments

San Juan, Argentina
May 2012

SPECIAL REPORT: GLACIERS AND MINING SERIES

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Risks and Impacts to Rock Glaciers and Periglacial Environments by Los Azules (Minera Andes – *now McEwen Mining*)

Project:	Los Azules
Mineral:	Copper (open pit)
Company:	Minera Andes (now McEwen Mining, Canada)
Location:	San Juan, Argentina
GPS Site:	31 6 14.42 S, 70 12 52.03 W (cut & paste in Google Earth)
Glaciers Affected:	226

Satellite image of Los Azules mining project revealing numerous rock glaciers in the project area

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About CEDHA

The Center for Human Rights and Environment (CEDHA) is a non-profit organization based in Córdoba Argentina working to create a more harmonious relationship between people and the environment. CEDHA works to protect human rights, strengthen judicial and normative frameworks on social and environmental protection, and to encourage the compliance and enforcement of environmental law by State and corporate actors. CEDHA has programs focusing on climate change, deforestation, right to water and sanitation, international finance corporations, corporate accountability, and mining and human rights.

Introduction

In October of 2010, the Argentine Congress adopted the world's first National Glacier Protection Act[1]. The law could not come at a more timely moment. Climate change is bringing unparalleled impacts to our global environment. Glaciers are an indicator of this change. They are melting faster than ever recorded. In 2011 even the Vatican through its' Pontifical Academy of Science published a scholarly piece entitled *The Fate of Mountain Glaciers in the Anthropocene*[2], calling attention to anthropogenic impacts on one of the world's most delicate and important natural resources, glaciers.

Some 20-25% of the world's freshwater reserves are packed in the ice of the high Andes mountains, much of it located in the dry and arid regions of western Argentina. Our global society understands very little about glaciers. Their remoteness at very high altitudes or in extreme latitudinal zones, make glaciers largely inaccessible to most of the population. Even mountain populations living in the general vicinity of glaciers tend to live at significant distances from the ice and hence come into very little contact with these magnificent ice bodies. Consider that in central Argentina or Chile, most glaciers exist only above 4,000 meters, where for health reasons, human life is practically non-existent. So unless you've got some very good reason to trek up to where the air thins and the bitter cold reigns at 13,000 feet above sea level or more, you're probably not going to see too many glaciers in your lifetime, and certainly not come into physical contact with one. Even ski resorts and vacation areas are usually at much lower altitudes, due to the altitude sickness that is experienced at the levels where most glaciers exist. In fact, most of the world's population has never seen a glacier, and many that have stood on one, maybe on a ski trip or during a trek though the mountains, didn't realize they were standing on one of Mother Nature's most fantastic and efficient inventions to store fresh water during the warm and dry season. In some cases, a passerby may have stood on a glacier and not even noticed there was any ice on the mountain at all, and that's because sometimes glacier ice is invisible. But if it weren't for the densely packed snow converted into perennial ice that forms glaciers, winter snowfall would melt rapidly in the first months of spring, filling rivers quickly and at high volumes, but then the ecological system's water supply would rapidly disappear for many months until the cycle began anew each winter and spring.

Glaciers act in nature like a slightly open tap feeding water into a home. By being slightly open all year round, the home has a slow and steady supply of water which is fundamental to sustain any ecosystem. We can also think of glaciers like a natural dam in the mountains, which releases water as is needed, instead of all at once. In glaciological terms we say that "a glacier acts as a regulator of water basins". Packed ice in cold and high-mountain altitudes are a critical resource and hydrological reserve for all ecosystems below. This is why the new national glacier law in Argentina treats *all glacier ice*, irrespective of form or size, as of the *public interest*. In some especially dry areas, Mother Nature has very innovatively figured out a way to keep *more* ice in reserve at lower attitudes where the temperature is higher during the summer which would otherwise melt away winter snowfall in the early months of springtime. She does this by placing a rock cover over the ice, creating a cooling effect and protecting the ice from the warm environment. In these cases, *glaciers exist below the surface* making them invisible to the beholder. There are clues however that we can identify to ascertain that there is indeed ice under the earth's surface. These clues include the formation of glacier lakes at the foot of a debris-covered glacier, or the positioning of loose rock on the surface over the ice, which occurs in systematic wave-like forms. We'll discuss this further in this report.

This report is mostly about rich *ice glaciers* found under rock, which scientists call "rock glaciers". These glaciers are a type of glacier, just as important to sensitive ecosystems as the more commonly recognized *uncovered* ice glaciers that exist exposed to the environment, on the surface of the earth.

The general ignorance of the role glaciers play in nature, their remoteness and difficult access to them have led to their state of vulnerability. In fact, quite remarkably, until very recently, *no law* ever stated a need to protect glaciers. Glaciers and their public interest role were simply ignored by societies' legal and governance structures. In some very unique instances in Europe, the commercial value of tourism activities in glacier vicinities led to jurisdictional conflict about who had rights over commercially exploiting glaciers. In places like France and Switzerland, people ski on glaciers, and they serve (in addition to their ecological value) as attraction for commercial profit. But in terms of the public interest *water value* of ice, law has always been focused almost exclusively on "liquid" water protection and as such has focused legislation and regulatory stipulations and controls on the

[1] See: http://wp.cedha.net/wp-content/uploads/2011/09/Argentine-National-Glacier-Act-Traducción-de-CEDHA-no-oficial.pdf
[2] See: http://www.vatican.va/roman_curia/pontifical_academies/acdscien/2011/PAS_Glacier_110511_final.pdf

management and protection of *running* or *stationary* water in rivers, in lakes, in reservoirs, etc, almost as if the water just naturally appeared in these places from some unknown source. While in some cases, over the years, water laws established the protection of water *in all of its forms*, which would include liquid, gas, *and ice*, no law that we have been able to find, mentioned the particular dynamics, presence, existence, natural ecosystem, role or other characteristics of one of the world's most sophisticated ways of conserving and protecting water, …. *glaciers*. That changed recently when faced with growing risks to glaciers from evolving climate change, but also from anthropogenic activity, Argentina began to pass several glacier protection laws, the first the planet has ever seen.

We've mentioned that climate change is impacting glaciers. Global warming warms the glacier environment, or what we call, the "glaciosystem", a term we've coined and defined for public policy development purposes. Global climate change is raising the altitude at which the environment is at freezing temperatures (where glaciers form), and that means that any ice lower than this melting point, begins to melt. That's why glaciers are generally "retreating" around the world, in other words, they're slowly creeping *up* mountains in search of colder climates. It's not that the ice body is moving upwards, but rather, that the lower extremities of glaciers are melting away. Once the melting points reach the peak of a given mountain glaciers disappear completely, and at that point, the ecosystem they used to feed will run completely dry during non-winter or non-rainy seasons. This is both a consequence of natural evolution cycles of 50,000 years or more, but it is also being accelerated dramatically in eras of merely decades or centuries by the anthropogenic emission of CO2 and of non-CO2 climate forcing gases, like methane.

But in the Andean region in places like Chile and Argentina, (where glaciers suffer directly from global warming), glacier melt is being *further accelerated* by *local* anthropogenic activity on the ground. This impact is being caused by three distinct types of activity, mining, road works, and contamination.

This report is largely about the impact of a particular mining project, Los Azules of Minera Andes (now owned by McEwen Mining) on glaciers, in this case, rock glaciers. We should note that the Los Azules project is not the only mining project impacting glaciers. There are hundreds. What is important however about the Los Azules project, is that it is one of the very first mining projects in glacier territory for which glacier impacts will be addressed following the recent passage of Argentina's Glacier Protection Act. How Minera Andes (now owned by McEwen Mining), and how local and federal authorities handle this project's impacts to glaciers, will help set the tone and trend for how subsequent projects' impacts to glaciers are treated. And since most projects (like Los Azules), are today in exploratory phases, we still have time to influence these projects so that they better address present and future glacier impacts. In some cases, their impacts are already irreversible, because even in exploratory phases, mining projects can have very large impacts to glaciers. But in other cases, we still are in a position to lower and mitigate this impact, or even reverse it.

Mining operations flocked to Argentina encouraged by favorable legal and investment incentives introduced in the mid 1990s. Mining exploration teams are liberally crisscrossing the Andes in search of metals, sometimes indiscriminately cutting through terrain without safeguards in place and with practically no government regulatory control to ensure that they do not impact glaciers and other ice reserves which are widely present in along the Andean and other high altitude ranges. In many cases, tractor operators and perforation teams have no idea they're penetrating ice. We even have cases as in the Los Azules project where drilling companies complain about the difficulty and equipment wear of having to penetrate the ice to take their samples.[3]

The case of Barrick's Pascua Lama project, in terms of glacier impacts, launched an era of concern and discussion about the impacts of mining to glaciers. Barrick's Pascua Lama project is surrounded by hundreds of glaciers (in contrast to the few dozen the company reports through official documents), many of which feed water directly into an autonomous indigenous community's territory, the Diaguita of the Huascoaltino area in the Huasco Valley in Chile.

One of the main problems with Pascua Lama for the region's glaciers is that much of the gold reserves found at the site actual rest underneath glaciers and in permafrost grounds. Permafrost is essentially frozen ground that can have high water content, and acts like glaciers, as a water basin

[3] See paragraph 10.2 of page 78 of Los Azules' Updated Preliminary Assessment. December 1, 2010: http://wp.cedha.net/wp-content/uploads/2012/05/page-78-preliminary-assessment-los-azules.pdf ; This report was on Minera Andes' website until the buyout by McEwen Mining at which point it was removed. You can obtain a full copy of the report by contacting the author of this report at: jdtaillant@gmail.com

regulator. In the late 1990s and early 2000s when Barrick was designing the Pascua Lama project and compiling its Environmental Impact Studies, there was hardly any awareness over the risks posed to glaciers by mining activities, that is, until Barrick published in Chile, it's *glacier management plan*, for Pascua Lama. Barrick intended to get at gold below the ice, and essentially proposed to bulldoze and dynamite the several glaciers that rested over the metal deposits and haul off the ice in dump trucks, ironically argued Barrick, *to protect the environment* where their operations were planned as the instabilities cause the unstable grounds occupied by glaciers (glaciers move) could cause security risks to workers. This proposal to destroy glaciers to get at gold spurred immediate repudiation from farmers and indigenous communities which eventually led the government of Chile to reject Barrick's Glacier Management Plan and force a change in the project design, obliging Barrick to protect the existing remaining glaciers, many of which had already been impacted by Barrick's exploratory operations.

This incident with Pascua Lama marked the onset of a flow of public outcry and mobilization to protect glaciers in the area from mining operations. Across the border, in Argentina, millions of people and environmental groups reacted to the news about Barrick's plan to dynamite glaciers, and to the growing presence of similar or larger mining operations in the glacier-rich Andes. Society called for a National Glacier Protection Act, the world's first glacier law, which was eventually passed unanimously by both houses of Congress in Argentina in 2008.

In reaction to the glacier law, which now risked barring the advancement of the Argentine half of Pascua Lama, Barrick leveraged pressure at the highest level of the Argentine government, and obtained a presidential veto of the law. The Environment Secretary of Argentina resigned as she had helped craft the law, including Article 6, banning mining where there are glaciers. Argentine society quickly mobilized through social networks behind the cause to get the glacier law reenacted, which eventually occurred in 2010. Barrick has since filed an injunction order in federal courts to have the law suspended in San Juan Province where the Argentine half of Pascua Lama is located. While usually taking several months to treat emergency injunction orders, the San Juan Federal Circuit Court made way to Barrick's request in 48 hours, and the law was effectively and temporarily suspended, and rests now with the Federal Supreme Court for final ruling.

The Los Azules case which we present here, follows another report we produced recently focusing on El Pachón, by Xstrata Copper, a nearby and very similar project to Los Azules also in San Juan Province. The glacier impact situation of El Pachón is quite similar to Los Azules. Xstrata Copper, like Barrick Gold, and following Barrick's victory at the first legal stage, also filed an injunction order request to the court to suspend the glacier law for El Pachón in San Juan. That order was also immediately granted.

The resolution of the legal contention for the two cases, Pascua Lama and El Pachón, will set the tone for how the judicial system will rule in cases involving violations of the National Glacier Act. Whatever the end result at the federal court level, a further judicial context exists for the future of mining in glacier zones in addition to possible legal conflict of mining with the national glacier act/ There are also new glacier protection laws in the various mining provinces where mining is occurring in glacier areas, including a law recently passed in the Province of San Juan. As such, we foresee possible legal conflict where mining operations are not complying with provincial glacier protection laws. Los Azules is a case in point, where mining activity is in violation of both the federal and the provincial glacier laws.

The question we face is not one about choosing between mining and glaciers, but rather if we can conduct mining operations without impacting glaciers. Clearly, the importance of glacier ice cannot be overstated for dry and arid areas like San Juan, La Rioja, Salta, Jujuy or Catamarca province, where most of the conflict between mining and glaciers resides. In such areas, it is reasonable to expect that perennial ice that serves as a water basin regulator, should not be destroyed in the quest for minerals.

The question hence really is *can we extract minerals without destroying perennial ice*. At the very least it seems reasonable to mandate that mining activities should refrain from plowing bull-dozers into ice when they introduce exploration roads, or that they should not drill into a glacier for the mere sake of testing whether there might be a precious metal underneath. There are, *or should be*, specific black and white "no go" with regards to glacier presence, just as other *no-go* issues for mining might exist for other reasons (mining in hurricane areas, or in indigenous territories with no consent).

We've seen for instance, that the placement of mining sterile rock debris on ice leads to ground instability and enormous risks to the local environment and to operators. Barrick Gold recently had a

massive landslide occur at their Veladero mine in Argentina precisely due to the gross disregard of such risk in their project design, despite the fact they had been warned they should not locate their waste dump on permafrost zones.[4] In both El Pachón and Los Azules (as we shall see in this report), the current project design places sterile rock piles on glaciers and permafrost. This design should be ruled out.

The destruction of glaciers due to exploratory roads or drilling is unfortunately a common practice that occurs today, including in the Los Azules project, because the authorities that should control such impacts are not complying with their due diligence to ensure that this does not occur, even though we've now had a national glacier law and several provincial glacier laws in place for two years. Mining companies like Xstrata Copper, Minera Andes, Barrick Gold, NGEX Resources, Peregrine Metals, and others are also not taking the due diligence measures to avoid such impact.

The problem is further aggravated due to the region's governance systems' lack of capacity and political will power to ensure that mining operations are fully complying with social and environmental laws more generally. Argentina's federal government and the governments of mining provinces are aggressively *promoting* mining as a solution to underdevelopment, but they are not pursing with the same vigor, the monitoring and regulatory control of mining operations to reduce their social and environmental impacts. In fact, instead of separating promotion and control in State agencies (as through the separate and independent actions of a Mining Ministry vs. an Environment Ministry), the trend set by provinces like San Juan is to create parallel environmental authorities *within and underneath* the Mining Ministries. The *Mining Environmental Vice Minister* is therefore employed by *and underneath* the Mining Minister, which he/she must audit. The formula is ripe for failure and inefficiency and that's precisely what we see occurring in San Juan's mining sector.

While Argentina now has the world's first glacier laws, and will be a laboratory for how to deal with mining impacts to glaciers, there are no guidance tools available to orient the sector. We're addressing this through the proposition of a "Protocol for Mining in Glacier Territory", now in draft form, which would lay out the key elements to consider, when conducting mining activity where there might be glaciers. Such a protocol would be a useful tool for companies, for State agencies having to control mining operations, and for society to understand what the key issues are and what risks need to be addressed and mitigated when considering mining operations in glacier zones.

We hope that the strong debate that took place over glacier resources, the passage of the Argentine National Glacier Protection Act, and the implementation of the regulations that are now following, as well as reports such as this one on Los Azules, and others that are starting to appear, will help ensure that the sector is more respectful of such delicate natural resources, so important to environmental systems, to environmental services, and to local populations.

In parallel to what will be the first Argentine official glacier inventory, expected to be complete by 2015, CEDHA is carrying out its own glacier inventory, convinced that the 5 years set forth by the national glacier institute (the IANIGLA) are not needed to register the most vulnerable glaciers at or near mining operations. Through this effort, CEDHA is helping ensure a more effective implementation of Argentina's National Glacier Protection Act. This and other activities related to glacier and mining are part of CEDHA's efforts to "democratize" glaciers which includes the wide dissemination of information about glaciers, their water provision value to local communities and their importance as key and strategic natural resources (established now by the National Glacier Protection Act as "of public interest") as well as encouraging and empowering stakeholders and communities to actively engage in debate about the protection of glaciers and glacier environments.

[4] See: http://wp.cedha.net/wp-content/uploads/2011/10/Special-Report-waste-pile-collapse-ENGLISH.pdf

Acknowledgements

This work is dedicated to the people and communities of the Province of San Juan.

We would like to especially thank Alexander Brenning, of the Geography Department of the University of Waterloo, for his patience in reviewing and revising our work and our glacier impact analysis for this and other reports we have prepared, including for example, a previous report we produced on the impacts of the El Pachón mining project by Xstrata Copper to rock glaciers and permafrost. He has been a key contributor to help protect and democratize glaciology and bring attention to the impacts on glaciers in the region by the mining industry and other large public works.

Also special thanks go to Mateo Martini, geologist of the National University at Córdoba, a Conicet fellow and member of the Center for Science and Research of the Earth (CICTERRA). Mateo provided invaluable assistance in the review and analysis of this report and in our rock glacier inventory of both the El Pachón project as well as the glacier inventory carried out in this report of Los Azules.

To Cedomir Marangunic (Geo Estudios of Chile), Juan Carlos Leiva (IANIGLA), Benjamín Morales Arnao (Patronato de las Montañas Andinas, Perú), and Berard Francou (IRD), our trainers at the United Nation's Environmental Program's Glaciology Course. Cedomir, Juan Carlos, Benjamin and Bernard were extremely patient in answering our many questions on the characteristics and techniques for identifying rock glaciers, and periglacial environments. We also would like to thank Isabel Martinez of UNEP who gave an environmental policy oriented NGO the opportunity to learn about glaciers and glacier recognition opening a door for us into a fascinating field and a network of glacier specialists that has changed our perspective on the planet we live on. Without their help, this report would not have been possible.

Juan Pablo Milana, geologist and one of Argentina's most renown glacier specialists, who has spent probably more time than anyone exploring Argentina's central Andes glaciers has also provided continuous technical support to our team on the evolution and risks posed to glaciers in the region and an invaluable perspective into the actual and potential impacts of the Los Azules project.

To Richard Mott and the Wallace Global Fund, that provided critical financial support to our Mining, Environment and Human Rights Program to carry out our glacier research and mining advocacy. The Wallace Global Fund has been a key player in the financing of initiatives defending the environment and human rights around the world.

To the team at CEDHA that worked on this report, Alejandro Vera, Giulana Beltramone, Guadalupe Soler Franco Aguilar, and Laura Zeller. Special thanks goes to Fernanda Baissi who helps with the website for the Mining, Environment and Human Rights Program.

And finally, to Romina Picolotti, who as Environment Secretary of Argentina (2006-2008) helped introduce and fight to get our National Glacier Act through Congress and who has inspired this and many other social and environmental causes.

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Report Summary

(We recommend this report be read with Google Earth open on your computer)

Finalizing its exploratory phase a mere few kilometers from the Chilean border on the western limit of San Juan Province of Argentina, the copper mining project Los Azules of Minera Andes (now merged with US Gold to form McEwen Mining of Canada and which trades under the symbol MAI under the Toronto Stock Exchange-TSX) is surrounded by some 226 glaciers, including rock and uncovered glaciers, and permafrost zones. Seventy nine (79) glaciers are directly in the project's activity area. Forty nine (49) are outside the project area but along or near project access roads used by the company. Ninety eight (98) are outside the formal project area but in the general project vicinity.

Easily accessible satellite imagery (as publicly available through Google Earth) shows that exploratory roads introduced and/or used in the region by Minera Andes have already impacted at least 6 rock glaciers in the immediate project vicinity, while another five glaciers have potentially been affected by drilling and the construction of drilling platforms. The reader can see these impacts clearly on Google Earth, simply by following the instructions sited below. We should note, that contrary to the claims by some mining companies (Xstrata Copper for instance) that one cannot use Google Earth to conduct a glacier inventory, this in fact is what most glaciologists do in the initial stages of their glacier inventory work, before any site visits are necessary. In some cases satellite images are so precise, that site visits are simply not necessary to verify findings.

In the case of this report on Los Azules, we have also reviewed photograph imagery and information which shows that McEwen Mining's access road maintenance and new road introduction is currently impacting or placing rock glaciers at risk.

The impacts to permafrost areas (essentially frozen ground with high water content) cannot be gauged from satellite imagery, but due to the presence of rock glaciers (which indicates likely presence of permafrost) we expect that past and present activity also had and has impacts to permafrost. Further, drilling companies working for Minera Andes have reported equipment difficult and delays from the difficulty of drilling into permafrost and rock glaciers. Lack of up-to-date imagery does not provide the necessary information to ascertain *just how many* additional glaciers might have been damaged by exploratory activities at Los Azules, either by Minera Andes' tenure of the project or by past mining company activity.

In terms of eventual project implementation, five (5) rock glaciers are in the projected pit area[5], while seven (7) other rock glaciers presently are located where McEwen Mining plans to locate sterile rock waste[6], the tonnage of which if placed on rock glaciers would irreparably impact these glaciers with acid drainage as well as generating physical instability that could result in landslides as we have seen for example recently at the Veladero mine (Barrick Gold).[7] Five (5) other glaciers could also be affected as they are adjacent to the project's projected *Tailing Storage Facility*[8]. Rock glaciers and any permafrost existing in the pit area would be terminally destroyed.

Because of the characteristics of the region, and the altitude at which the project is located (above 3,500 meters—11,500ft), it is likely that permafrost is widespread in the area. In the similar nearby El Pachón project (Xstrata Copper) which is a few hundred meters lower on

[5] These rock glaciers can be coordinate referenced and viewed through Google Earth using the glacier inventory in the annex. They are: 316-7013 (f); 316-7013 (e); 317-7013 (b)316-7014 (b); 317-7014. Also download the KMZ project map file to superimpose the Los Azules Project map along with the satellite images from Google Earth.

[6] These rock glaciers can be coordinate referenced and viewed through Google Earth using the glacier inventory in the annex. They are: 313-7014 (b); 314-7014; 319-7013; 319-7012; 3110-7012 (b); 3110-7012 (d); 3110-7012 (c). Also download the KMZ project map file to superimpose the Los Azules Project map along with the satellite images from Google Earth.

[7] For report on the Veladero sterile rock pile collapse see: http://wp.cedha.net/wp-content/uploads/2011/10/Special-Report-waste-pile-collapse-ENGLISH.pdf

[8] These rock glaciers can be coordinate referenced and viewed through Google Earth using the glacier inventory in the annex. They are:317-7016; 317-7016 (d); 317-7016 (c); 318-7016 (b); 318-7016 (d). Also download the KMZ project map file to superimpose the Los Azules Project map along with the satellite images from Google Earth.

average, there is approximately 20% permafrost area as mapped by Xstrata Copper's hired consultants, URS[9]. The rich wetland areas (vegas systems) in the Los Azules project vicinity suggest that rock glacier and permafrost melt, discharge to the local streams and rivers with significant water run off, and one can only assume that at least a similar percentage of permafrost to that found at El Pachón (if not more) is also present at the Los Azules project.

Glaciers, debris-covered glaciers, rock Glaciers, *and* permafrost are all protected by the National Argentine Glacier Protection Act[10]. San Juan's provincial Glacier Protection Act[11] also protects glaciers. Both laws establish glaciers as reserves of "public interest". Current legislation prohibits any industrial activity, including specifically "mining" that impacts glacier resources. Minera Andes (now part of McEwen Mining of Canada), because Los Azules is in a glacier zone, is mandated by the recent legislation to produce a glacier impact study. This study is past due as of April of 2011 and should review any past impacts that may have occurred in previous project exploratory phases. No such study by Minera Andes/McEwen exists as of yet. The company has indicated that a glacier impact study to comply with this law *is* underway, however this study should have been completed and approved by public authorities *before* any further exploration takes place on the project. If any current activity *is* taking place at Los Azules at present, without such a study or authorization from the public authority, such activity is illegal by law. McEwen Mining publishes on its website at the very time of this publication, confirming that drilling is occurring at present.[12] This activity is illegal if the proper studies on glacier impacts and corresponding government approvals have not been carried out with permits obtained.

While Minera Andes fails to mention the presence of ice at the project site, two passing references in the company's reports suggest that Minera Andes *has* been made aware by their subcontractors that there are glaciers in the project region. More recent discussions we've maintained with the project management team have also revealed that a scientific study regarding ice presence in the project area is also underway.

A newer posting on the new McEwen Mining website suggests that the company is carrying out "glaciology studies", but then indicates that "no ice glaciers are present in the project area".[13] This last affirmation is a misleading statement confusing the untrained reader, since glaciers naturally have ice and suggesting that there are no "ice" glaciers would lead the reader to conclude that there are no glaciers present, and more specifically that there is no ice present, when we know for a fact that there are indeed many glaciers at the project site, and specifically rock glaciers that definitely have large quantities of ice, and that could be definitely called "ice glaciers". If there were no *ice glaciers* at the project site, Minera Andes would not be carrying out a full glacier inventory and study as they suggest is taking place, and which we now know has been commissioned to experienced glacier experts (at ERM). Even the investor community considering investments in Los Azules has already identified and is discussing the glacier risk at the McEwen mining project.[14]

The suggestion that there are no "ice glaciers" is at the very least wrongly employed, and at worst, intentionally misleading to the reader. Since the glaciers at the immediate project site are mostly debris-covered rock glaciers, the company should have said that there are no "uncovered" glaciers, that is, glaciers that show ice to a viewer standing near the glacier. However, even this affirmation is not correct since indeed there are several uncovered glaciers near enough to the project site to warrant a study as to the impacts that operations at Los Azules' might have on these glaciers.

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[9] To see El Pachón's geomorphological map, indicating over 200 rock glaciers and 20% permafrost, see: http://wp.cedha.net/wp-content/uploads/2011/09/MAPA-2.6.1-AM-GEOMORFOLOGIA.jpg

[10] SEE: http://wp.cedha.net/wp-content/uploads/2011/09/Argentine-National-Glacier-Act-Traducción-de-CEDHA-no-oficial.pdf

[11] For the San Juan Province Glacier Law (available only in Spanish) see: http://wp.cedha.net/wp-content/uploads/2011/04/glaciares-docs-ley-glaciares-san-juan.doc

[12] http://www.mcewenmining.com/Media-Events/News-Releases/News-Releases-Details/2012/McEwen-Mining-Expansion-Drilling-Intersects-053-Copper-Over-351-Meters-at-the-Los-Azules-Project1129434/default.aspx

[13] http://www.mcewenmining.com/Media-Events/News-Releases/News-Releases-Details/2011/Minera-Andes-Reports-Drill-Results-and-Development-Update-for-the-Los-Azules-Copper-Project/default.aspx

[14] See for example:

a) http://messages.finance.yahoo.com/Stocks_(A_to_Z)/Stocks_M/threadview?m=tm&bn=140141&tid=1493&mid=1493&tof=11&so=E&frt=2

b) http://www.siliconinvestor.com/readmsg.aspx?msgid=28004507

As per the two previously mentioned references, first p. 78 of the 2010 technical report, reveals one of the most important elements of proof not only of the existence of rock glaciers in the project area, but of the intromission of drilling in glacier areas within the project site:

> "Drilling by Minera Andes Inc. was contracted to various drilling companies including Connors Drilling, Patagonia Drill Mining Services, Adviser Drilling, Boland Minera and Major Drilling. Drilling conditions have been particularly difficult especially in faulted intersections or in areas of unconsolidated surface scree/talus/**rock glacier** in which resulted in an average drilling rate of 700 meters per month (Rojas, 2010)." [bold added]

Drilling into a rock glacier is illegal by law in Argentina.

On p.148 we find another reference to a *Prefeasibility Study* which includes a line item labeled: "Environmental Permitting including Vegas and **Rock Glaciers** $566,000" [bold added]

Minera Andes does not address the presence of rock glaciers or permafrost in the project zone in its main Environmental Impact reports, and minimizes all possible environmental impacts from the project, suggesting "At the present time, there are no known environmental liabilities at the project site, as it is an exploration project".

Counter to this appraisal, and specifically in terms of glacier, rock glacier or permafrost impacts, the mining *exploration phase* is in fact one of *the most detrimental* to rock glaciers and permafrost due to the common destruction of ice mass both in the opening of virgin roads which oftentimes (due to the ignorance or disregard of project design, environmental precaution, and the general unawareness of tractor operators) run straight through rock glaciers and permafrost. It is also common to discover that drilling operations have occurred into ice bodies. All such impacts to uncovered glaciers or rock glaciers are illegal in Argentina.

There are extensive examples the high Andes mountains of many mining projects in exploration phases that have seriously impacted glaciers and permafrost (El Pachón (Xstrata), Pascua Lama (Barrick), Vicuña (NGX Resources), Las Flechas (NGX Resources), Del Carmen (Malbex), El Altar (Peregrine), Aguilar (Glencore), are but a few examples). There are several rock glaciers in the Los Azules project site area that clearly evidence road impacts. Due to the non-availability of more recent satellite imagery, the actual count of impacted glaciers from mining exploration activity may be considerably higher.[15] We also have recent reports and photographs of glaciers impacted by access roads introduced or maintained by Minera Andes, leading to the Los Azules project site.

Los Azules is scheduled to initiate operations in 2012-2013. As it stands, Los Azules is in violation of both Argentina's national and provincial glacier protection laws, with regards to glacier and periglacial environment impact and protection. This project could not legally advance if these impacts are not corrected. While no legal action has yet been filed by environmental groups against Los Azules, this is probably due to the fact that little is known in public circles about the project, and less so regarding glacier presence. Yet, these impacts as they become public, would invariably lead to serious undermining and complications of McEwen Mining's environmental impact assessment approvals or significant delays in the issuance of extraction permits, indefinitely stalling the project until these impacts can be assessed, mitigated and future impacts avoided (should the project be allowed to continue forward). This may involve considerable redesigning (such as rethinking the location of sterile rock pile sites, or having to conduct an extensive review of permafrost zones) and/or the introduction of extensive glacier repair and protection contingency plans for the Los Azules project.

Glaciers (uncovered/white glaciers and rock glaciers) and periglacial environment (permafrost) are critical to San Juan Province's local water supply for small farming, local industries and populations. Rock glaciers (which are glaciers where ice is mixed with rock debris and where a layer of rock actually covers the glacier, making the ice invisible to an onlooker) in the Los Azules project area discharge water into local rivers and tributaries, including the Río La

[15] See for example the following glaciers, with clear evidence of mining roads running through their mass: 313-7014 (b); 314-7014; 316-7013 (e); 317-7013 (b). Also download the KMZ project map file to superimpose the Los Azules Project map along with the satellite images from Google Earth.

Embarrada, Río Frío, Río de las Salinas, which in turn feed the San Juan river, the province's most important waterway.

Los Azules' impacts to rock glaciers and periglacial environments are primarily caused (or will be caused) by roads and infrastructure both during the project's exploratory phase as well as in the project's implementation phase. Further irreversible impact would be caused by excavation of the pit area (this site cannot be changed), while impacts will also result from the sites chosen for waste piles (these site choices are avoidable).

Exploratory and access roads were and continue to be introduced by Minera Andes, while some roads may predate Minera Andes' acquisition of the Los Azules project site, however, these roads and their impacts to the environment and to rock glaciers and periglacial environment in particular, are part of the environmental impact of the project, for which Minera Andes (McEwen Mining of Canada) is responsible. Furthermore, road upkeep of existing roads and use of those roads by McEwen Mining, if they are impacting glaciers, should be avoided. As such it is presumed that past damage to rock glaciers and periglacial environments continue today and will continue indefinitely if not addressed.

A preliminary version of this report was ready for publication in October of 2011. At that time, CEDHA approached Minera Andes' management team in Argentina, and informed the company of our findings, providing samples of the satellite images we had in our possession and of some of the conclusions we were able to draw from those images regarding glacier impacts. In fact, since this initial contact, we have posted our glacier inventory for Los Azules online. This inventory can still be downloaded from our website.

To the credit of Minera Andes, and to Country Director, Mr. Carlos Liggesmeyer, the company was the *only* company that we have contacted in our 3+ years of work on mining impacts to glaciers, that immediately responded in a constructive manner to our inquiry, and engaged in an initial discussion around any potential impacts they might have to glacier resources. CEDHA has contacted Minera Andes on at least 30 occasions, since our first contact.

In what we consider to be good faith engagement, the company went as far as to invite CEDHA and our technical experts to visit the Los Azules project site to verify our findings, and to have our team engage with Minera Andes' technical team *before* we published our report to discuss our finding compared to their own data. The project manager, Carlos Liggesmeyer, also indicated that the company would address any problems that we found regarding glacier impacts that were verified on the ground. We believe this attitude marks an important advancement compared to other responses we have witnessed from other mining ventures in the region, such as those of Barrick Gold (Pascua Lama and Veladero), Xstrata Copper (Filo Colorado and El Pachón), and Yamana Gold (Agua Rica), for instance, that have outright denied glaciers impacts, that have unfoundedly criticized our work, and have even suggested that there are no glaciers at their project sites, which is clearly refuted by existing evidence that we have documented extensively in our various reports.

Other companies, such as Osisko, Newmont, and Peregrine Metals, have simply ignored our information requests about potential glacier impacts. We should however note that the more recent decisions and information posted by McEwen Mining on its new company website has changed this discourse now simply denying the extensive existence of glaciers at the project site. The present text published on the site, misleadingly denies glacier presence at Los Azules, suggesting that "no ice glaciers are present in the project area".[16]

The visit to the Los Azules project site, which we announced in a press release on November 1 2011, was agreed with Minera Andes and which was to be carried out in February of 2012, has unfortunately not occurred. The company suggests that unforeseen delays in the 2012 exploration season due to weather conditions and other logistic impediments have indefinitely postponed the agreed visit. Yet we see today that the claim by McEwen mining that weather conditions have delayed project activity at Los Azules, does not seem to coincide with their

[16] See: http://www.mcewenmining.com/Media-Events/News-Releases/News-Releases-Details/2011/Minera-Andes-Reports-Drill-Results-and-Development-Update-for-the-Los-Azules-Copper-Project/default.aspx

press statements, which prominently publish positive results of the 2012 season drilling. [17] The company is hence able to move heavy machinery and conduct intensive drilling producing drill results for investors, but is not able to conduct a non-invasive site visit by concerned stakeholders with very legitimate evidence of the impacts of their current operations.

Due to this unfortunate change of attitude on the part of Minera Andes (McEwen Mining), and because the company is now clearly denying the obvious presence of *ice glaciers* at their project site, we have decided to move forward with publication as previously planned. We hope that McEwen Mining will maintain its commitment to address the impacts we have cited in this study, and that it will cease publishing that there are no ice glaciers at the Los Azules site which from the evidence provided here is clearly a false statement. We also hope that following this report, we are able to engage constructively with the company, and conduct a site visit to verify the information presented herein. We maintain a constructive disposition to engage with the company to address the conclusions we draw on the risks and impacts to rock glaciers and other ice resources protected by law, from our analysis of satellite images.

This report as well as our inventory of rock glaciers has been prepared by CEDHA staff with the scientific contribution of Dr. Alexander Brenning, Department of Geography and Environmental Management University of Waterloo, Canada and Mateo Martini, Geologist and PhD Candidate of the Geology Department of the National University of Córdoba, Argentina. We would like to thank Dr. Brenning and Martini for their scientific contributions to this report, for their assistance in reviewing our glacier inventory for the Los Azules project site, and for contributing to the analysis on the risks posed by Los Azules to glaciers in the project vicinity. We would like to stress that all of the opinions in this report belong primarily to CEDHA, as well as any errors in the present analysis and conclusions drawn.

We call on the Federal and Provincial environmental and mining authorities of San Juan to:

- **Suspend** all activity at the Los Azules' project (including exploration work) as established by Argentine national and provincial law, until a proper *glacier impact assessment* can be carried out to determine if Los Azules was, is, or will indeed destroy, move, or impact the more than 200 glaciers in its vicinity and related periglacial environment areas;
- **Ensure no more harm is done to rock glaciers or periglacial environments** in the area by this or other largescale industrial projects, particularly large mining projects, such as El Pachón, El Altar, Del Carmen, Filo Del Sol, Vicuña, Las Flechas, José María, Pascua Lama, Potrerillos, Argento, Amos Andrés, Batidero, Cerro Amarillo, La Ortiga, and several others, whether they are in exploratory or implementation phases;
- **Ensure full compliance** with National and Provincial glacier protection laws;

Our demands to Minera Andes (McEwen Mining of Canada) are:

- **Suspend** all activity at Los Azules until a proper glacier impact assessment clarifies what past, present and future impacts to rock glaciers and periglacial environments have been or will be;
- **Establish** a clear and transparent policy to protect all glacier and other cryogenic resources in all of the company's operations;
- **Repair** damage to rock glaciers and periglacial environments in the project area that have been caused by the project and avoid future impacts;
- **Avoid** any future impact to glacier resources as might be caused by roads, exploration, drilling, extraction, waste piles, contamination, etc.
- **Remove** from the company's website the statement that there are no ice glaciers present at the project site;
- **Contribute** to the creation of a Protocol on Mining Operations in Glacier Areas;
- **Ensure fluid and transparent communication** with stakeholders and society;
- **Guarantee public participation** in future discussions about glaciers as is mandated by the Argentine National Glacier Act;

[17] http://www.mcewenmining.com/Media-Events/News-Releases/News-Releases-Details/2012/McEwen-Mining-Expansion-Drilling-Intersects-053-Copper-Over-351-Meters-at-the-Los-Azules-Project1129434/default.aspx

What are Rock Glaciers?

This report is about impacts to rock glaciers by the Los Azules copper mining project operated by Minera Andes (now McEwen Mining of Canada) in the Western edge of San Juan Province, in Argentina, in the high, dry Andes mountains. The first issue we will review before proceeding to examine Los Azules' impact to rock glaciers and to periglacial environments is precisely *what is a rock glacier*, its properties, and what is the relationship between a rock glacier and what you normally refer to, simply as a *glacier*.

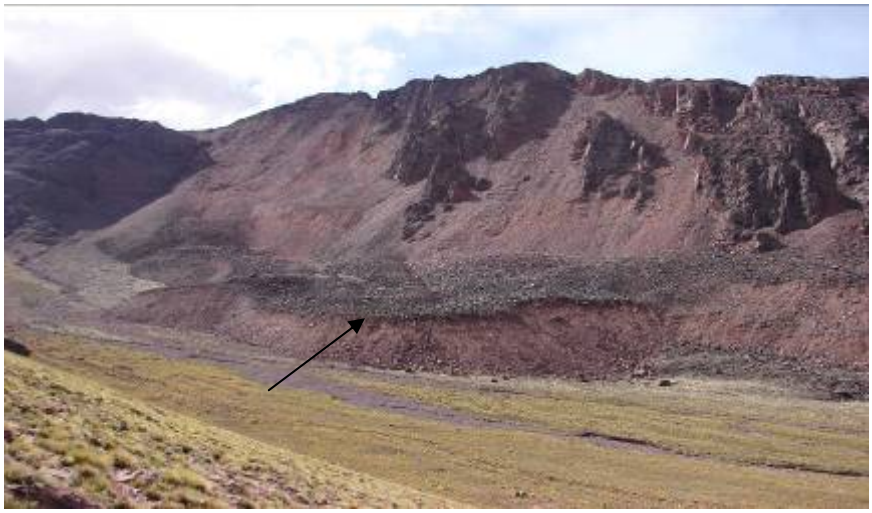
First of all rock glaciers are a type of glacier. Rock glaciers are definitely as McEwen Mining puts it, "ice glaciers". They are essentially frozen groundwater bodies, or bodies of ice and debris (rock fragments) which move down a slope or valley floor as a consequence of their own weight as well as the angle of the surface on which they rest. Rock glaciers are distinct ice and landforms, with characteristic steep frontal and lateral slopes, and furrows and ridges on their surface as a result of their deformation. Rock glaciers are very hard to spot for the untrained eye because ice is normally *not* visible (as opposed to common uncovered or *white* glaciers). For this reason, someone with no scientific training that examines and area that contains rock glaciers, for example, by viewing a satellite image, or consulting Google Earth, may mistakenly think that there are no glaciers present in the area.

The ice within rock glaciers (which can be many meters thick) is conserved under what may be several meters of rock and debris, providing key "protected" water storage at lower elevations where common uncovered glaciers could not survive. This lower altitude survival characteristic of rock glaciers makes them vulnerable to rising temperatures due to climate change, possibly transforming them from water storage systems into systems that provide a net contribution to streamflow as a consequence of permafrost degradation and ice melt. In fact, in many parts of the arid-Andes, rock glaciers are more abundant and contain more ice than ordinary uncovered glaciers. (Azocar and Brenning 2010)

Below is a picture of a typical and well-documented active rock glacier called *Zenta*, in Jujuy Province in northern Argentina, similar to the ones that are found in the Los Azules project area. While the geological formations in the picture to the untrained eye would seem to be merely rocks on a mountainside, in fact, these rocks are covering large amounts of sensitive and environmentally critical ice. You can visit the Zenta glacier in Jujuy by going to the following *Google Earth* address: by copying and pasting the following coordinate address exactly as typed here in *Google Earth's* search box:

23 12 11.33 S, 65 3 43.18 W

The following image is what you will see appear. Immediately below the *Google Earth* image is an actual recent photograph of the area marked by the yellow circle (photo: courtesy of Universidad Nacional de Córdoba).



Typical Rock Glacier (black arrow points to glacier top and frontal edge)

In the next picture, we see one of the rock glaciers in the vicinity of Los Azules. We can see the very similar characteristics between the glacier in *Jujuy Province* and the glacier at Los Azules in San Juan Province. These are typical rock glaciers of the high and dry Andes mountains. You can visit this glacier of the Los Azules project area yourself by pasting the following coordinate address in *Google Earth*, exactly as it appears here:

31 2 59.24 S, 70 15 10.17 W

Rock Glacier from the Los Azules Area is Typical of High Andes Rock Glaciers

In some cases, the ice structure of rock glaciers can be several meters underneath the surface. In the above image, the body of ice and rock is some 20 meters thick! You can determine approximate thickness in an image like this one by moving your pointer over the top edge of the glacier and then over the very tip of the tongue at the valley floor, and noting the altitude reading that varies as you move your pointer over the Google Earth image. Satellite images always look far smaller than they really are if you were at the site, in this case, the glacier is many times taller than a person standing at its side.

Below is a photograph of a cross section of a rock glacier, showing fine rock matter above ice.

Debris-covered Glacier showing ice beneath rock (source: Geostudios)

Below is another incredible image of a debris-covered glacier in San Juan province, showing massive ice content underneath the rock.

Massive Ice Content Dozens of Meters Thick in Debris-Covered Glacier of San Juan: Photo. JP Milana.

Why are Rock Glaciers Important?

> "Glaciers and rock glaciers in the semiarid Andes constitute natural sources of water that control the runoff of mountain rivers, especially in the dry summer months. They are responsible for the water supply to the agglomerations of Santiago, Chile (5.3 million inhabitants), and Mendoza, Argentina (1.1 million inhabitants), and the irrigated land in the surrounding lowlands". (Brenning 2008). Rock glaciers are also key sources of freshwater in other arid regions such as San Juan Province.

Rock glaciers and mountain permafrost are extremely important to the natural environment and to ecological systems. Snowfall on the rock glaciers and in their upslope contributing area and resulting meltwater, can be captured permanently or temporarily in the rock-ice structure and underlying active layer, where it is stored for future water needs. The rock cover protects much of the ice from quickly melting off. Rock glaciers can be found at elevations significantly lower than ordinary uncovered glaciers, where exposed ice would melt off quickly due to higher ambient temperatures. That means that thanks to rock glaciers, we have more ice volume than would otherwise be possible if this ice were not protected. These *rock glaciers* are a fantastic adaptation Mother Nature has developed *to conserve more ice for longer periods of time, so that streams and rivers get water from ice melt for many more months than just the first snowmelt months in the spring*.

Some mining authorities and companies have argued that rock glaciers are not glaciers per se, but rather "cryogenic forms". They are employing in this case a deceiving play on words, since *cryo*=ice and so when we say "cryogenic forms" we are indeed talking about *ice* forms, and glaciers of course are indeed ice forms. In the same way, we can also call rock glaciers *ice glaciers with rock debris in their interior*.

What this deceiving semantic tactic is falsely attempting to convey is that rock glaciers are a ''different" sort of ice form, that are not actually glaciers. Yet clear evidence exists to sustain that rock glaciers and debris covered glaciers are not only glaciers and meet the characteristics evidenced by more commonly recognized *uncovered* glaciers with fewer sediments in their ice body. Research, such as that done by glacier experts at Geostudios, for example, has shown than rock glaciers have similar or identical dynamics as uncovered glaciers. We might even go as far as to say that debris-covered glaciers and rock glaciers are actually MORE important than uncovered glaciers, precisely because they are more vulnerable, because they can survive at lower altitudes and because they greatly increment the water storage in dry and arid regions like San Juan.

The stored ice in rock glaciers becomes available during the warm season and in particular during extremely hot summers, or dry years when water demand is greatest. The area where Los Azules is located is also a critical region with very little water supply, making the glaciers of the region extremely important in terms of water provision to local ecosystems. Juan Pablo Milana, a renown glacier specialist, has indicated that glaciers and rock glaciers in San Juan and Mendoza Province can provide up to 80% of a rivers water flow in years with no snow o rainfall. In the long term (decades to centuries), as the climate warms and glaciers around the world begin to melt, many rock glaciers near the melting point may also become inactive and finally start to thaw as a consequence of climate change, in which case thawing rock glaciers and permafrost will contribute more and more significantly as nonrenewable resources to the water supply.

Arenson, Pastore, Trombotto et.al., recognized geologists and glacier experts, and in relation to the El Pachón project (Xstrata), which is located a mere 70km south of Los Azules, make the critical observation that "the ground ice in these latter permafrost zones is often the only source of multi-year ice in the absence of substantial surface snow and ice areas." (p.1501) They also establish that "most likely the majority of the rock glaciers in the vicinity are still active, i.e. they contain renewable ice-rich zones that are creeping downslope". (p. 1502)

The distinction between active vs. in-active rock glaciers is important, as it is related to the state and evolution of a rock glacier. In the case of active rock glaciers, they are dynamic and

advancing in a down-slope direction. Inactive rock glaciers have stopped moving and are static, but, they still contain ice and as such are important water reserves. Inactive rock glaciers that are inactive for climatic reasons are, however, degrading, i.e. the ice-rich permafrost is thawing and water that had been stored for in some cases, thousands of years is being released. A third category is referred to as "fossil rock glaciers". As their name suggests, these are remnants of past rock glaciers that no longer contain ice. They are, as such, simply an accumulation of rocks that leave evidence that some time ago, a glacier was present.

The Argentine National Glacier Protection Act protects all types of glaciers with ice content, *including inactive rock glaciers*. The San Juan Provincial Glacier Protection Law protects glaciers and active rock glaciers, but not inactive rock glaciers, although the Minister of Mining of San Juan, Felipe Saavedra (presently on leave) has indicated that his ministry will insist that mining companies recuperate ice from inactive rock glaciers if they are to destroy them in their activities. We should note however, that as per the National Glacier Protection Act, the destruction of rock glaciers, even if they are inactive, is illegal.

The following image of the nearby Central Andes Region of Chile, in the Laguna Negra Basin, shows water appearing amidst rocks in a rock glacier area. This is most likely due to glacier melt from the rock glacier as well as from remnant snow patches within the ice.

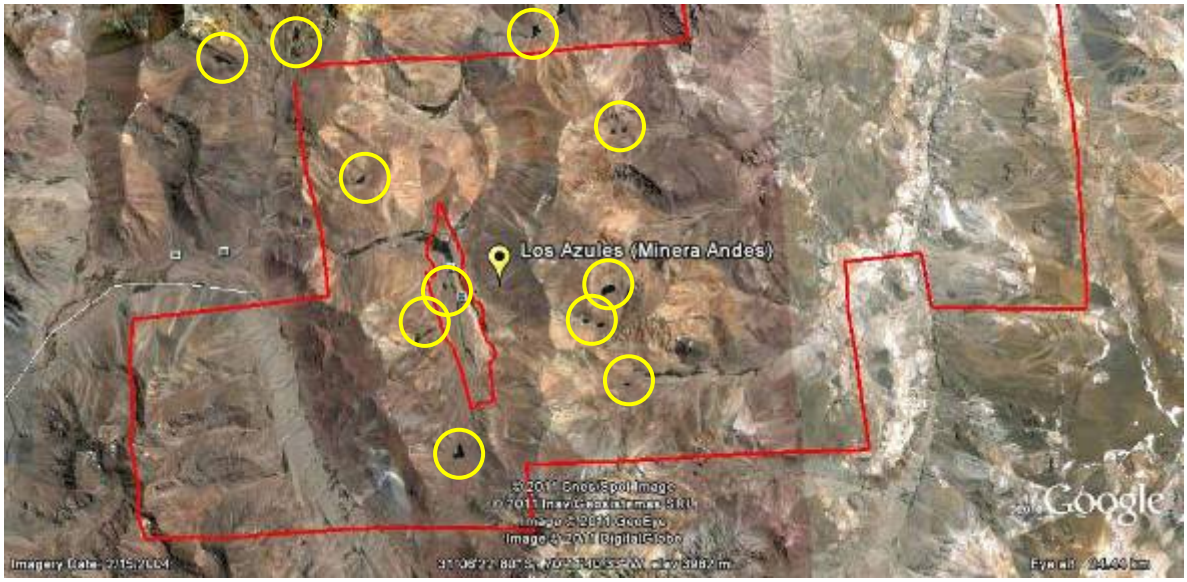
Water gushing forth from rocks below a rock glacier in the Central Chilean Andes region (Laguna Negra Basin); by Pablo Irribarren

Immediately below rock glaciers we can sometimes find glacier lakes, fed by snowmelt in rock glacier watersheds and, later in summer, thawing ground ice. In this context, rock glaciers also act as aquifers through which meltwater from their watersheds is conducted towards lower areas while interacting with the rock glacier's permafrost core. Below is an image of a typical glacier lake nearby the Los Azules project. Notice the majestic beauty of the crystalline turquoise water with the Andean background. This lake can be seen via satellite at:

31°14'55.67" S 70°10'16.61" W

Typical Glacier Lake near the Los Azules project area; the blue tone is likely due to natural copper mineral drainage that occurs as the melt water from the glacier runs over fragments of debris. Photo: JP Milana

Below is a satellite image of the Los Azules project area identifying lakes that result from ice/snow melt in the Los Azules area. The fact that so many lakes exist in this very dry area is evidence pointing to the presence of rock glaciers.



Mining Risks to Glaciers, Rock Glaciers and Periglacial Environments

Generally because of company ignorance and/or disregard for existing glaciers, rock glaciers, and permafrost, as well as the failure of State authorities to control glacier impacts by industrial activity, mining operations in the high Andes mountains have caused *and continue to cause* enormous impacts to glaciers, rock glaciers and periglacial environments. Satellite imagery of the high Central Andes region along the Argentine/Chilean border offers dozens and dozens of images of mining exploratory work crisscrossing near, into and across glaciers, rock glaciers and permafrost. There is even evidence of some mining projects such as Aguilar (Glencore) in Jujuy province, where dozers have removed entire portions of rock glaciers along a mountain slope.[18] The problem is so extensive, that Argentina chose recently to enact legislation to protect this critical water reserve resource. The first project to come into the public eye for its extensive impacts to glaciers was Barrick Gold's Pascua Lama project, which incredibly proposed Barrick Gold's plan of dynamiting glaciers to get to mineral deposits under ice.

With over 200 new largescale mining projects in the pipeline for the Central Andes region, the cumulative impacts to glaciers, rock glaciers and permafrost could be devastating if it is not controlled. San Juan, the province of focus of this report has over 150 projects in preparation according to the Minister of Mining of the Province, [19] most of these in glacier territory.

Mining impacts to glaciers come from many aspects of mining operations, including:[20]

- Modifications to mountain sides whose particular shape and environmental conditions lead to the accumulation of snow and ice, the transport and accumulation of rock fragments, and the existence of the thermal condition of permafrost, which in turn allow for the formation of ice-rich permafrost and ultimately rock glaciers;
- Disturbance of the delicate steady-state creep of the rock-ice mixture, which may lead to the collapse of the structure and ultimately the destruction of the rock glacier;
- Explosions which may alter and collapse ice structures or destroy necessary glacier containment valleys;
- Introduction of roads onto, adjacent to, or near rock glaciers, which can lead to modifications in meltwater discharge into the rock glacier, possibly reducing or inhibiting temporary and permanent water storage in the rock glacier, and modifying the surface heat flux which may possibly affect any underlying ice structure;
- Deposit of residues, waste rock, and other solids on the rock glacier surface which can lead to an acceleration of the rock glacier's flow and eventually to its collapse;
- Contamination of the rock glacier's surface, leading to color changes and material cover change, and subsequent temperature absorption changes, which could in turn lead to ice melt and eventual collapse;
- Contamination from the deposits made on the surface of the rock glaciers, leading to acidic chemical and heavy metal drainage (acid rock drainage, ARD) into the ice and water of the rock glacier, and possible permafrost degradation related to the heat created by these geochemical processes.

We now turn specifically to look at McEwen Mining' Los Azules project and the impacts we have documented to rock glaciers and periglacial environments (permafrost) in the project vicinity.

[18] See the impact of the Aguilar Project (Glencore) on rock glaciers via Google Earth at: 23 11 35.54 S, 65 43 34.43 W.
[19] See Entrevista con Felipe Saavedra, ministro de Minería provincial: San Juan: Avanza la Construcción de Tres Megaproyectos Metalíferos por $36,000 Millones. El Inversor Energético y Minero. Año 5 Nro.55 Abril 2011. p. 17.
[20] compare Brenning, 2008; Kronenberg, 2009; Brenning & Azócar, 2010

Los Azules Project Description

According to a recent update (December 2010) of the Preliminary Assessment, carried out by Samuel Engineering for Minera Andes (which recently entered into a partnership agreement with US Gold and has now become McEwen Mining of Canada),

> "Los Azules is an advanced-stage porphyry open pit copper exploration project [covering some 28,400 hectares] located in the cordilleran region of San Juan Province, Argentina near the border with Chile. A Preliminary Assessment (scoping study) has been completed, and a Preliminary Feasibility Study is underway. Based on over 30,000 meters of diamond core drilling, an indicated resource of 137 million tonnes at a grade of 0.73 percent copper containing 2.2 billion pounds of copper and an inferred resource of 900 million tonnes at a grade of 0.52 percent copper containing 10.3 billion pounds of copper. The resource also contains low, but recoverable, values of gold and silver."[21]

The project is located in Argentina, adjacent to the Chilean border, some 80 km north west of the town of Calingasta, in the province of San Juan, and about 75km due north of the El Pachón copper project by Xstrata Copper and just under 200km south of Barrick Gold's Pascua Lama project. Other projects in the Los Azules vicinity include: El Altar (Peregrine), Casposo (Troy Resources), Vanessa (Anglo American). The project can be viewed at Google Earth at:

31 6 14.42 S, 70 12 52.03 W

Los Azules is accessible by dirt roads leading principally from Calingasta with 8 river crossings and two 4000m+ mountain range crossings. The project site is located approximately between 3500m and 4,500m above sea level (11,500-14,800ft). The climate is semi-arid, with abundant snowfall and extremely low temperatures (below -30-Celsius), typical of the highland Andes region in San Juan province.

According to the Preliminary Assessment, "the project is located in a broad valley, with a central ridge called *La Ballena* ridge (whaleback). Vegetation is sparse and is virtually absent at higher elevations. Long, narrow wetlands (vegas systems), formed by snow [and rock glacier melt], occupy the valley floors on either side of *La Ballena*. Springs are noted at about 3,790 meters in elevation upstream of the lake, along the west side of *La Ballena*, probably formed by rock glacier, permafrost and seasonal snow melt. Groundwater-fed springs and lakes are also noted around the range to the west between 3,800 and 3,900 meters in elevation and along the eastern flank of *Cordillera de la Totora*. These lakes feed the westerly flowing *Rio La Embarrada*, which is joined by the *Rio Frio* to the west before turning south into the *Rio de las Salinas*, a main tributary to the San Juan River.

Battle Mountain Gold Corporation (BMG) explored Los Azules in the mid 1990s in search of gold deposits.

In 2003, Minera Andes (now in a joint venture with US Gold as McEwen Mining of Canada), initiated an exploration program at the Los Azules site, which included the introduction of roads and drilling in the project vicinity. By 2009-2010, 87 diamond drill holes totaling 24,457 meters were drilled at Los Azules. An additional 6,545 meters were also drilled by Mount Isa Mines (MIM)[22] .

After the BMP-Newmont merger in 2000, BMG properties were acquired by Solitario Resources, a Canadian mining exploration company (now called TNR Resources). In 2007, Xstrata acquired the project, pulling out in 2009, leaving the property in the hands of Minera Andes, who now owns 100% of the project.[23]

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[21] Canadian National Instrument 43-101 Technical Report. Updated Preliminary Assessment Los Azules Project, San Juan Province Argentina. December 1, 2010. Page 1. ; see also the official project website at: http://www.minandes.com/projects/los-azules-project/default.aspx

[22] Preliminary Assessment update. Samuel Engineering. December 2010, p. 2.

[23] Preliminary Assessment update. Samuel Engineering. December 2010, p. 2-3.

While TNR is battling ownership of Los Azules with Minera Andes, on September 22, 2011, Minera Andes announced a merger with US Gold to become McEwen Mining of Canada.

Location Map

Drilling programs were undertaken by between 1998 and 2010, by three different companies, Battle Mountain Gold (BMG), MIM Argentina (now Xstrata) and Minera Andes Inc. As of the last information we obtained, there are a total of 116 drill holes at the Los Azules Project, totaling some 31,100 meters of drilling.[24] As we will see below, some of this drilling has occurred directly into ice, at or near rock glaciers and likely through permafrost terrain. This would be illegal under Argentine law.

More recent information on the new McEwen Mining website, suggests that the 2011 exploration campaign produced further drilling in the west and north regions of the project site.[25]-[26]

The company intends to extract the mineral deposit 24 hours per day, 7 days per week, using "conventional shovel-truck methods. Rock would be drilled and blasted" … at an open pit site, while tailings would be deposited in the project vicinity. Some of the principal machinery used includes: 5 blast hole drills, 3 electric cable shovels, a front loader, 29 345 ton haul trucks, 7 crawler dozers, 4 rubber tired dozers, six motor graders, and 4 water trucks. The project expects to process 907 million tons of rock over its lifetime.[27]

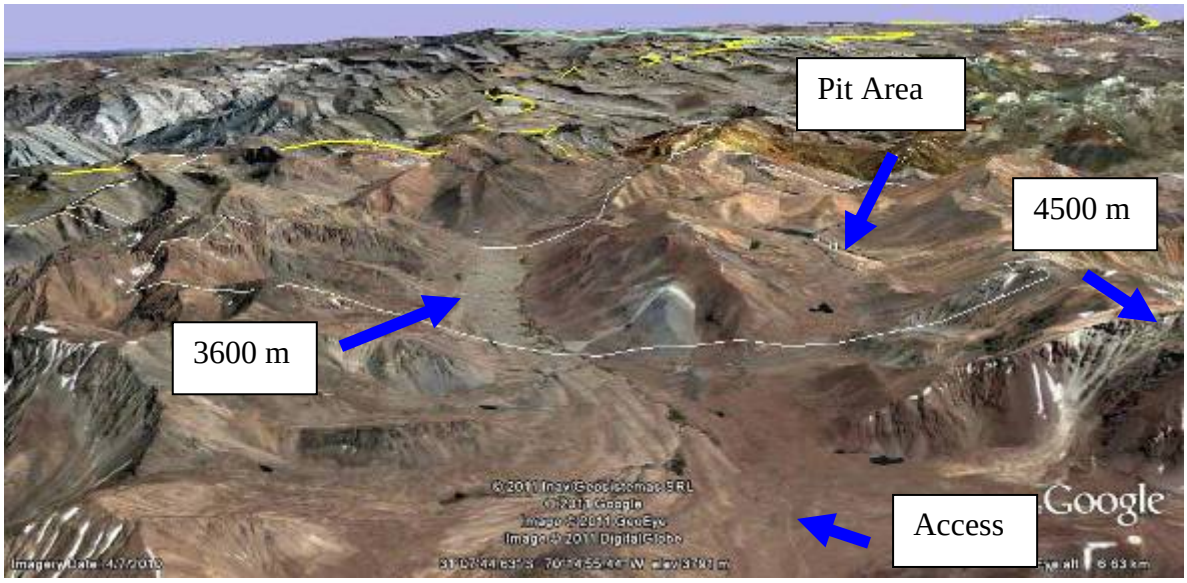
The Tailing Storage Facility (TSF), to be located west of the main pit area, will receive some 909 million tons of waste over the project life cycle. During the 25+ years of operation, 1,037 million tons of waste rock will be generated from the open pit. Some 236 million tons of waste rock will be placed in the northern end of the pit as backfill.[28]

[24] Preliminary Assessment update. Samuel Engineering. December 2010, p. 8.
[25] See: http://www.mcewenmining.com/Media-Events/News-Releases/News-Releases-Details/2011/Minera-Andes-Reports-Drill-Results-and-Development-Update-for-the-Los-Azules-Copper-Project/default.aspx
[26] http://www.mcewenmining.com/Media-Events/News-Releases/News-Releases-Details/2012/McEwen-Mining-Expansion-Drilling-Intersects-053-Copper-Over-351-Meters-at-the-Los-Azules-Project1129434/default.aspx
[27] Preliminary Assessment update. Samuel Engineering. December 2010, p. 9.
[28] Preliminary Assessment update. Samuel Engineering. December 2010, p. 10.

Topography

The project is centered along the Ballena Ridge, and the project area is situated between 3,500 and 4,500 meters above sea level (11,500-14,800 ft). The following *Google Earth* image shows the project's formal contours marked by a thin white polygon. The yellow line is the border with Chile. We can see a bit of the Pacific Ocean in the upper left corner of the image. We've also indicated approximate altitude levels at two locations 3,600 (in the valley) and 4,500 meters at one of the higher peaks, as well as the project's projected pit area. The main access road to Los Azules is also visible as a fine line in the lower middle area of the image.

Altitude is the first variable to consider when examining whether a mining project might be affecting glaciers. It's the first thing glaciologists ask when beginning a glacier inventory, that is, *at what altitude do we begin to find glaciers in the given analysis area.* Wherever there are glaciers, we also may find permafrost (frozen grounds) which are also protected by the National Glacier Act. We should consider that rock glaciers and permafrost are common in this region above 3,500 meters. In this case it would be highly unlikely for glaciers to exist below 3,500, but highly likely that they occur above that altitude.



One immediate aspect that we notice is that this satellite image was taken in early April (see date at bottom left corner) which is just after summer in the Southern hemisphere. *There is practically no snow in the image.* We cannot see any uncovered or "white" glaciers, which might lead us to conclude that there are no glaciers in the area, or as McEwen Mining states on its website, "ice glaciers". Several investment bloggers reacting to news about glaciers at the Los Azules site make this observation. An investor who calls himself "huntforvalue" on one blog states—in response to another expressing concern over glaciers at Los Azules:

> "I've hear this story before about Los Azules and glaciers, but I have yet to find a single glacier anywhere near LA [Los Azules]. Perhaps you can back-up your comment by providing a single satellite image of one of these glaciers that you purport "surround" Los Azules. You don't need to find them all. Just one of them would be fine. Thanks"[29]

Huntforvalue's comment is a logical reaction of someone who is unfamiliar with the physical characteristics of glaciers, to the affirmation that there are many glaciers at Los Azules. A glacier novice looking at the above satellite image would probably presume there is little or no ice in the area. In fact, most residents of San Juan have no idea that there are glaciers in this region, or for example, surrounding the El Pachón project.

[29] http://www.siliconinvestor.com/readmsg.aspx?msgid=28005404

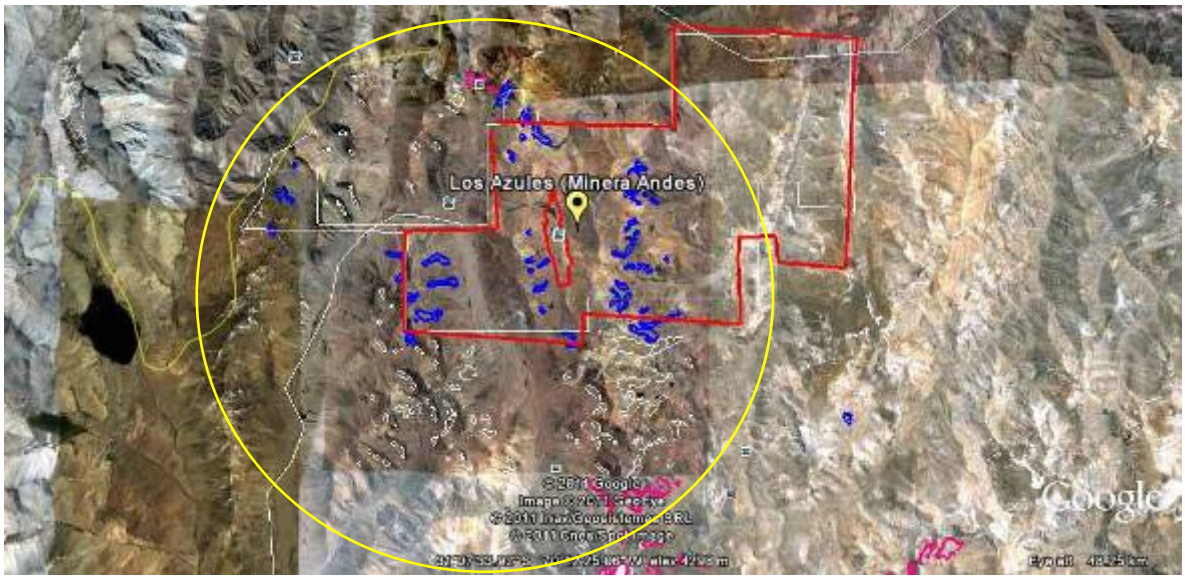
If we visit El Pachón on Google Earth (see: 31 45 5.26 S, 70 26 2.61 W), the area looks almost identical in terms of visible snow to Los Azules. Yet in this case, aside from what *we* have said about glaciers at El Pachón, the company itself recognizes in its geomorphological survey, that there are over 200 *ice glaciers*—in this case, also rock glaciers—at the project site. [30]

Below is a satellite image of the El Pachón project. Notice the similar characteristics to the Los Azules site further below. No *white* uncovered glaciers showing ice are visible. The small white patches are small snowfields. The blue polygons however, are rock glaciers mapped by Xstrata.

[30] http://wp.cedha.net/wp-content/uploads/2011/09/MAPA-2.6.1-AM-GEOMORFOLOGIA.jpg

Yet it is well known to geologists that are familiar with the dry Andes region, that this area is rich in cryogenic forms (ice forms), including primarily debris-covered rock glaciers, as well as permafrost. The presence of lakes and vegas (wetlands) in the area are clear indicators suggesting there may be substantial year round glacier and permafrost melt feeding these natural ecosystems.

Our glacier inventory reveals 226 glaciers, most of which are rock glaciers in a 15-20km circle radius around the project center, forming as such a key element of the topography.



We should also note the important number of “vegas” or wetlands in the project area. These are sensitive high mountain plant ecosystems, which can survive thanks to the water run off from rock glaciers, permafrost and seasonal snow melt. The following image shows how wetlands form at the foot of high altitude mountainsides, thanks to permafrost and glacier melt.

Vegas (wetlands) form in Los Azules valley due to ice melt from glaciers, permafrost and seasonal snow melt. Photo: JP Milana

Another image below, taken from Minera Andes' website[31] shows a drilling platform placed adjacent to a vegas (wetland). We also see the exploratory mining roads traversing the mountain slopes on each side of the valley.

Drill Rig Adjacent to Wetland at Los Azules. This is a typical image of roads and drill platforms introduced by mining companies. These are very visible in satellite imagery as can be seen through *Google Earth*. Photo: Minera Andes

[31] Images by Minera Andes are available at:
http://www.flickr.com//photos/58557003@N02/sets/72157625898940994/show/

Environmental Impact Assessments and References to Glacier Presence at Los Azules

Two official documents prepared by Minera Andes have been reviewed in the preparation of this report to gauge the company's attention to glacier and permafrost impacts:

- Informe de Impacto Ambiental: Etapa de Exploración. Proyecto Los Azules, by Vector Argentina. April 2010, and
- Updated Preliminary Assessment: Los Azules Project, December 1, 2010, by Samuel Engineering.

A third document was presented unbeknownst to us in February of 2012 in San Juan Province, by Minera Andes' team of glacier experts that provided information about aspects of their study. We requested this document to Minera Andes several times, as well as to the province of San Juan, but neither has provided the documentation. We presume that this presentation should have provided clear evidence that there *are indeed* ice glaciers present in the project area. Further, it is natural to conclude that if there is a team of glacier experts working for some time now in the project area (as the company has indicated) to carry out an inventory and a glacier analysis, it is precisely because there are glaciers present at the project site.

Informe de Impacto Ambiental: Etapa de Exploración (Vector Argentina)
(Environmental Impact Assessment for Exploration Phase)

This previous EIA study[32], by Vector, in Section 24.0 (which can be downloaded from the San Juan Mining Ministry website) indicates that "in the area of the project, goat grazing is the principal existing negative environmental impact". (p.36). The study adds "roads, platforms (limited to the La Totora Stream Basin), the crossing of Vega Confluence and the Embarrada, and the campgrounds, are the secondary environmental impact in the area. (p.36)

The EIA then states, that "Grounds are substantially affected by ground mass movement for the introduction of exploratory roads and for the construction of mining platforms" (p. 36). This reference is important to our findings of road impacts to glaciers and permafrost. Section 26.0 suggests that the project will prioritize the use of existing roads, and that it will close roads and platforms that are in disuse. Roads on heavily inclined surfaces will have drains, permitting road maintenance and usability for longer periods. While this report at least mentions earth impacts, the document fails to make any mention of the various ice resources (or cryogenic forms) that are present at and near the project site.

Section 26.1 on drilling platforms suggests that the project will avoid blocking water drainage and passage. Section 32 (Page 45) of the EIA concerning impacts to grounds, in addition to restating that preference will be made for utilizing preexisting roads, suggests that "disturbed grounds should be rectified no more than 6 months after their final use … These rectifications should be documented and photographed". On this point the issue of water drainage relevant to glacier reserves begins to surface, but since there is no mention or consideration for ice resources in relation to the roads, the extent or importance of the issue is completely undervalued and/or ignored.

[32] See: http://mineria.sanjuan.gob.ar/los_azules/IIA_LOS%20AZULES/ACM_IIA_LAzules_Rev00_1[1].pdf

Updated Preliminary Assessment (Samuel Engineering)

The Environmental Impact Assessment (EIA) prepared by Samuel Engineering states, "at the present time [December 2010], there are no significant environmental or reclamation issues at the project site, as it is an exploration project".[33]

We were surprised to read this qualitative statement as it is simply not true that exploratory mining work does not impact the environment. Even if we leave glacier resources aside, we can expect numerous impacts from mining exploratory work, including mass land removal from the introduction of roads; the impacts of building drilling platforms; the impacts from drilling itself; land, water and air contamination from machinery and lubricant use; noise pollution; the impacts from human presence, including but not limited to sanitary issues; and the list goes on. One would expect that such impacts would be documented by an EIA more than simply to say "there are no significant environmental impacts … as it is an exploration project." Additionally, the easily verifiable fact that there are abundant glacier resources, including dozens of rock glaciers—or *ice glaciers*—within the project concession area and hundreds within the project's impact area, warrants further in depth impact studies.

On page 23, section 3.5 on Environmental Liabilities, Samuel Engineering states, "there are two principle environmental impacts in the Los Azules area. One is the over-grazing of pasture lands and the second is access roads and drill platforms on the property". The same section also refers to the fact that "there are numerous previously existing exploration roads in the area, including drilling platforms".[34] There is no mention in the document of impacts to ice forms or permafrost from current project activity, which is evident from photographs we were able to obtain.

Page 28 of the EIA indicates, "Deposits of glacial debris (morainal materials) and scree account for much of the surface area covering the deposit and adjacent mountainsides. In the area of the deposit, these materials locally exceed 60 meters in thickness, but on La Ballena, the cover is typically 10 meters or less." This reference, considering the high mountain altitude (above 3,500 meters), and that at this altitude in San Juan it is common to find rock glaciers, the findings should have at least spurred an inquiry to identify rock glaciers, as they are likely present. Moraines are earth displaced by the movement of glaciers. The Provisional Geological Map of Los Azules on pages 34-35 (by W.T. Pratt, April 2010) identifies the following elements: Ponds and wetlands, Moraines Fluvialglacial sand and gravel. We discuss this in the next section, but again, these references, considering the location of the project, are clearly pointing to evidence that glaciers exist in the area.

Page 78 reveals one of the most important elements of proof not only of the existence of rock glaciers (or ice glaciers) in the project area, but of the intromission of drilling in glacier areas within the project site:

> "Drilling by Minera Andes Inc. was contracted to various drilling companies including Connors Drilling, Patagonia Drill Mining Services, Adviser Drilling, Boland Minera and Major Drilling. Drilling conditions have been particularly difficult especially in faulted intersections or in areas of unconsolidated surface scree/talus/**rock glacier** in which resulted in an average drilling rate of 700 meters per month (Rojas, 2010)." [bold added][35]

Unfortunately, and rather surprisingly, this revelation by subcontractors that are having a difficult time drilling, ironically, because they are finding ice, and presumably, destroying ice, should have resulted in further analysis by Minera Andes, but this is the extent of the commentary. No further information about the presence of ice or rock glaciers is present in the EIA documentation. If present drilling operations are occurring at/on rock glaciers, this is illegal by law.

[33] This study has been removed from the company's website. You can obtain the full study by contacting the author of this report at: jdtaillant@gmail.com
[34] Preliminary Assessment update. Samuel Engineering. December 2010, p. 23.
[35] See: http://wp.cedha.net/wp-content/uploads/2012/05/page-78-preliminary-assessment-los-azules.pdf

Finally, on page 148, we find a line item budget for several future costs to complete the Pre-Feasibility Study. Included is an item for $566,000 to conduct a "Environmental Permitting including Vegas and **Rock Glaciers**". [bold added]

Clearly, the EIAs either fail or do not appropriately address the impacts that exploratory work has had or is having on ice resources. No consideration for rock glaciers or for permafrost impacts are covered in either report despite the fact that these Minera Andes' official documents indeed make references to the presence of ice. This makes the present statement on McEwen Mining website that "no ice glaciers are present in the project area", both false and deceiving. It is further unexplainable why there is a glaciology study taking place in the project area, as the website also indicates, if there are no glaciers at the project site, as the website states.

The impact to ice forms is not only *not considered* but it is not even registered as a risk. Minera Andes completely neglects the very serious risks to rock glaciers and actual visible impacts that have visibly already occurred at the project site from past activity, and that are likely continuing to occur at the project site due to ongoing exploratory work.

Many other companies evidence the same sort of omission in EIAs relative to ice impacts (both to glaciers and to permafrost), these include for example reports from projects such as, Veladero and Pascua Lama (Barrick Gold), El Pachón and Filo Colorado (Xstrata), Agua Rica (Yamana Gold), Del Carmen (Malbex), El Altar (Peregrine Metals), and many others. As the implementation of Argentina's national and provincial glacier protection laws begin to be implemented, and as civil society organizations begin to call on business and government to protect glaciers, mining companies are beginning to contract glacier specialists to carry out more in-depth and focused studies on glacial reserves. This is the case for example of El Pachón (Xstrata) which is at present finalizing a glacier study and mapping exercise. From what we have learned in recent months, Minera Andes is now also carrying out a glacier study. While this is an important first step in addressing its' glacier and permafrost impacts, no activity should be carried out until this study is complete and the conclusions taken into account.

The EIAs, particularly those produced for the exploratory phase are a key instance where *proper and extensive* glacier impact analysis should be carried out before exploratory activities begin. It is essential for a mining company operating in glacier territory to know the landscape, to know where ice formations exist, to know where permafrost is located and to fully understand the natural eco-system balance *before* sending in a tractor with shovel to tear into mountainsides in search of minerals.

In the picture below, we see a typical image of a Caterpillar D9N tractor and shovel plowing through a mountainside in Argentina at 4,500 meters, opening up a mining exploration road. Considering that ice is not visible on the surface, if the tractor driver is not told where he/she can go or not, and where to avoid digging into the earth, the result in areas like that of Los Azules is that sooner or later, the tractor will plow through ice.

In the picture below, we can see four glaciers at the Los Azules mining project site that have suffered precisely such impact. The image can be seen through *Google Earth* by copying and pasting this precise address in the *Google Earth* search box:

31°03'55.90" S 70°14'05.14" W

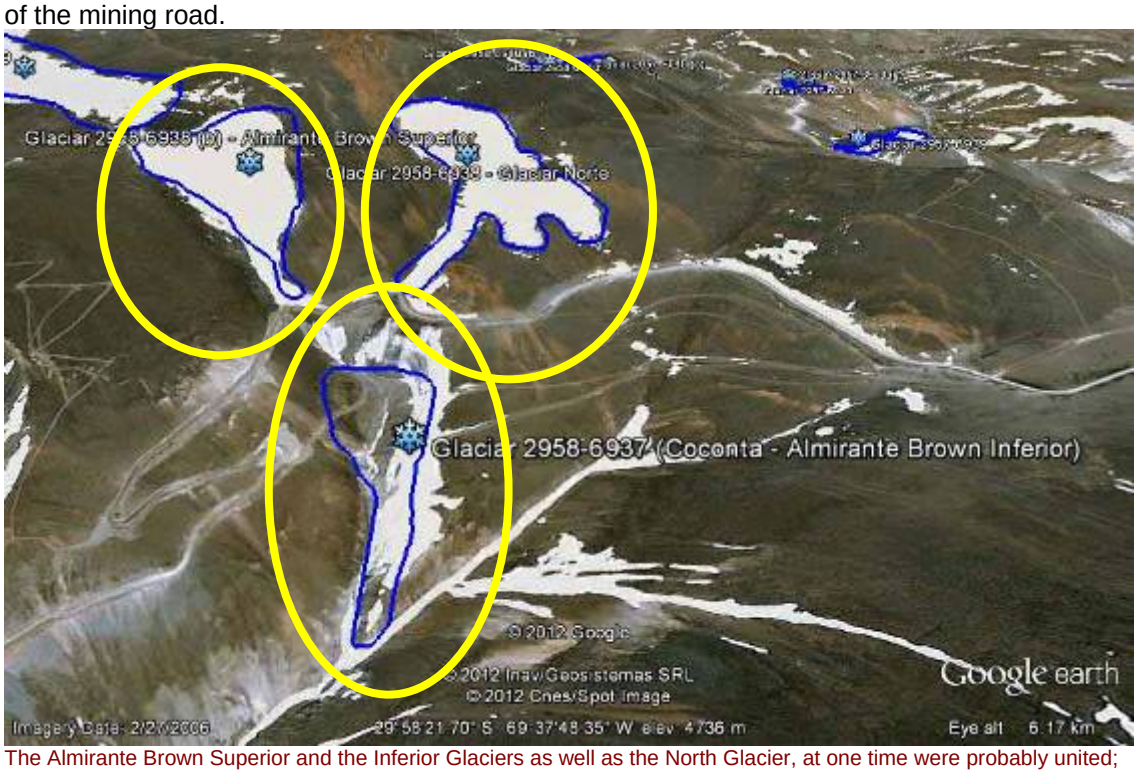
The Los Azules exploratory road enters the image through the right hand side, and then proceeds to cut through the root area of the rock glacier delineated in blue (which feeds the glacier with water and rock debris) advancing down the mountain side. It then crosses the small valley and runs alongside another rock glacier, and then before exiting the image on the left hand side, also cuts through the root area of the other glacier.

It is precisely this sort of impact which a proper EIA must address in any mining project that is located in a region such as Los Azules, which is known to be rich in rock glaciers and permafrost.

It's worth noting the impacts that a road can have on a rock glacier, either from an exploratory road that digs through ice, or from a transit road that is used for transport, in which case road maintenance and dust from transit can have important and even devastating impacts on glaciers.

In Barrick's Veladero Project, we have seen extensive impact to glaciers in the project vicinity including to access roads. While in this case the glaciers impacted by Barrick's access roads are uncovered white glaciers, and are being affected among other things by dust and black carbon that settles on the ice and creates unnatural warming leading to accelerated melting, the initial and most important impact to these glaciers is due to the introduction of a transit road that sectioned two glaciers, the North and the *Almirante Brown Glaciers*, separating them from the lower unified portion now called the *Almirante Brown Inferior*. This potential impact is essentially the same whether we are taking about an uncovered white glacier or a covered rock glacier.

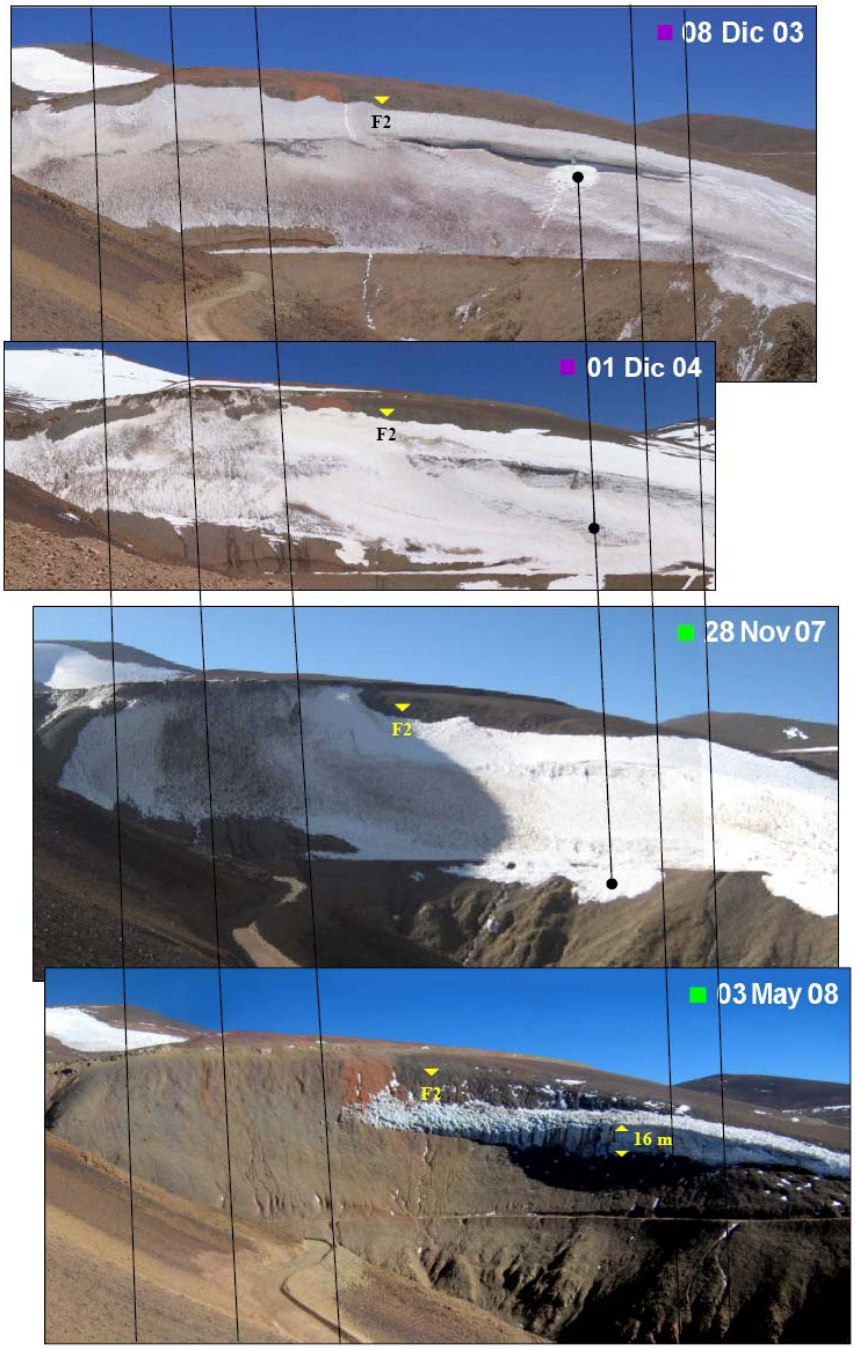
The following image is from a 2007 taken from *Google Earth*, of the three mentioned glaciers. In the images, we clearly see the presence of Barrick's mining road which has literally cut the glaciers in half (before the road, the lower portion was linked to the higher portions of the Almirante Brown Superior and the Norte glaciers). In a report by Leiva and Cabrera, the glacier experts from IANIGLA tell us that the *Almirante Brown Inferior* glacier is dying. A visit to this glacier via *Google Earth* (see: 29°58'16.94" S 69°38'11.00" W) reveals that in fact, this remnant from Barrick's impact has in fact already disappeared only a few years following the introduction of the mining road.



The Almirante Brown Superior and the Inferior Glaciers as well as the North Glacier, at one time were probably united; today the Inferior is extinct and the others are in peril of disappearing due to Barrick's access road to Veladero.

While we do not have images prior to Barrick's unfortunate choice of the placement of its road, we can logically conclude, firstly, that the two glaciers *Almirante Brown Superior* and the *North Glacier* were at some point in time linked to the *Almirante Brown Inferior*. Now Veladero's access road dissects the glaciers at the point where they were linked. The ice of the two glaciers probably advanced naturally to fill the crevasse we can see below the road. This crevasse is over 100 meters deep and probably contained an enormous quantity of ice.

What is also clear from the images, is that Barrick's access road cut the lifeline to the lower portion of the glacier, strangling it to its complete demise. The authors of the report publish a sequential photograph of available images (see below), showing the rapid and alarming deterioration and melting of the ice contained in the *Almirante Brown Inferior*. Although they do not attribute this deterioration to Barrick's road (they were hired by Barrick and they clarify that they are not conducting and environmental impact study), it is absolutely logical to conclude that this indeed is the case.



Near total reduction by 2008 of the Almirante Brown Inferior due to Barrick's road impact

If we go *Google Earth* today, a more recent image confirms our fear. *Almirante Brown Inferior* has ceased to exist. (see: 29°58'36.97" S 69°37'37.13" W).

The Almirante Brown Inferior Glacier on the Conconta Pass completely disappeared since Barrick introduced an access road dissecting the glacier. The blue polygon marks the past presence of the glacier.

As we indicate above, the impacts that a poorly placed access road might have on a glacier can be devastating, and this is the case be it a white uncovered glacier as in the case of the *Almirante Brown Inferior*, or a rock glacier as in the several rock glaciers visible in the Los Azules project area already with mining roads plowing through their surface and volume.

Glaciers and Permafrost in the Vicinity of Los Azules

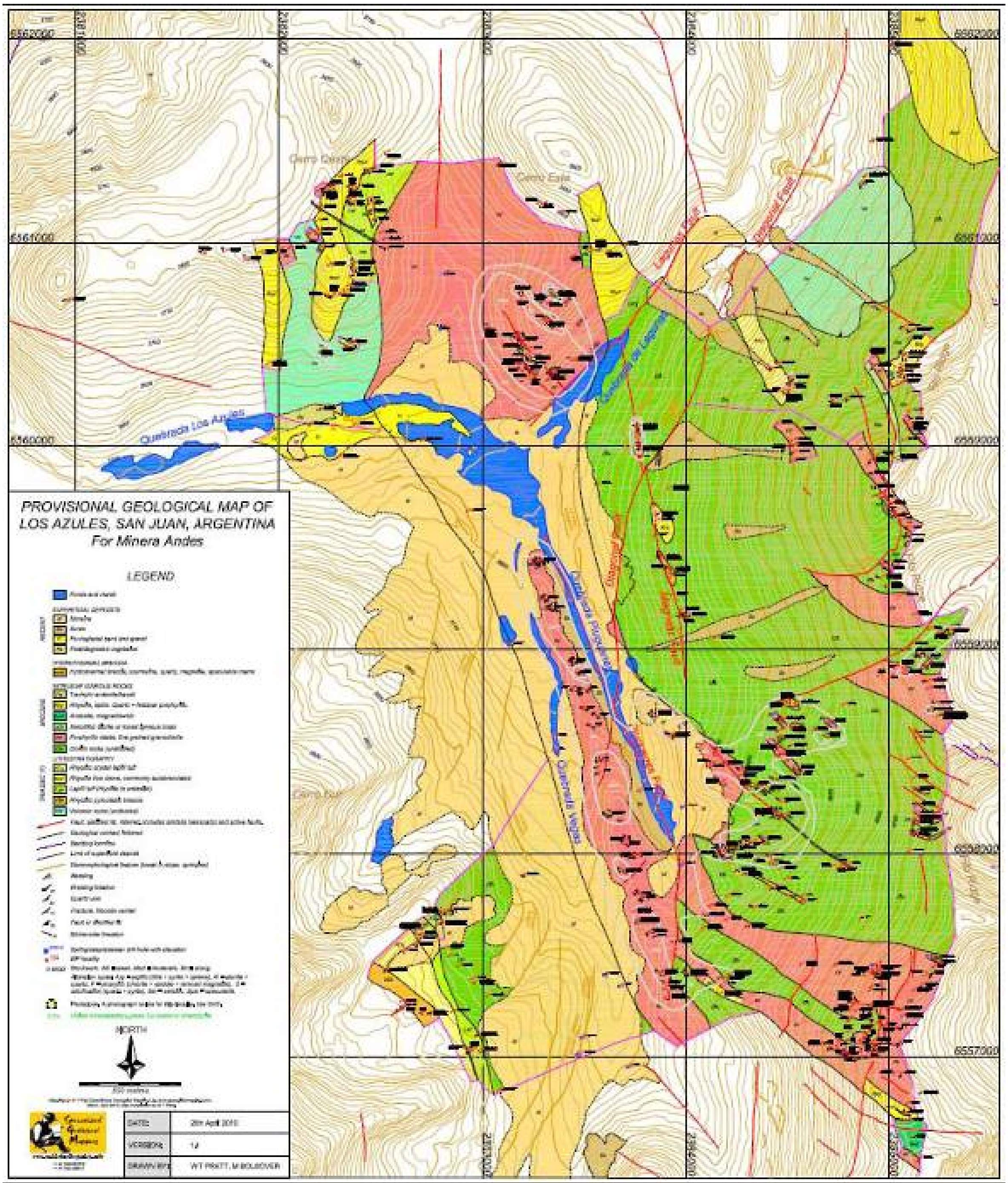
The Los Azules valley as well as surrounding valleys and mountains are very dry and arid, but they are also fortunately rich in glacial activity and periglacial environments (including permafrost), critical to feed San Juan's limited water supply, year round.

Arenson, Pastore, Trombotto et.al., recognized geologists and glacier experts, referring to the El Pachón area, which is a similar copper project south of Los Azules, but in the same general area, make the observation that "the ground ice in these latter permafrost zones is often the only source of multi-year ice in the absence of substantial surface snow and ice areas." (p.1501) They also establish that "most likely the majority of the rock glaciers in the area are still active, i.e. they contain ice-rich zones and are creeping downslope. (p. 1502)

One of the maps available in the Los Azules technical report (reproduced below) shows the geomorphological characteristics of the project area.

While this map should have identified the presence of rock glaciers and permafrost in the project vicinity, it does not. We reproduce this map and legend (separately) below. You can download the map from our website either in PDF or KMZ (for viewing as a transparency in Google Earth) formats.[36]

[36] See: http://wp.cedha.net/wp-content/uploads/2011/10/mapa-geomorfologico-los-azules.pdf
For KMZ format: http://wp.cedha.net/wp-content/uploads/2011/10/Los-Azules-Mapa-Geomorfologico-kmz-file.zip


PROVISIONAL GEOLOGICAL MAP OF
LOS AZULES, SAN JUAN, ARGENTINA
For Minera Andes
LEGEND
NORTH
Quebrada Los Azules
DATE:
VERSION:
DRAWN BY:
WT PRATT, M BOLSOVER

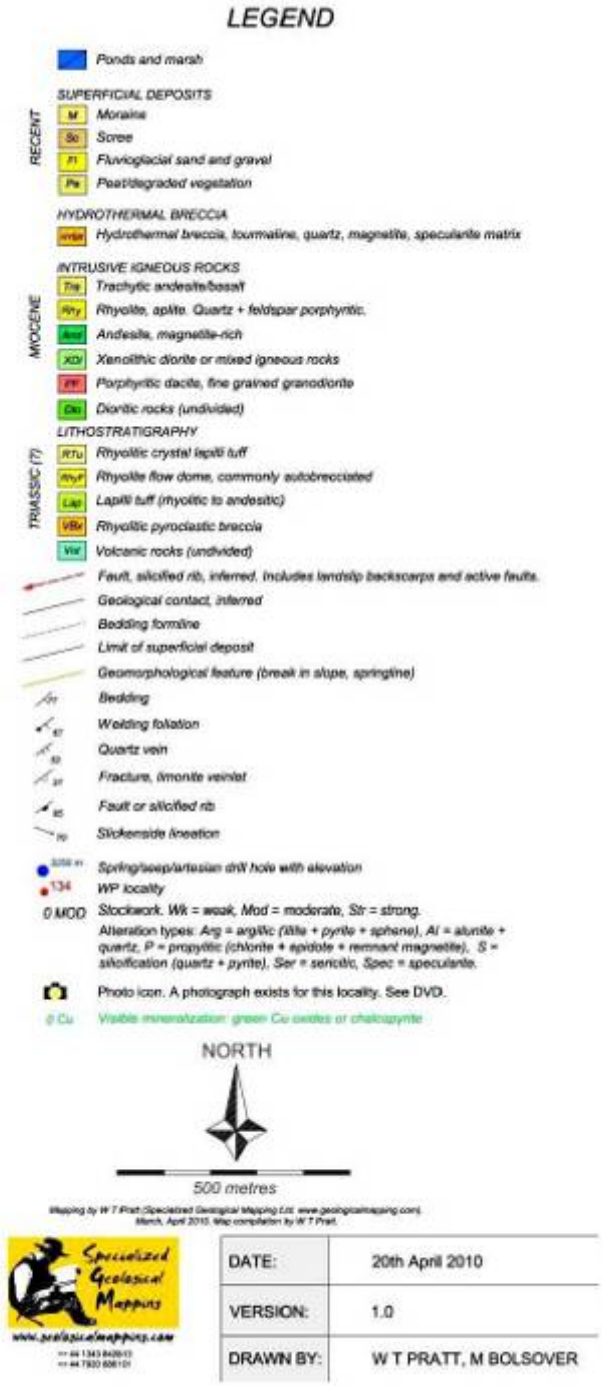
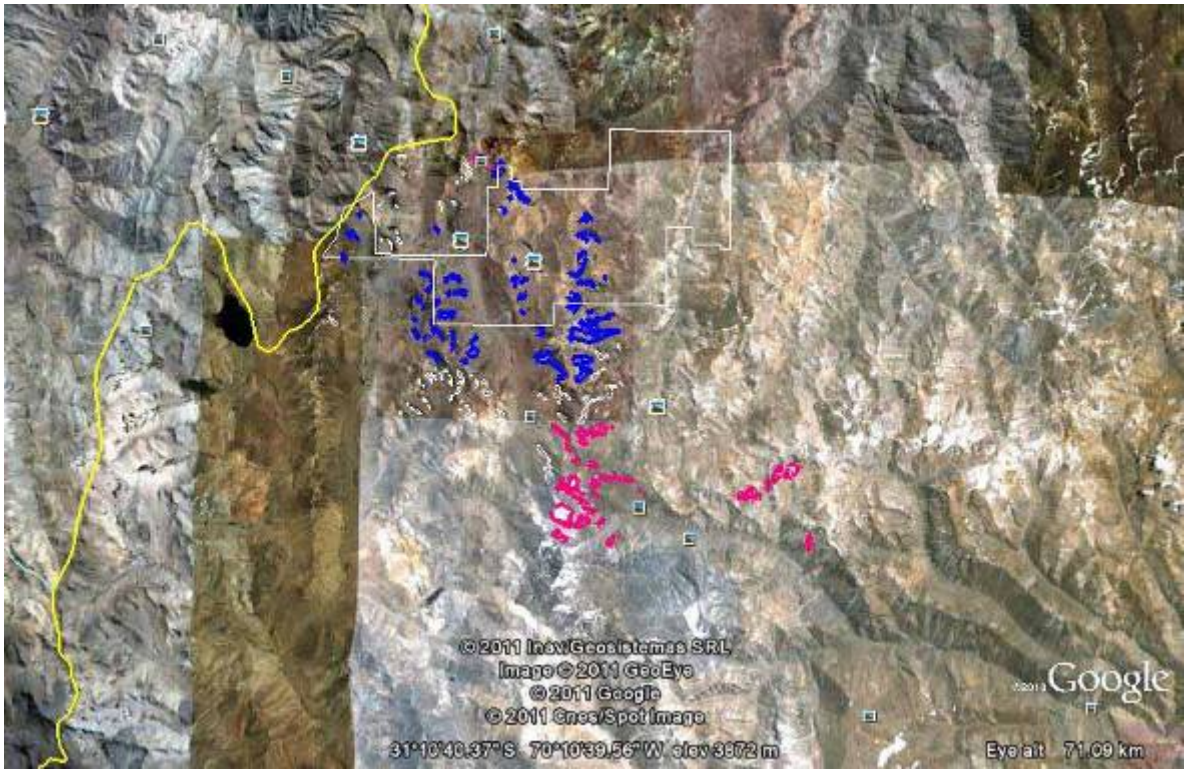


Figure 6.4 - Legend for Figure 6.3

In our own review of satellite imagery, we have identified 226 glaciers, including uncovered glaciers and rock glaciers in the project vicinity. These are all “ice glaciers”, debunking the statement on McEwen Mining’s website suggesting that there are no *ice glaciers* at the project site. We reproduce a *Google Earth* image below showing the location of these glaciers, with 79 glaciers in the project’s formal area (represented as blue polygons), 49 glaciers not in the project area but along the access roads to Los Azules (represented as magenta colored polygons), and 98 glaciers that are neither in the formal area or near roads, but that are in the project’s general vicinity at potential impact areas (represented as white polygons).



The same image brought closer to view the glaciers in the project area (blue polygons):

We should note that as a consequence of the limited resolution and quality of the available imagery, our inventory is also likely to be incomplete or may fail to identify smaller rock glaciers (approximately <0.01 km2). Field mapping is required to obtain a complete inventory of these rock glaciers. However, as we have only inventoried those glaciers of which we are confident that there is indeed a glacier at the site, we estimate that this error will result in the *addition* of glaciers and not the downgrading of ones that we have inventoried, likely bringing the total number significantly higher. This may also be true for inactive rock glaciers, which sometimes lack the characteristic morphological features such as a steep front slope and flow-related surface structures with which to determine their existence from a satellite image. Inactive rock glaciers missed by our analysis would be just as important as ice/water reserves, and are protected by the National Glacier Protection Act.

Official Inventories of rock glaciers in the vicinity of Los Azules are currently underway, both by the Province of San Juan Argentina, as well as by the IANIGLA and Conicet, Argentine national scientific centers which have been mandated by the recently enacted and regulated Argentine National Glacier Protection Act[37] to carry out an official glacier inventory for the entire country. Unfortunately, at present, the provincial glacier inventory fails to include rock glaciers, despite the fact that we have information indicating that at least a partial inventory may exist for rock glaciers of the province, including for the Los Azules project region. We should also note that the national glacier act mandates that specific inventories be carried out immediately for glacier areas with mining operations underway. This element of the law has not yet been complied with.

Further limiting the access to official information about Argentina's glaciers is that the national inventories may take upwards of 5 or more years to carry out, long after Los Azules is set to complete its pre-feasibility study in 2013, and could conceivably initiate operations soon there after. For this reason, the Center for Human Rights and Environment (CEDHA) decided to carry out *it's own glacier inventory* for San Juan focusing on areas where mining operations are active. This is our way of helping move the Glacier Protection Act more quickly into implementation. We received training in glacier inventorying from the United National Environmental Program, which offers a yearly course in glacier recognition and inventorying techniques. Through the analysis of satellite images that are publicly available through *Google Earth* we have already inventoried more than 2000 glaciers (many of which are rock glaciers), in San Juan as well as in Catamarca, Tucuman, La Rioja, Mendoza, Jujuy and Salta provinces. In our latest report, CEDHA published a preliminary *full* glacier inventory of the entire province of La Rioja, which can be downloaded from CEDHA's Glacier Inventory website.

CEDHA's ultimate objective is to help ensure full implementation of the national and provincial glacier laws, and guarantee above all, the protection of all of Argentina's glaciers and preservation of water reserves. The technical team participating in this report included two trained professionals (Dr. Alexander Brenning of the University of Waterloo, and Mateo Martini, Geologist and PhD Candidate of the University of Cordoba, which contributed to the content and review of this report.

In its *Glaciers and Mining Series*, CEDHA has already published three reports on impacts from mining to glaciers by three mining projects, Agua Rica (Yamana Gold) in Catamarca Province, Filo Colorado and El Pachón (Xstrata Copper) in Catamarca and San Juan Provinces, respectively, as well as a more recent report on mining projects and glaciers in the Province of La Rioja. Several other reports are underway focusing on other mining projects in glacier territory, including, Pascua Lama (Barrick Gold), El Altar (Peregrine Metals), Del Carmen (Malbex), Vicuña and Las Flechas (Suramina), Northern Properties (TNR), Vanessa (Anglo American), Amos Andres (Cerro Vanguardia), Aguilar (Glencore) and others.

In relation to our glacier inventory for Los Azules, CEDHA has generated a .[*kmz*] *file* with corresponding rock glacier locations and polygons, with longitudinal and latitudinal coordinates which can be entered and viewed by the reader on Google Earth. To view this file, download it from our website and open it in *Google Earth*[38]. We also provide at the end of this report, as an annex, a glacier inventory in an excel spreadsheet,[39] which sites glacier name, type, coordinates, and elevation. The glaciers can also be seen by simply copying the map coordinates and pasting them in the search box in *Google Earth*.

These glacier polygons, visible in *Google Earth* should also be seen with the polygons we've created citing the project infrastructure, which includes, roads, exploration limits, pit area, tailing deposit sites, and other features, which can also be downloaded from our website. [40]

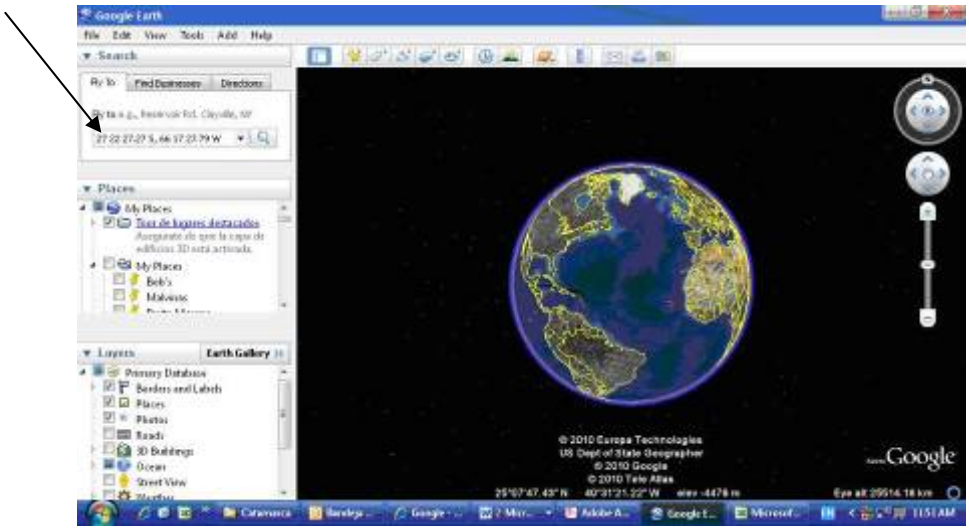
[37] For regulatory decree of National Glacier Act see: http://www.cedha.org.ar/contenidos/Reglamentacion%20de%20la%20ley%20de%20glaciares.pdf; for regulatory guidelines of National Glacier Act see: http://www.cedha.org.ar/contenidos/CronogramaInventarioGlaciaresIANIGLA.pdf
[38] See: http://wp.cedha.net/wp-content/uploads/2011/10/Los-Azules-Glacier-Polygons-Only.zip
[39] See: http://wp.cedha.net/wp-content/uploads/2011/10/Inventario-Glaciares-Entorno-a-Los-Azules-al-12-0ct-2011.xls
[40] See: http://wp.cedha.net/wp-content/uploads/2011/10/Los-Azules-Glacier-Polygons-Only.zip

If you wish to see one of the glaciers we've listed in the excel file version, which is presented as follows:

#	Glacier Name	Type	Coordinates	Altitude (meters)
1	Glaciar R 312-7014	Rock	31 2 59.46 S, 70 14 53.12 W	3745-3950

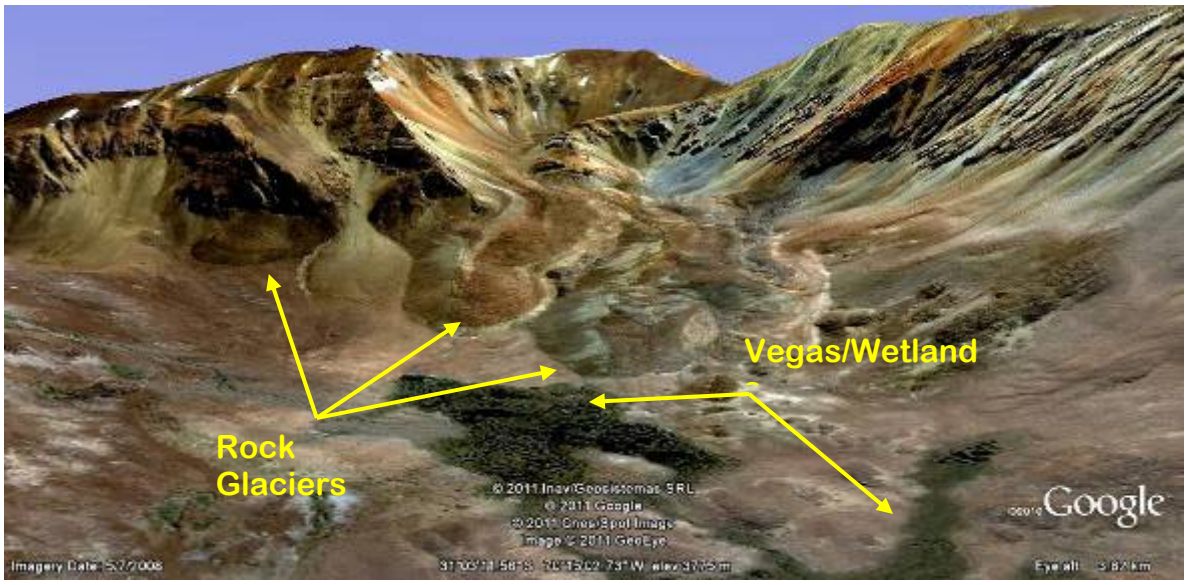
simply copy and paste the address exactly as is in the "Coordinates" column—in this case 31 2 59.46 S, 70 14 53.12 W --, in *Google Earth's* search box.

To see this glacier, you could simply copy exactly as is: 31 2 59.46 S, 70 14 53.12 W and paste this direction in the Google Earth search box (see image below). A simple "enter" will take you to an actual satellite image of the glacier.



This is the image we see when we do this:

We see here several beautiful and well-developed rock glaciers (ice glaciers) in the Los Azules project area, coming off the mountain in a flowing pattern with tongue-like terminations. We also see a Los Azules mining exploratory road encroaching into the image at the top left corner. Tilting the image with Google Earth's 3D function (found in the upper right corner of the screen, by pressing on the northern arrow and then using the up/down/left/right keys) we can position this image in 3D to see these majestic glaciers in their full breadth and form. We can also see vegas (wetlands) at the foot of the glaciers.



Most of the rock glaciers (ice glaciers) found at the Los Azules project site are located in south-facing mountain sides and valleys ranging from [31 2 S to 31 16 S] and from [70 09 W to 70 21 W]. In the southern hemisphere, south-facing mountain sides at high elevations (above 3500 meters in San Juan's latitudes) offer ideal cool shady temperatures for the development and preservation of rock glaciers and permafrost. While we cannot identify permafrost regions directly using satellite imagery, we can expect permafrost to be present in areas where we find rock glaciers. If we take findings at Xstrata's El Pachón project as a reference, as El Pachón is similar in nature and in geographical location, that project has some 20% permafrost coverage at the project's site, coinciding with the areas where rock glaciers are present.

The rock glacier-permafrost relationship is substantiated by scientific research (Barsch, 1996). We expect that the permafrost area in the high arid Andes in San Juan Province to begin at approximately 3500 meters above sea level, although we have identified a few rock glaciers that suggest the periglacial environment region, for example, in some of El Pachón's valleys may be a few hundred meters below this line.[41] This needs to be confirmed however, by site inspection in the sort of visit that we originally agreed upon with Minera Andes but which was canceled by McEwen Mining.

In the following image, which we had already reproduced above, we see the relationship and importance of permafrost terrain to local ecosystems. The vegas formed at the foot of this mountainside near the Los Azules project receive a regular discharge of water from seasonal thawing ground ice in upslope permafrost terrain. This photograph is extracted from Juan Pablo Milana's book, "Ice and Desert" (in Spanish, Hielo y Desierto), and the caption reads: "Talus Cones, separated by mountainsides with crawling permafrost. Note that the vegas of this valley are only nurtured by permafrost".[42]

Permafrost (marked by oval) is a key source of water for wetlands in much of Los Azules area. Photo: JP Milana

[41] See for example: Glacier R 3145-7019: 31 45 51.34 S, 70 19 26.08 W; 3220-3470 meters
[42] Juan Pablo Milana, Hielo y Desierto: Los Glaciares Áridos de San Juan. 2010. P.124

Oval shows more permafrost feeding vegas/wetland lands below in the Los Azules area. Photo: JP Milana

In the nearby Chilean Andes about 70 km south of the Los Azules site, Azócar & Brenning (2010) found the lower limit for rock glaciers to be located at approximately 3400 m above sea level, active rock glaciers being more widespread above 3700 m above sea level, which would coincide with findings at nearby El Pachón (Xstrata Copper). Xstrata reports the periglacial environment (permafrost) limit to be approximately 3800 meters, (pp.12-13 of the 2008 Environmental Impact Assessment Addendum).

Much of the existing exploratory work in the Los Azules project is located on south-facing mountain sides and valleys, thus placing these rock glaciers and periglacial environments (permafrost) at risk. From our satellite imagery analysis, we have been able to pinpoint specific sites where impacts to rock glaciers and periglacial environments from exploratory mining roads of the Los Azules copper project are evident and need immediate study for verification and deeper analysis. From Minera Andes' EIA documents, we can also ascertain that if project pit sites and waste deposit sites are maintained as planned, there will be further impacts to rock glaciers and periglacial environments resulting in a violation of provincial and national laws.

Drilling at Los Azules

Various companies and subcontractors have been responsible for exploration and drilling to date. Amongst these, Xstrata Copper, BMG, Minera Andes, Connors Drilling, Patagonia Drill Mining Services, Advisor Drilling, Boland Minera, and Major Drilling.

As indicated above, drilling conditions were particularly difficult especially in faulted intersections or in areas of unconsolidated surface as a result of the presence of scree, talus, and rock glaciers. Average drilling rate was 700 meters per month (Rojas, 2010).

BMG drilled some 5.6km between 1998 and 1999, Xstrata 0.8km, and Minera Andes 24.4km between 2003 and 2010. The April 2010 EIA (by Vector) indicates that some 130 drill sites exist (totaling > 20,000m), 28 of which were explored by BMG/Xstrata/Mina Andes and 64 of which belong to Mina Andes exclusively. (Vector EIA, p.25) This number rose to 160 by the end of 2010. (see pages 26-27 of Vector EIA for precise drill sites).

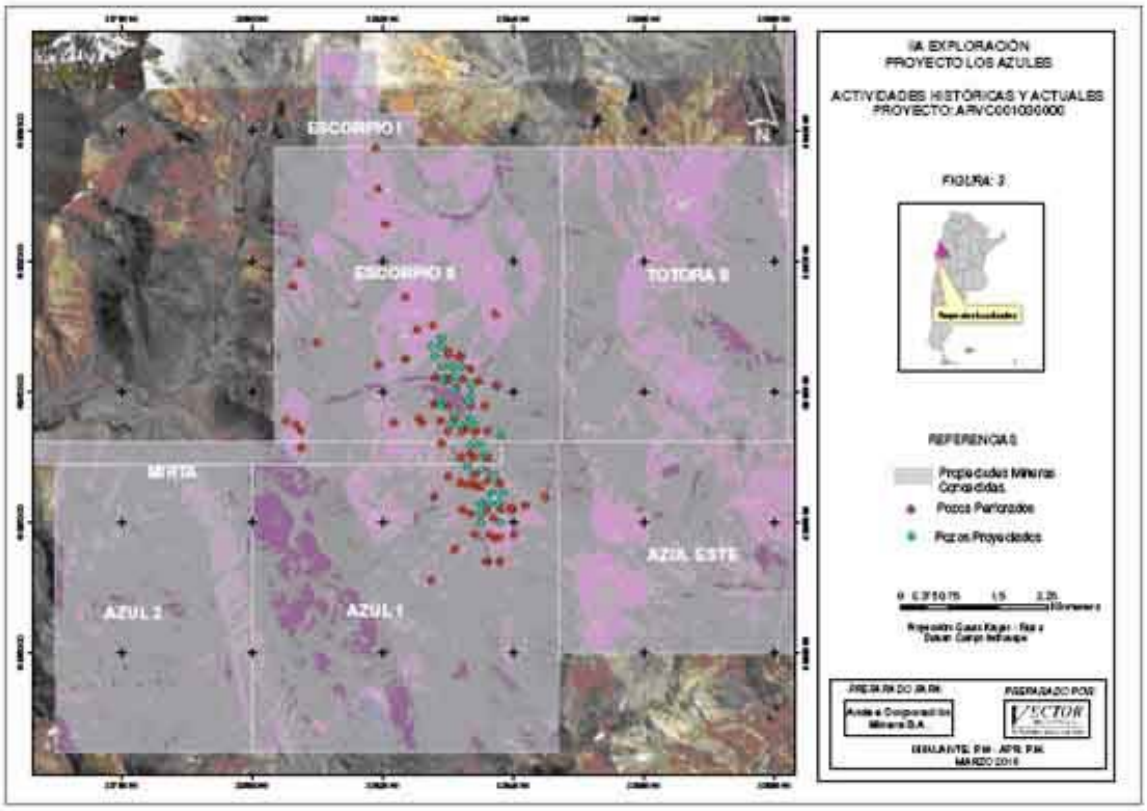
More recent press documents on McEwen's website indicate that further drilling as occurred, however we do not have the precise drill sites for this activity.[43]-[44]

Drill Platform at Los Azules. Photo: Minera Andes

[43] See: http://www.mcewenmining.com/Media-Events/News-Releases/News-Releases-Details/2011/Minera-Andes-Reports-Drill-Results-and-Development-Update-for-the-Los-Azules-Copper-Project/default.aspx

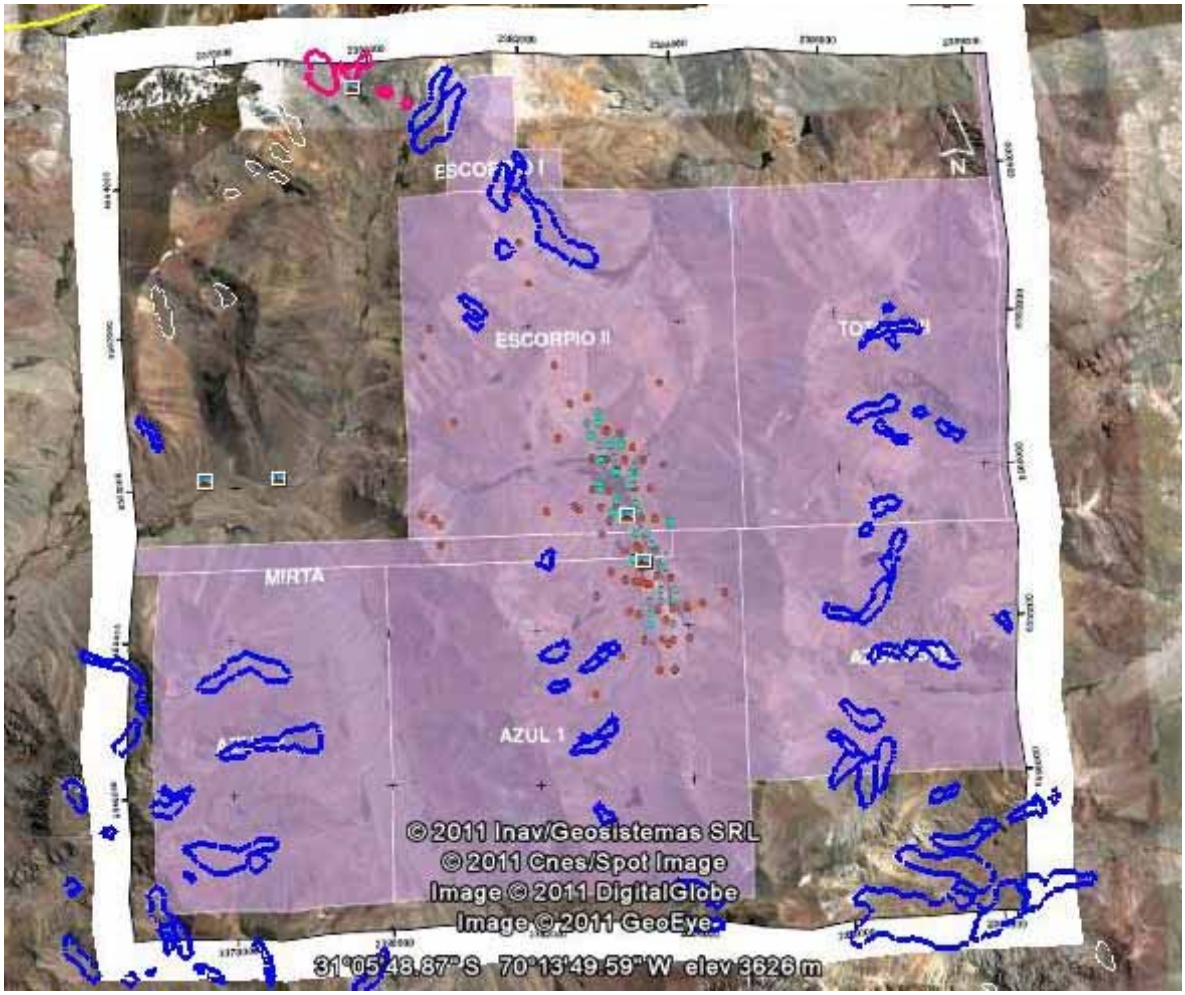
[44] http://www.mcewenmining.com/Media-Events/News-Releases/News-Releases-Details/2012/McEwen-Mining-Expansion-Drilling-Intersects-053-Copper-Over-351-Meters-at-the-Los-Azules-Project1129434/default.aspx

The following map from Minera Andes EIA shows the precise "past" drill sites for Los Azules.



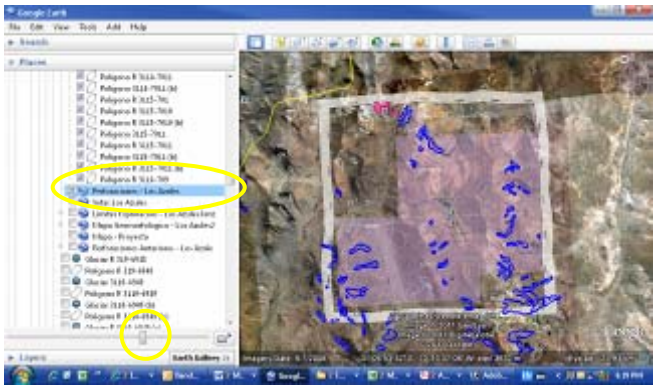
We can superimpose this map in Google Earth to view the drill sites in relation to rock glaciers (you can do this yourself by downloading the .kmz files for *Google Earth* from our website.[45] This reveals the following image:

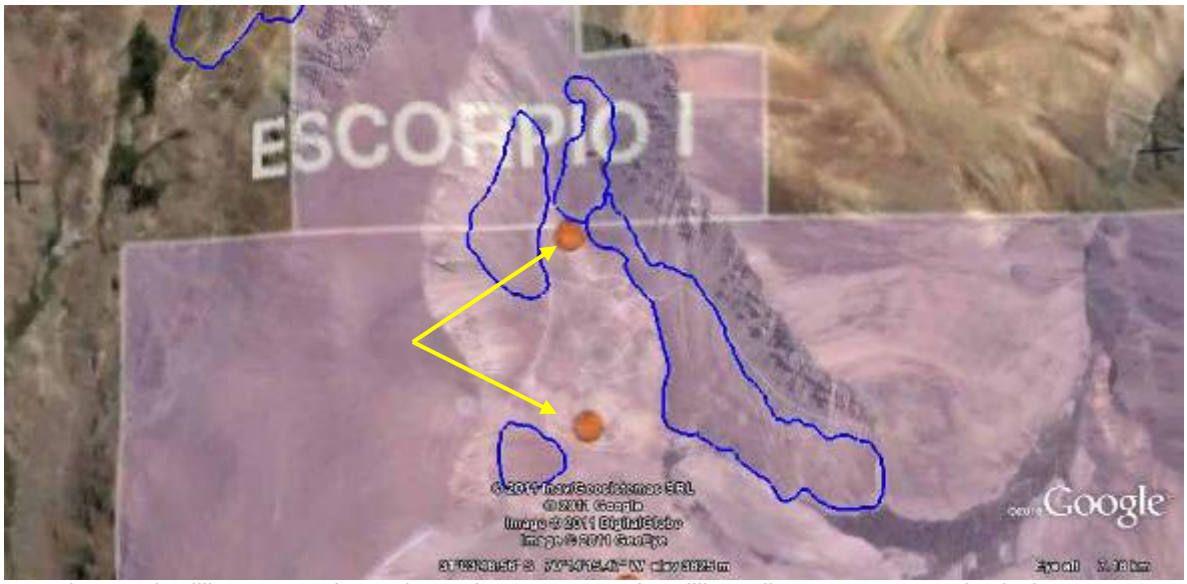
[45] See: http://wp.cedha.net/wp-content/uploads/2011/10/Los-Azules-Glacier-Polygons-Only.zip (5MG)



Drilling at Los Azules with Superimposed Google Earth Image Showing Glacier Mapping

Zoomed-in images show drill sites that are dangerously close *or at* rock glacier sites, particularly glaciers (as cited in our inventory in the annex), 313-7014, 313-7014 (b), 313-7014 (d), 314-7014, 316-7013(f), 316-7013 (e), and 317-7013 (b). These glaciers can be viewed in *Google Earth* by copying the location coordinate from our inventory in the annex into the *Google Earth* search box. The reader can also download the drilling map transparency image which is also viewable in *Google Earth*. With the transparency lever, which will appear once the map is loaded in *Google Earth*, you can make the map more or less transparent and thus compare the drill site with the rock glacier and other natural elements visible in *Google Earth*. Below is a reproduction of what the reader will see on *Google Earth*. The yellow ovals indicate where the transparency lever is. Be sure to click the pointer on the map folder in left pane, otherwise the transparency level will not work!





Superimposed Drilling Map and Google Earth Image Reveals Drilling adjacent to Four Rock Glaciers

Superimposed Drilling Map and Google Earth Image Reveals Drilling adjacent to three Rock Glaciers

Obviously, drilling into glaciers would not be an acceptable practice under any circumstance, but it becomes further problematic in Argentina as a law exists prohibiting impacts to glaciers, rock glaciers, and permafrost. Considering that permafrost is widespread in areas containing rock glaciers, we can presume these drill sites have perforated ice.

While the two images we reproduce don't show that the drilling has taken place *exactly on a rock glacier surface*, we cannot be sure if this surface or any of the other numerous drill sites contain permafrost. We can however deduct from the commentary by the subcontractor on page 78 of Minera Andes' Updated Assessment technical report indicating that drilling was made difficult by the presence of rock glaciers, and this suggests to us that indeed at these drill sites, rock glaciers were indeed perforated. You can read this claim at the following link, or request the full report to the author at: jdtaillant@gmail.com

> "Drilling by Minera Andes Inc. was contracted to various drilling companies including Connors Drilling, Patagonia Drill Mining Services, Adviser Drilling, Boland Minera and Major Drilling. Drilling conditions have been particularly difficult especially in faulted intersections or in areas of unconsolidated surface scree/talus/rock glacier in which resulted in an average drilling rate of 700 meters per month (Rojas, 2010)."

We are to presume hence that drilling exercises *did in fact take place where there were rock glaciers*, and that there must have been hence, some impact from this exercise on the glaciers. We can also presume that periglacial environments were also impacted.

While the drilling itself can cause harm to rock glaciers and permafrost (through mass alteration as well as the use of drilling fluids which can alter and contaminate the ice), the mass movement of earth and opening of roads to reach drill sites can cause even greater impacts to ice resources and particularly to the type *ice glaciers* that are present at the Los Azules project site and surrounding areas, as we have already seen above with the Barrick-Veladero access road example. As can be seen from the above photo of a drill platform, drilling implies moving large machinery into place, opening of roads, as well as the movement of large vehicles into the site. All such activity would imply impacts to rock glaciers if they were underneath or adjacent to the platforms and access roads.

Glacier Impacts of Tailing Storage Facilities (TSF) and Waste Rock Disposal Facilities (WRDF)

Two sites are identified in the EIA technical report (p.125). Option 1 is located in the valley west of the open pit area. The TSF is designed to contain 909 million tons of tailings.[46]

The two principle concerns with regard to the impacts of tailing deposit sites on rock glaciers and permafrost are, on the one hand, the enormous weight placed on the surface (on the rock glacier), in this case 909 million tons, which may in the first place accelerate rock glacier deformation by an order of magnitude (as observed in two mines in the Chilean Andes: Brenning and Azocar, 2010) and ultimately potentially lead to instabilities and the collapse of the ice-debris structure. Additionally, acid drainage from the waste deposits will contaminate the water and ice in the rock glacier, making the water no longer potable. We can presume additionally that since Minera Andes has not identified the presence of rock glaciers, nor have they calculated the amount of water contaminated by the production process.

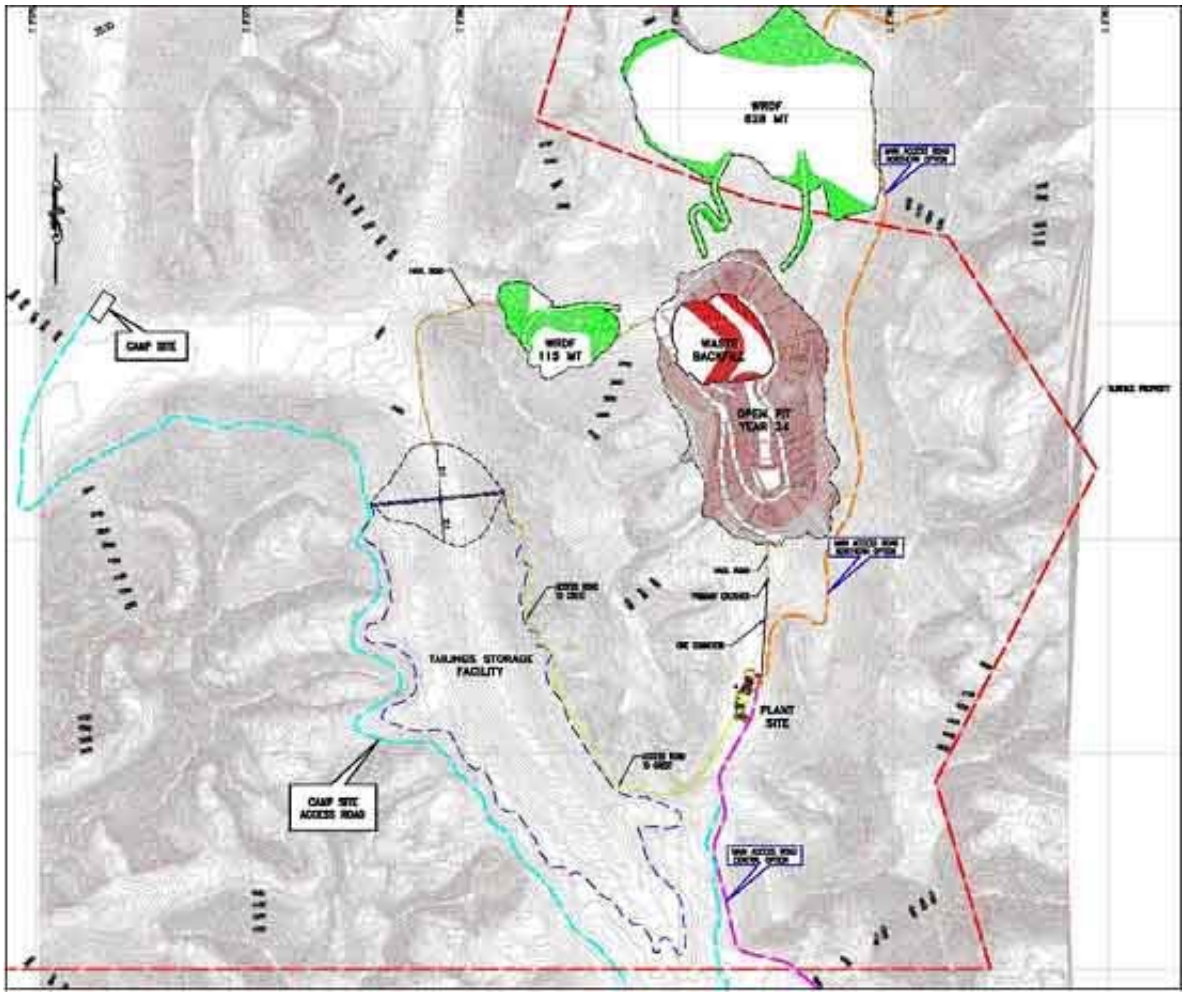
The location of the WRDFs and TSF are taken from p.124 of Samuel Engineering Preliminary Assessment. The criteria used to determine the best location for these sites were:

- Storage capacity to facilitate management of the waste and mitigate potential environmental impacts;
- Proximity to the pit and plant;
- Low rainfall runoff;
- Limit to one watershed;
- Limit to a single embankment;
- Not to be upstream of critical mining infrastructure

None of these criteria take into account the presence of rock glaciers or permafrost, which should have been done, not only because these are sensitive environmental resources and because placing sterile rock waste on permafrost or glaciers can lead to dangerous accidents (as occurred recently in the Veladero project), but also because placing sterile rock on a permafrost zone or on a rock glacier, is against the law.

[46] Updated Preliminary Assessment, Los Azules Project. Samuel Engineering. December 2010. p.125.

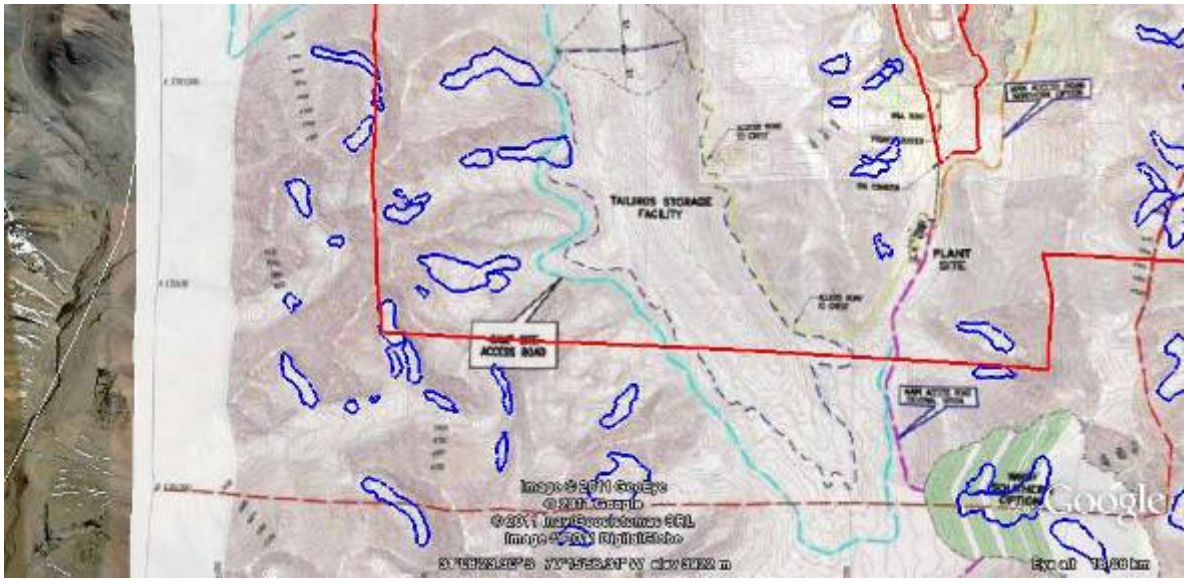
Below is the map from the EIA which identifies the options for the waste sites.



By superimposing this map as a transparency in *Google Earth* we can analyze the site choices in relation to the presence of rock glaciers. We recall that we cannot see permafrost zones in these images which may also be affected. We have made this map available on our website.[47]

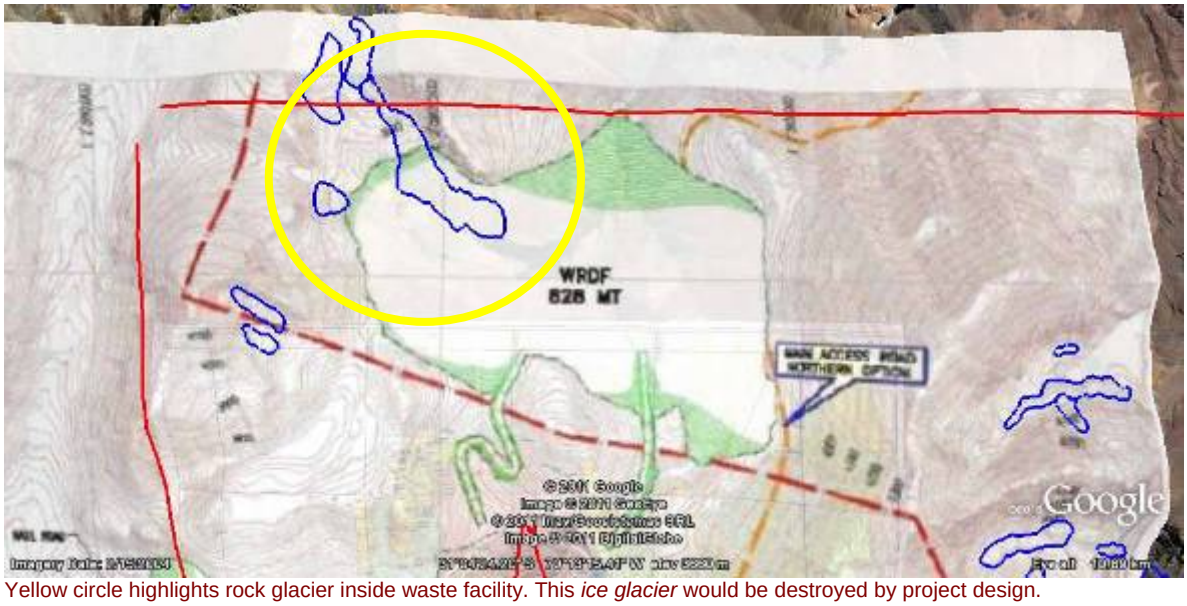
[47] http://wp.cedha.net/wp-content/uploads/2011/10/Los-Azules-Mapa-Proyecto-kmz-file.zip

Zoomed in versions of this transparency in *Google Earth* show a clear conflict between the waste site choices and existing rock glaciers. We can presume there is also permafrost area at these sites.



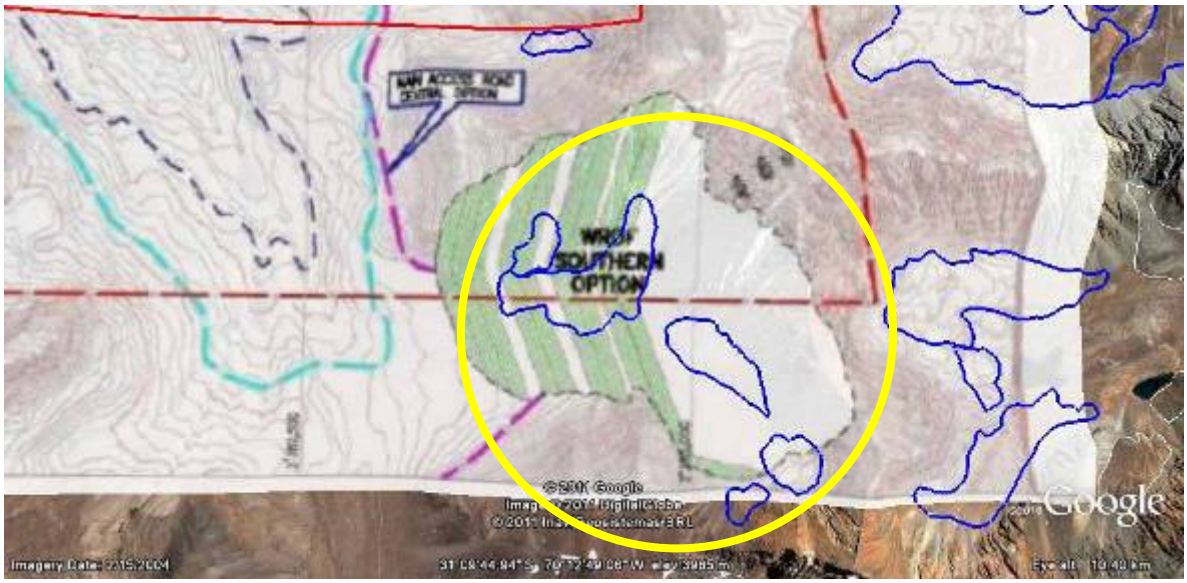
Below is option one for the waste site, there are two glaciers affected by the site choice, one which is inside the waste site (rock glacier 313-7014 (b)), and the other tangential to it (rock glacier 314-7014). The reader can find these glaciers utilizing the *Google Earth* coordinates in our glacier inventory in the annex. The project map transparency can be downloaded at:[48]

[48] See: http://wp.cedha.net/wp-content/uploads/2011/10/Los-Azules-Mapa-Proyecto-kmz-file.zip



Yellow circle highlights rock glacier inside waste facility. This *ice glacier* would be destroyed by project design.

Option II for the waste facility is no better than Option I, in fact, it is worse. We see five glaciers impacted by the site choice, three of which are entirely in the waste site (rock glaciers 319-7013, 319-7012, 3110-7012 (b)), one is straddled on the edge (rock glacier 3110-7012 (c)), while the fifth is adjacent to it (rock glacier 3110-7012 (d)).



Impacts to Rock Glaciers and Permafrost by Los Azules

A review of the limited available documentation from Minera Andes as well as satellite imagery that is freely and widely available on *Google Earth*, indicates that the Los Azules project zone is rich in rock glaciers and periglacial environment (permafrost). The McEwen Mining website incorrectly states that "no ice glaciers are present in the project area".[49] This statement is both false and misleading.

Areas pertaining to the Los Azules project, particularly exploratory mining roads intervene periglacial environments and penetrate, are adjacent to, or are extremely near enough to rock glaciers and periglacial environments to warrant an in-depth study of past or potential future impact from mining activity occurring or to occur in this project. Projected project infrastructure, such as the Pit, Waste and Tailing Facilities, and possibly other infrastructure are at sites which would imply the impact to or total destruction of rock glaciers and/or permafrost. The Environmental Impact Studies produced for the Los Azules project either minimize or totally ignore rock glaciers and permafrost zones in the project area.

The present Argentine National Glacier Protection Act (October 2010) prohibits much of the activity that has taken place and that is planned for implementation of the Los Azules project. Simply stated, as is, the Los Azules project does not comply with national or provincial glacier protection laws.

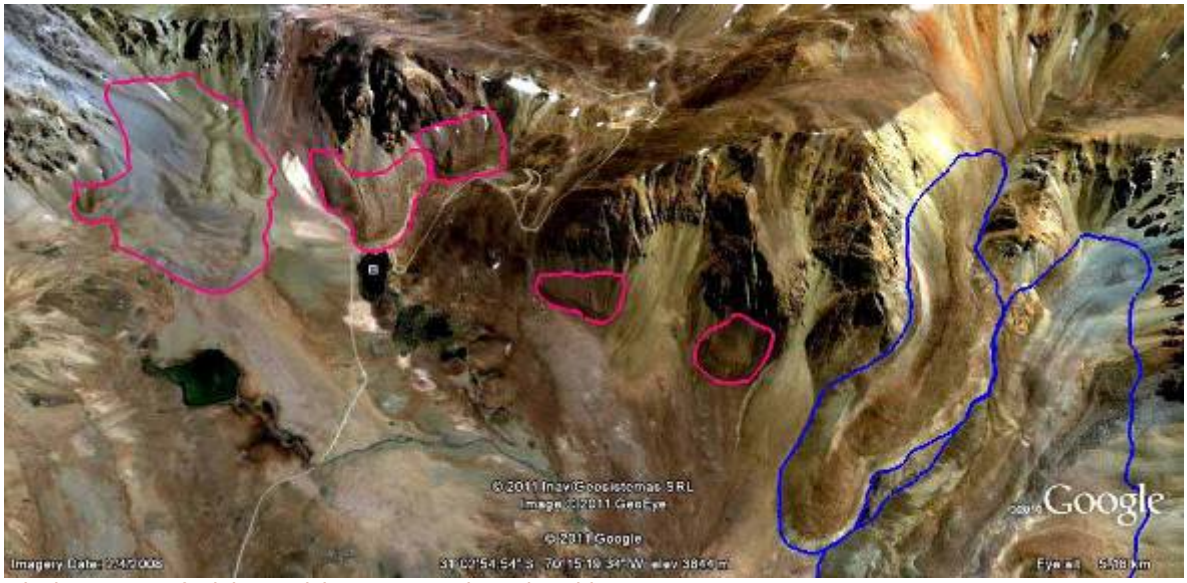
It should be noted that the maintenance of existing access roads can cause ongoing impacts to glacier preservation and sustainability, since companies generally try to avoid water flow from entering road areas. Glaciers, by contrast, need that water for their own sustainability.

Below are a few images, some of which we have reproduced in other sections of this report showing clear incompatibility between mining activity and glacier presence at Los Azules. We can clearly see the zigzagging roads go up and down the mountain sides, in some cases penetrating rock glaciers indiscriminately. In other cases, the roads are adjacent to the rock glaciers, some of these in their rooting zone, i.e. the area in which the deposition of rock fragments and snow 'feed' the rock glacier.

[49] See: http://www.mcewenmining.com/Media-Events/News-Releases/News-Releases-Details/2011/Minera-Andes-Reports-Drill-Results-and-Development-Update-for-the-Los-Azules-Copper-Project/default.aspx

Glacier Impact of Mining Activity at Los Azules. Viewable at: 31°06'58.42" S 70°13'42.45" W

Glacier Impact of Mining Activity at Los Azules. Viewable at: 31°04'16.59" S 70°14'18.88" W



Glacier Impact of Mining Activity at Los Azules. Viewable at: 31°02'54.54" S 70°15'19.34" W

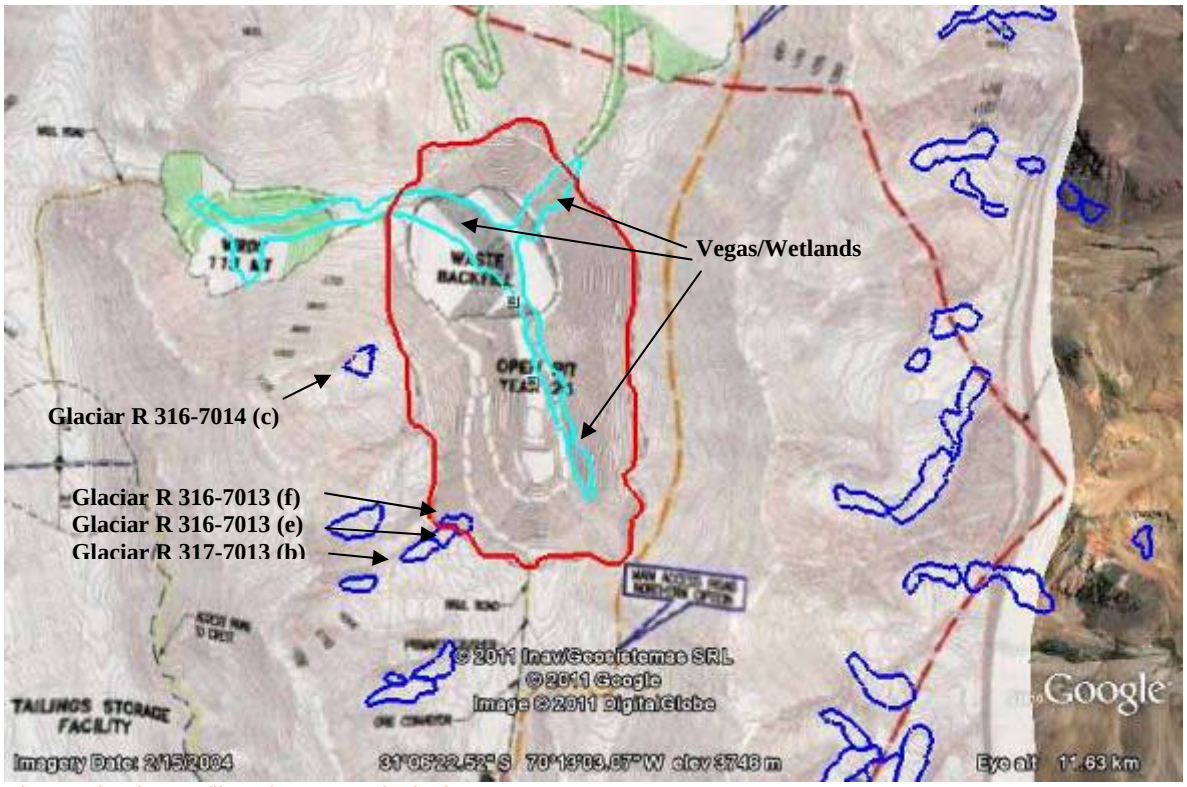
Glacier Impact of Mining Activity at Los Azules. Viewable at: 31°13'58.64" S 70°09'15.21" W

We have also received troubling images registered recently from the Los Azules access road, leading to the Los Azules mine site, in which evidence clearly shows that the alternate roads recently introduced by the company *after* the passage of the Provincial and National Glacier laws, are damaging rock glaciers. Below are two extremely revealing photographs taken on Minera Andes' access road, which is the same road and area visible in the Google Earth image above.

In the image we can see how mining access roads have been built with absolute disregard for rock glaciers in the terrain. The yellow ovals indicate the rock glaciers. We can expect that the rock glaciers below these roads will be strangled and eventually destroyed by the insertion of these roads in the critical zone where the glacier feeds from water and snow coming off of the mountainside. Further, introducing roads on a glacier is not a safe venture as glaciers move and could collapse with heavy weight placed on the surface, such as that of a mining truck. This is an environmental and human hazard for anyone using this road.

Pit Excavation

The Los Azules Project contains one pit area. Three rock glaciers are located at the pit site. We cannot determine permafrost presence at the site without onsite analysis but we presume there is also permafrost present at the pit site. The image below shows the pit area (red polygon). The blue polygons are rock glaciers, while the sky-blue polygon shows vegas presence in the pit.

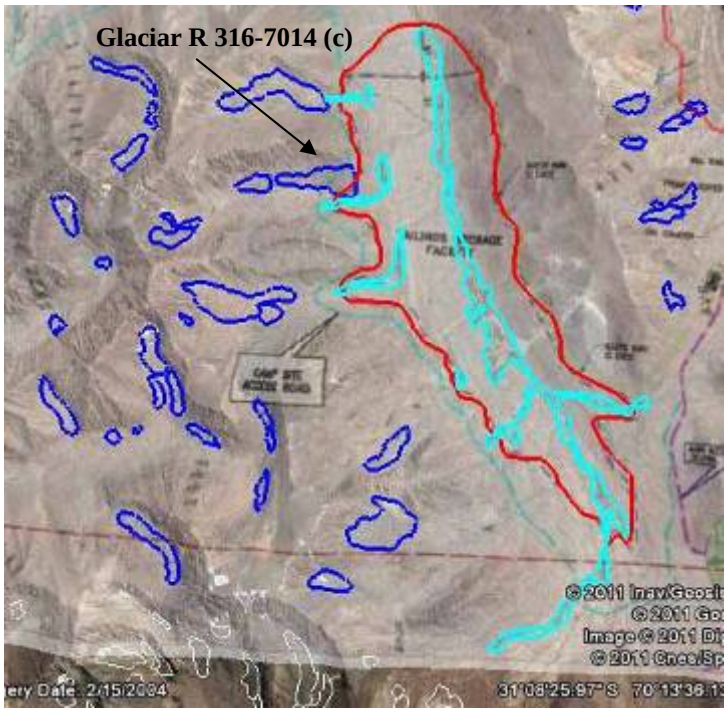


Pit Location in Conflict w/Vegas and Glaciers

One of the glaciers, Glacier R 316-7013 (f), is entirely within the pit area. Glacier R 316-7013 (e) is immediately adjacent to the glacier, while Glacier R 317-7013 (b). Glacier R 316-7014 (c) is also in the immediate vicinity. The extensive vegas presence in the pit region also suggests we might find important permafrost zones in the area, although this cannot be determined by satellite imagery.

If we examine the Tailing Storage Facility (red polygon), we also find conflicts both with glaciers as well as with vegas presence, which again, may indicate that there is extensive permafrost in the area.

The next image shows extensive vegas presence inside the TSF, as well as significant rock glacier presence along the western end of the valley (with glaciers particularly close along the most northern end of the TSF. One of the glaciers, Glaciar R 317-7016 (c).



Rivers and Streams in the Los Azules Project Area

The Argentine National Glacier Protection Act states in Article 2,

> … we understand by the periglacial environment of high mountains the area with frozen ground acting as regulator of the freshwater resource. In middle and low mountain areas, it is the area that functions as regulator of freshwater resources with ice-saturated ground.

Rivers, especially those in arid regions such as in the high Andes of San Juan Province, depend on seasonal snowfall and ice melt during warmer months, to sustain water flow.

Nature has figured out a way to provide this water flow during the many months of little or no rain. During the winter season, snow accumulates on mountaintops, on mountainsides, and in the Andes valleys. Much of that snow melts off as spring arrives and the winter months turn into the scorching months of summer, with temperatures that can top 40 degrees in some areas.

At the highest elevations, usually above 4,500-5,000 meters above sea level, temperatures stay cool, and even below zero for most if not all of the year. The repeated snowfall over many years, compacts snow and forms glaciers, which store ice for when the rivers need it most, particularly for example, during years with little snow or rain fall. This melting snow in some cases, is practically the only source of water for these rivers during such dry spells.

A particular phenomenon occurs in the San Juan region between 3,500 and 4,500 meters, which is a further adaptation of Mother Nature to the especially dry climate of the region. Mountainsides release rock and soil from their surface, and mix with fallen snow which compacts and slowly creeps down the mountainside. Eventually this debris covers the packed ice, forming debris-covered glaciers which when mixed with rock content, are referred to as *rock glaciers*. The debris cover acts to protect the ice, conserving it at much lower elevations than ordinary uncovered glaciers which would probably melt at elevations under 4,000-4,500 meters. These *rock glaciers* or *debris covered glaciers, particularly when they begin to melt,* become a key source of additional water for local streams and rivers.

This section focuses on the rivers in the Los Azules project area, highlighting the importance of rock glaciers and permafrost in the project vicinity as “regulators of freshwater resources”, which is why the National Glacier Protection Act established glaciers as of the “public interest”. We wish to draw attention to the importance of these rock glacier and permafrost-fed rivers in terms of their water provision to areas such as San Juan.

We show these rivers as they are, where they flow, and the relationship between the rivers and the rock glaciers and permafrost in the Los Azules area. We also show the location of communities which while in some cases are at a considerable distance, depend nonetheless on the water provided by these rivers throughout the year.

While it is evident that the 200+ rock glaciers in the Los Azules project area only contribute a fraction of the river flow volume of the rivers in the region, the decisions made by companies like McEwen Mining, as well as decisions by the public authority to regulate the more than 150 mining projects that will collectively launch operations in the same region, will have enormous collective impact on the future water supply of San Juan province and even for other provinces further downstream. Further, this concern is magnified as there are several other similarly large mining projects at nearby locations, including, El Pachón (Xstrata Copper), El Altar (Peregrine Metals), Casposo (Troy Resources), and Vanesa (Anglo American). We are gravely concerned when we see mining companies and public authorities negate the presence of these glaciers, which they have been systematically doing since the passage of the National Glacier Protection Act in 2010. The cumulative impact to rock glaciers and permafrost from the large number of mining projects already exploring and to begin operations in the coming years, if not properly regulated, could be devastating.

Our main objective in publishing this report is to protect glaciers and permafrost because they are a critical water resource, in an area that is already strained by a greatly limited supply of

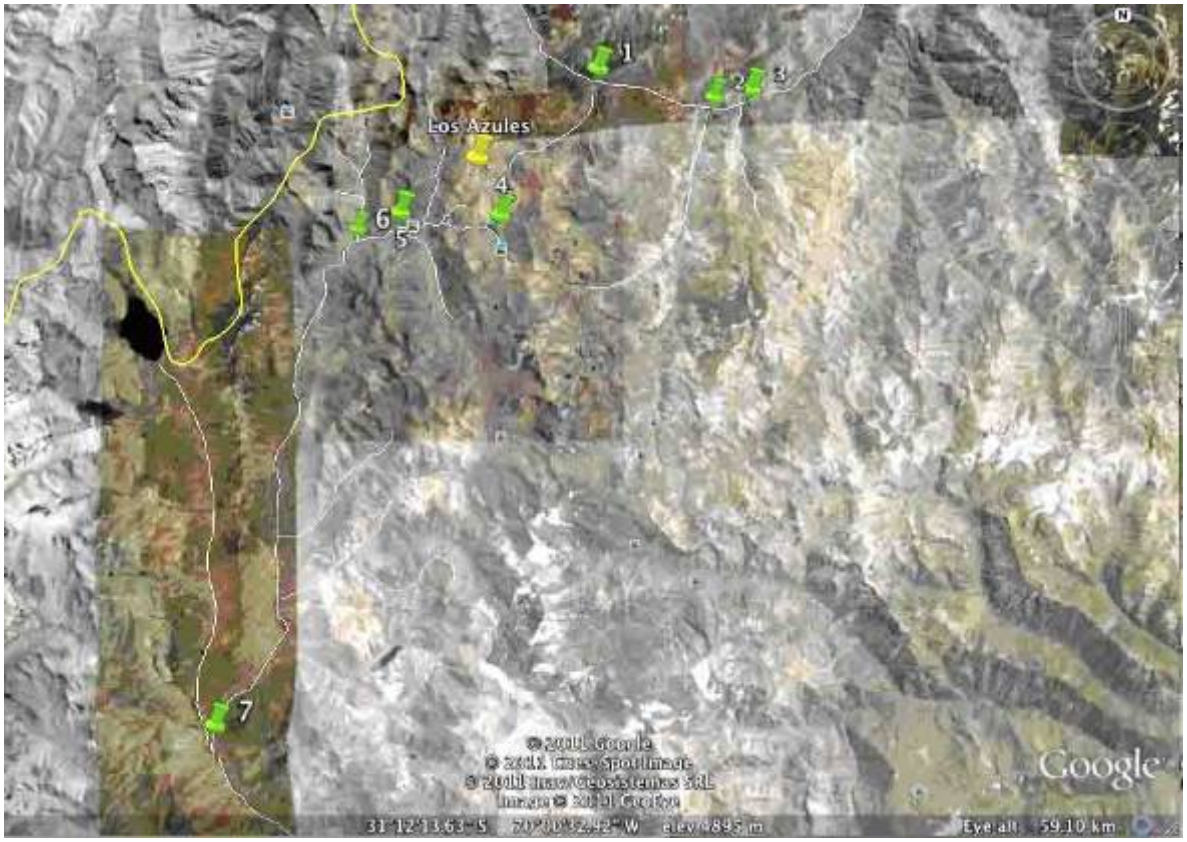
water. Understanding the physical relationship between these glacier resources, and life and ecosystems downstream, is a fundamental necessity of our modern society, and is especially important to this region of the world.

The Los Azules project is situated at the western end of the San Juan river basin, approximately 250 kilometers west of the provincial capital of the same name, and approximately 3 kilometers due east of the Chilean border. The area where the project is located, despite its arid and high altitude is rich in water resources such as nascent streams, this is largely thanks to climate conditions as well as to the presence of various cryogenic forms such as seasonal snow, rock glaciers and permafrost.

The area of the project is drained by tributaries of two river basins. The first, and most significant waterway for the project is the *Embarrada River* (the Muddy River). And the second one is the *Rio Valle Hermoso* (Beautiful Valley River) located in the northern area of the project.

Below is an image taken from *Google Earth* which shows the key points of confluence between the streams and rivers as well as a general relationship to the Los Azules project area. The GPS view location of Los Azules central project area is at:

31° 4'8.46"S 70°14'23.82"W.



In this image, the green land marks numbered 1 to 7 locate the river confluence points of the main waterways in the project area.

1	Rio Cortez joins Rio Valle Hermoso	31° 1'22.26"S 70°10'15.76"W
2	Rio Cerrado joins Rio Valle Hermoso	31° 2'6.77"S 70° 6'12.15"W
3	Rio Colorado joins Rio Valle Hermoso	31° 1'56.41"S 70° 4'56.08"W
4	Rio La Totora joins Rio La Embarrada	31° 5'47.81"S 70°13'34.46"W
5	Rio Frio joins Rio La Embarrada	31° 5'42.45"S 70°17'1.38"W
6	Rio La Embarrada joins Rio Salinas	31° 6'6.04"S 70°18'26.96"W
7	Rio Salinas joins Rio de las Lagunas	31°20'53.43"S 70°23'26.87"W

More than 200 rock glaciers and an extensive permafrost contribute water discharge to the *Río Embarrada* and the northern area basin of *Rio Valle Hermoso*, before they join their corresponding main river downstream. See the image below which maps the many rock glaciers in the project vicinity.

The *Embarrada* river receives water from many permanent and temporary streams which flourish in the area, from vegas (wetlands), lagoons, and other cryogenic forms (rock glaciers and permafrost). The principal tributaries of the *Embarrada* river are the *Arroyo de la Totora* (the Totora Stream), and the *Río Frío* (the Cold River). The *Embarrada* is subsequently an affluent of the *Río Salinas* (the Salinas River), and belongs to the *Río Blanco/Río Salinas Sub Basin*. As is clearly visible in the above image (land mark: Confluencia Rio La Embarrada/Salinas), the *Embarrada* river feeds the larger *Salinas* river at the following geographical point, which we can see on Google Earth: [31 06 05.25 S, 70 18 19.92 W]. 90 kilometers downstream, and after being renamed as more tributaries join the river course, the water discharge from Los Azules nascents takes in the *Rio de Los Patos* at [31°53'39.96" S 69°41'39.18" W].

Shortly afterwards, the Calingasta Valley opens up before the *Río de Los Patos* (see picture below), with rich agricultural lands, and several towns along the river's banks, with an approximate population of some 10,000 inhabitants. These communities depend on the waters of the *Embarrada*, the *Salinas*, *Rio Blanco and Rio de los Patos* rivers for their human consumption and livelihoods.

The image above shows the Calingasta Valley with the towns of Calingasta, La Isla, Tamberias, Barreal and Villa Pituil along the Rio de los Patos banks.

While most project exploration activity takes place in the *La Embarrada* river basin, the north-easternmost area of the project is located in the *Castaño* River Basin, which includes the *Valle Hermoso*, and its tributaries: *Cortez*, *Cerrado*, and *Colorado* rivers. At the geographical point [31 02 06.88 S,70 06 06.52 W] the *Valle Hermoso* river is renamed into *Rio Atutia*.

The *Rio Atutia* runs 94 kilometers though Calingasta's northern area, being renamed into *Rio Castaño*, one of the most important water resources of the province, as it is the principal affluent of the northern San Juan River Basin.

The *Castaño* river and the *Los Patos* river, are the two principal affluents of the *Río San Juan* [at: 16 21.03 S, 69 24 47.42 W].

Both the *Embarrada* and the *Valle Hermoso* rivers are key tributaries of the other rivers that flow through the arid terrain of the high mountains of San Juan. They flow through the area's valleys in the high and mid Andes, taking in water from rivers and streams in the area, many of which are temporary. The river's intake regime from the *Castaño* and *Salinas* rivers, is primarily from snow fall, and as such, its highest flow volumes are in the spring and summer (from November to February), as the snow melts following the cold winter months. This flow might increase slightly with additional summer rains, at the foothills of the Andes mountain range.

We have little or no information about the seasonal variation of river discharge rates, for the streams and rivers affected by Los Azules. Of particular concern are moments when flow rates are reduced due to drought, for example, which is when rock glaciers and permafrost play a much more significant role in determining overall river discharges. What we *do* know is that water discharge varies considerably across seasons as well as from year to year. We also know that rock glaciers and permafrost terrain provide their largest contribution during the late summer months (see for example, Burger 1999).

We should also note that neither environmental impact report offers any information concerning the impacts of the project on river discharges of the rivers in terms of communities downstream, nor is there any consideration of cumulative impacts that might occur due to other mining projects such as El Pachón, El Altar, Casposo (which is already producing) and other mining projects planned for the area.

As we mentioned earlier, other mining projects will also be affecting these specific streams and rivers, and many of these will impact similar rock glaciers and permafrost zones or will contaminate these rivers in their extractive processes, generating a dangerous cumulative impact. Some of these include:

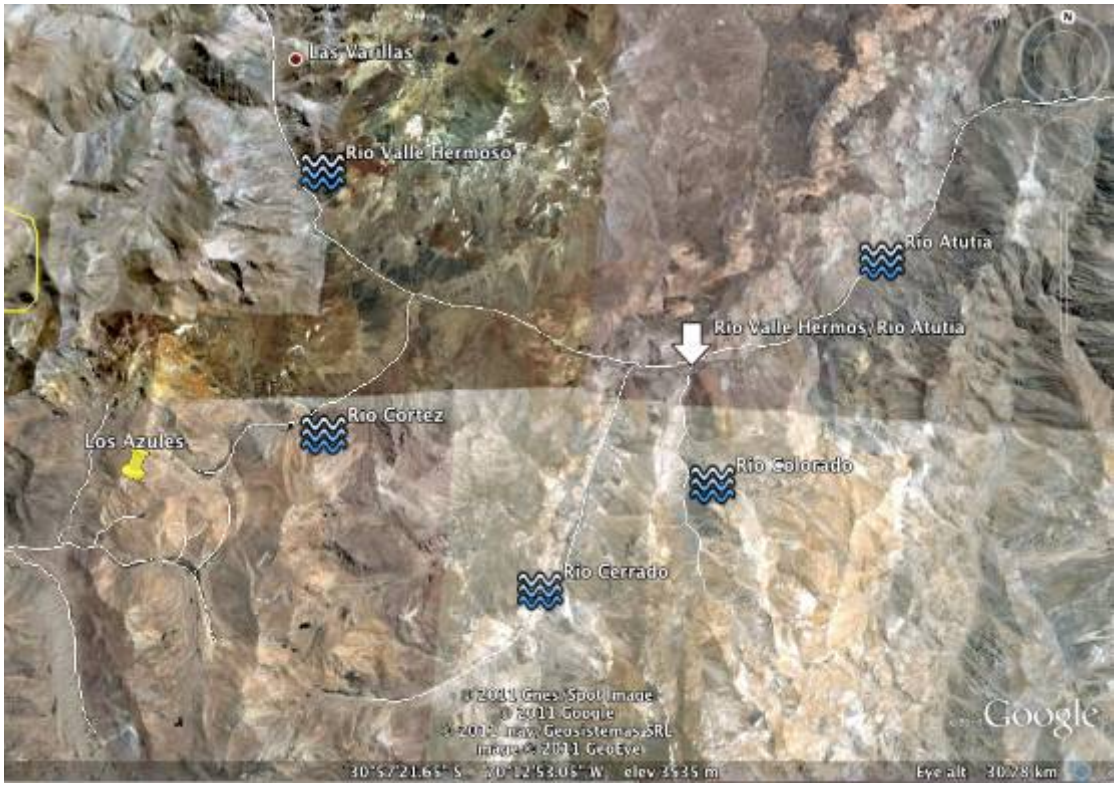
Casposo (58.56km away from Los Azules. owned by Troy Resources GPS: 31°12'30.08"S 69°37'44.59"W),

El Pachón (76.66km away from Los Azules. owned by Xstrata GPS: 31°45'8.96"S 70°26'3.37"W)

El Altar (50,74km away from Los Azules. of StillWater GPS: 31°29'10.18"S 70°28'55.36"W)

El Tapau, (68km away from Los Azules. owned by TNR Goldcorp GPS: 30 47 55.39 S, 69 36 03.67 W)

San Francisco (63,25 km away from Los Azules. explored by Petragold GPS: 30°38'59.69"S, 69°51'17.89"W)



The river discharge rates we were able to obtain are as follows: (more information is provided in www.hidricosargentina.gov.ar)

Rio Salinas/ Rio Blanco River Basins

Rio Frio N/A
Rio de la Totora N/A
Rio La Embarrada N/A
Rio Salinas N/A
Rio Blanco 5-20m3/sec23,24,25
Rio de los Patos 49m3/sec26,27
Rio San Juan 53-56m3/sec28,29

Rio Valle Hermoso/ Rio Atutia River Basins

Rio Valle Hermoso N/A
Rio Cerrado N/A
Rio Colorado N/A
Rio Atutia N/A
Rio Castaño Viejo 13 m^3/sec
Rio San Juan 53-56m3/sec28,29

Below are select images of the rivers and streams in the Los Azules project area and zone of impact.

Vegas at Los Azules (Informe de Impacto Ambiental, Etapa de Exploración, Junio 2010)

Below are several images of the various rivers in the project area.

Lagoon on Rio Santa Cruz: 31°41'33.95" S 70°17'25.58" W

Rio Blanco (by Richi Bruner): 31°53'40.28" S 69°49'44.66" W

Rio de los Patos (near Barreal): 31°49'23.94" S 69°36'00.81" W

Rio de los Patos (by Nan-CBA) at: 31°35'41.75" S 69°28'21.68" W

Rio de los Patos (by J.Carosio) 31°39'19.93" S 69°29'09.11" W

Rio San Juan (Near Calingasta) at: 31°16'47.42" S 69°24'22.95" W

We know that the rivers and streams of the region provide critical water supply to the local population, to regional agriculture and to industry, even if these population centers may be many kilometers away from the project area. It is for this reason that the recently passed national and provincial glacier protection laws make specific references to glaciers and permafrost areas as freshwater regulators.

While it is difficult to ascertain exactly how much water a rock glacier or permafrost zone provide to local rivers, we know that this contribution is significant and that it is especially important in extraordinarily dry years. Juan Pablo Milana, a very experienced glacier specialist in San Juan, and extremely knowledgeable about glaciers in the province, has noted that in especially dry years, glaciers in San Juan and Mendoza provide up to 80% of river water.

As Brenning states in his response to Arenson and Jakob (2010), we can use this information to draw some preliminary conclusions as to the eventual water content of the Los Azules rock glaciers:

> "The volumetric ice content of rock glaciers is known to vary strongly within a rock glacier and between individual rock glaciers, … . For regional scale estimation as in Azocar and Brenning (2010), however, only the average ice content of an entire rock glacier population can be of relevance. The average volumetric ice content of rock glaciers is widely accepted to vary between approximately 40 per cent and 70 percent, as assumed by Azocar and Brenning (2010) in their discussion of uncertainties (Barsch, 1996: 40-60%; Burger et.al. 1999: 50-70%) This is consistent with field data from different climate regions worldwide (Haeberli et.al 2006); see also Croce and Milana, 2002, Milana and Guell, 2008). If these local measurements are summarized by calculating the median values of the lower and upper bound of ice content of 47 percent and a median upper bound of 70 percent are obtained."[50]

With the arrival of dozens and dozens of new large-scale mining projects to the region, we must ensure above all, a rational approach to managing water resources. While a single project like Los Azules may not have a devastating impact on the water discharge and water quality of the San Juan River, when we take the collective impacts of projects like Los Azules, El Pachón, Casposo, El Altar, Del Carmen, Vanesa, and several others that are underway in the region, the impacts of avoiding glacier considerations could be devastating.

[50] Alexander Brenning. Short Communication. The Significance of Rock Glaciers in the Dry Andes – Reply to L. Arenson and M.Jacob. Permafrost and Periglacial Processes. Permafrost and Periglac. Process. 21: 286-288 (2010). Published online in Wiley Online Library (wilelyonlinelibrary.com) DOI: 10.1002/ppp.702

Cities and Towns near the Los Azules Project Area

An aerial view of the Los Azules Project site, reveals several towns near to the project. Our main concern of this proximity, in relation to the potential impacts to rock glaciers and permafrost, is to what extent cumulative reductions to river discharge may begin to affect water availability for human consumption and/or crop yields in downstream communities. In terms of agricultural impacts, the risks are of special concern for smaller agricultural projects which may not have the means by which to obtain water except from small rivers and streams.

The main towns in the project vicinity belong to the Department of Calingasta, which has approximately 10,000 inhabitants living year round and with activities in agriculture (fruits, legumes, etc.), tourisms, etc. A recent news article in a local mining newspaper revealed that Xstrata Copper intends to promote the establishment of a new “mining town” in the Calingasta Valley.[51] This project stems from the anticipated influx of people to the region to meet the human resources and consumption demands of the many mining projects that are appearing in the area and which will continue to place human resource demands on the region for at least the next 30 years. The idea is to transform season labor migration which occurs in the summer months for mining related activities, to permanent settlements. The project envisions the building of neighborhoods, hotels, commercial outlets, hospitals, schools, and accompanying infrastructure. This could substantially increase the permanent population in the area as well as the water needs for the burgeoning population.

City	Population	Distance to Project in Straight Line	Coordinate
Barreal	3202	93,6 km	31°37'57.33"S 69°27'59.97"W
Tamberias	860	87,7 km	31°28'5.19"S 69°25'0.05"W
Calingasta	2039	81 km	31°19'5.91"S 69°25'25.34"W

[51] See: El Inversor. Año 5, Nro. 60 Sept 2011, p.13,

City	Population	Distance to Project in Straight Line	Coordinate
La Isla	< 400	85 km	31°23'1.02"S 69°23'58.78"W
Villa Pituil	820	95 km	31°38'57.46"S 69°28'10.63"W
Hilario	< 400	90 km	31°28'59.78"S 69°23'58.09"W
Barrialito	N/A	73,4 km	31°21'45.16"S 69°31'32.92"W
San Juan	421640	169 km	31°31'31.55"S 68°31'0.49"W
Sorocayense	50	90,4 km	31°32'55.22"S 69°26'37.65"W
Bella Vista	N/A	75 km	31° 9'2.43"S 69°26'58.35"W
Puchuzun	N/A	72 km	31° 7'59.03"S 69°28'0.35"W
Villa Nueva	N/A	67 km	31° 4'30.62"S 69°30'7.07"W
Castaño Nuevo	N/A	69 km	31° 2'0.44"S 69°33'2.01"W

Barreal [31°37′60″S 69°28′00″W]

Barreal at the Foot of the Andes

is the first important human settlement downstream from the project site. At just over 90 km distance (measured as the crow would fly), with a population of 3202, is a agricultural and tourist driven locality. The town is located in the center of the Calingasta Department. The *Rio de los Patos* runs through the middle of the town area. In one European tourist guidebook it was cited as one of the most beautiful places in all of Argentina. With abundant water deriving from glacier melt, tourists visit Barreal for water sports such as Rafting and Kayaking.

Villa Pituil [31°38′60″S 69°28′00″W], A small town near Barreal, has approximately 820 inhabitants. It's located about 95km as the crow flies from Los Azules.

Agricultural Lands at Tamberias

Tamberías [31°27′29″S 69°25′20″W], population 860 is a town at the head of the Calingasta Department 86 kms from Los Azules. Tamberías is experiencing a significant population increase over recent years, largely driven by tourism. It is an agricultural center of the Calingasta valley. It has a significant number of small hotels/hostels.

Calingasta [31°19'34.61" S 69°25'36.44" W] population 2039 is on the *Río de los Patos*, and near the birth of the Río San Juan and at just 79km from Los Azules, is an agricultural hub for the region, and caters strongly to tourism.

Agricultural Lands in Calingasta Valley (by Ilfocall)

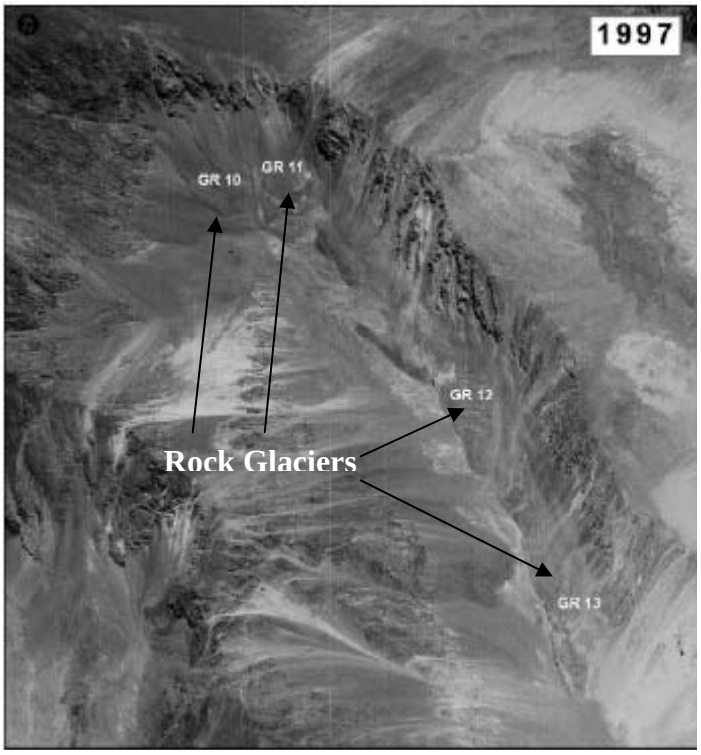
City of Calingasta. By Omar Gobbi 31°20'08.20" S 69°25'08.72" W

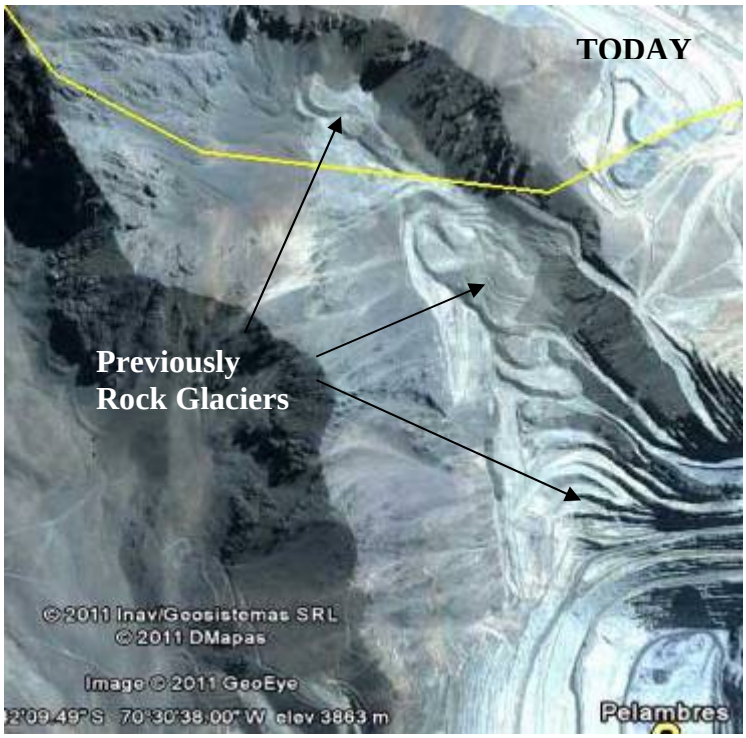
La Isla, Colón, and Hilario, Castaño Viejo, Bella Vista, Villa Nueva, Puchuzún, Sorocoyense and Barrialito are small settlements of less than 400 inhabitants each located in the general vicinity along the rivers or near the above listed towns.

Single family homes are found at Estancia del Río Blanco, Las Hornillas, Casa Amarilla and Alvarez Condarco.

Impacts to Glaciers at Nearby Los Pelambres Project

As an example of what might happen to rock glaciers at the Los Azules mining project site, we can look across the border at a very similar project, Los Pelambres (Luksic) , which is located 70 km south from Los Azules, in a similar area and mountain range, literally just over the top edge of the border mountain from El Pachón. Azócar and Brenning (2008) studied Los Pelambres examining rock glacier impacts of mining operations. The authors published the following 1997 image of a portion of the mine site adjacent to the border. We can compare this image to the image available from Google Earth today, showing extensive mining intervention to the rock glaciers.





Azocar and Brenning (2010) enumerate many types of impacts caused by mining to rock glaciers, and point to projects such as Barrick's Pascua Lama which will "bury a rock glacier under a waste rock pile" at the Barrick project site. Other cases have been documented, such as in *Los Bronces* and *División Andina* where glaciers are accelerating due to waste deposited on their surface. One of the key issues pointed out by the authors are the waste deposits generated by Los Pelambres (Luksic), many of which are on rock glaciers. The added weight (in the billions of tons) exerts enormous pressure on the rock glacier structure, which may ultimately lead to its acceleration and even collapse. According to Minera Andes' document, Los Azules will have similar sterile waste piles located in areas where there are rock glaciers and possibly also permafrost zones, which could hence lead to the same sorts of impacts on rock glaciers as in the Los Pelambres project.

Environmental impact studies in the Los Pelambres (Luksic) project do not mention the presence of rock glaciers, nor is there any information about potential impacts of mining activity on this ice. (Azócar & Brenning, 2008, p. 5)

Further, as in the Los Azules case, the second risk posed to the rock glaciers mentioned by the authors is the modification of the terrain in order to introduce access roads to the mine site (p.5). This modifies the glaciers' drainage system through the introduction of water deviation in order to better maintain the roads.

A recent article by Ahumada, Palacios and Paez, draws attention to the impacts to rock glaciers in Salta and Jujuy provinces of Argentina, from road introduction and road maintenance work.[52]

Azócar and Brenning alert of the near total disappearance of at least 4 rock glaciers due to waste deposits on these glaciers. These glaciers are very similar in characteristics to the rock glaciers found in the Los Azules project area.

Azocar & Brenning (2008) estimate that the volumetric content of ice at 40-60% and an ice-rich permafrost content of approximately 20m, with an ice density of 0.9 g cm3.[53]

In the case of the Chilean Los Pelambres project, the authors cite that the project owners failed to mention the presence of glaciers and later even denied their existence, although they clearly knew of their presence, since the mine owners contracted out studies from glacier specialists. However, the information stemming from these studies was not informed to the permitting authority in Chile, and as such, there is no approval for the project in regards to glacier impacts. This failure to inform or minimize glacier relevance at mining sites is typical of mining projects in the area, and very systematic of projects in the Andean regions of San Juan.

We know in the case of Los Azules, the same situation holds. Minera Andes makes no mention of glaciers in the Environmental Impact Assessments, and subsequently there is no mention or treatment of these in the permitting process. Nor do we know of any protocols or mitigating actions by the company to repair damages to rock glaciers or periglacial environments at Los Azules. Finally, the more recent statements on McEwen Mining's website indicating erroneously and misleadingly that there are no *ice glaciers* at the project site, further raise concern that ice resources are being completely ignored.

[52] See: http://www.cedha.org.ar/contenidos/ahumada-palacios-paez-caminos%20-%20punena.pdf
[53] See: Azócar & Brenning, p.7

What the National Law Says About Mining Impacts to Rock Glaciers and Permafrost

The recently enacted National Argentine Glacier Protection Act[54] clearly states in Article 6 that that mining as well as exploration activities for mining **is prohibited** where there are glaciers, rock glaciers or periglacial environments.

> **Art. 6º –** Prohibited Activities
> All activities that could affect the natural condition or the functions listed in Article 1, that could imply their destruction or dislocation or interfere with their advance, are prohibited on glaciers, in particular the following: *(unofficial translation)*
>
> a) The release, dispersion or deposition of contaminating substances or elements, chemical products or residues of any nature or volume. Included in these restrictions are those that occur in the periglacial environment;
> b) The construction of works or infrastructure with the exception of those necessary for scientific research and to prevent risks;
> **c) Mining and hydrocarbon exploration and exploitation. Included in this restriction are those that take place in the periglacial environment;**
> **[bold added]**
> d) The installation of industries or the building of works or industrial activity.

Los Azules' decision to extract minerals at a pit site with glaciers or periglacial environments in the site is illegal. So is the deposit of waste tailings onto glaciers as is presently projected.

Further, the law states in Article 15 (giving retroactive applicability to the law) that:

> The activities described in Article 6, in progress at the moment of the sanctioning of the present law, must, in a period of no more than 180 days from the promulgation of this law, submit to an environmental audit in which potential and actual environmental impacts to glaciers are identified and quantified. In the case of verification of negative impacts to glaciers or the periglacial environment, contemplated in Article 2, the authorities shall order the pertinent measures so that the present law is complied with, and could order the ceasing or relocation of the activity and protective measures, cleaning and restoration as appropriate.

Even San Juan's provincial glacier protection law prohibits activities at the Los Azules site if it is deemed to destroy glaciers, rock glaciers or periglacial environment environments. The provincial law says:

> **Article 6º.-**Prohibition. All activity that implies the destruction or movement of glaciers in the provincial inventory or that interferes in its advancement, affecting its functions cited in Article 1, all of which shall be determined by the corresponding environmental evaluation as mentioned in Article 7, is hereby prohibited. *(unofficial translation)*

Hence, the pit area as well as tailing deposit sites of Los Azules are illegal according to San Juan's provincial glacier protection law.

[54] See: http://www.cedha.org.ar/documents/Argentine%20National%20Glacier%20Act%20-%20Final%20Document.pdf

Reactions of the Provincial Government of San Juan to Glacier Impacts of Los Azules?

On July 12 2010, the Province of San Juan passed the Provincial Glacier Protection Law. Under Article 7 of the Provincial Glacier Law, all activities that might impact glaciers are subject to an Environmental Impact Assessment [of glacier impacts] that should include:

> A) Identification and characterization of glaciers (an inventory), according to the following:
>
> 1. Water Basin pertinence
> 2. Location coordinates
> 3. Dimensions (length, width, thickness, surface area, and volume)
> 4. Geomorphological classification
> 5. Geological specificity of the site
> 6. Climate parameters including radiation, temperatures, precipitation, winds, atmospheric pressure, and evaporation
> 7. Hydrological parameters (superficial, subterranean, flow, infiltration)
> 8. Water quality
> 9. Biological surroundings
> 10. Risks due to geological events and movement
>
> B) Potential impacts due to works or programmed activities
>
> C) Where applicable, an Environmental Management Plan

On the 24th of November, 2010, the Ministry of Mining of the Province of San Juan approved the Environmental Impact Report of the Exploratory Phase of Los Azules. In this five page resolution (Expte.1100-0162-A-10)[55], the Ministry notes to the company that the EIA is missing information on glacier impacts. The advertisement, point 15 (on page 3), is as follows:

> "the company shall respond by end of the 2010-2011 season (May 2011) on:
>
> a. The existence of uncovered or covered glaciers in the project area;
> b. The existence of rock glaciers in the project area;
> c. Altitude at which there is permafrost in the project area;
> d. Relationship of the glacier bodies to the Superficial and Subterranean Hydrological system;
> e. Impacts of exploratory work on the geoforms previously mentioned;

On March 3, 2011, CEDHA requested to the Ministry of Mining of San Juan, information concerning the provincial approval of the Los Azules (Minera Andes) and the El Pachón (Xstrata Copper) projects. We received a partial answer to this request on April 11, 2011, directing us to the provincial official mining website.

On August 19, 2011, CEDHA resubmitted an information request to the provincial government, specifically asking if Minera Andes has complied with the glacier impact information requested

[55] See government resolution in 5 jpg pages (particularly pp. 3 and 4):
p. 1: http://wp.cedha.net/wp-content/uploads/2011/10/resolucion-Expte.1100-0162-A-10-p.1-small.jpg
p. 2: http://wp.cedha.net/wp-content/uploads/2011/10/resolucion-Expte.1100-0162-A-10-p.2-small.jpg
p. 3: http://wp.cedha.net/wp-content/uploads/2011/10/resolucion-Expte.1100-0162-A-10-p.3-small.jpg
p. 4: http://wp.cedha.net/wp-content/uploads/2011/10/resolucion-Expte.1100-0162-A-10-p.4-small.jpg
p. 5: http://wp.cedha.net/wp-content/uploads/2011/10/resolucion-Expte.1100-0162-A-10-p.5-small.jpg

by the government to the company, as stated in above in the resolution. We have yet to receive a reply from the government concerning this request.

CEDHA once again approached the Ministry of Mining in San Juan, vía telephone in April of 2012, just before publishing this report. We spoke on this occasion with the Ms. Gimbernat, the person responsible for legal issues in the Ministry. We politely recalled and insisted to Ms. Gimbernat that her office was mandated by law to provide our organization with the information that we requested, and that the office under her leadership was failing to comply with national laws of access to information. Seemingly frustrated with our persistence, she lost her composure, began to yell at our representative, and hung up the phone indicating she would no longer speak to us. We were thus unable to obtain any information from the State agency regarding the documentation that Minera Andes should have presented to the government regarding glacier presence and impact, nor do we know whether or not the government has accepted and approved such documentation from Minera Andes.

As there is no evidence that Minera Andes has provided information about impacts to glaciers, and that the existing and publicly available EIAs do not contain any references to glaciers, we can only presume that Minera Andes is in violation with both the National and the Provincial Glacier Protection Laws.

What to do about McEwen Mining's Glacier Impacts at Los Azules

First and foremost, *all activity at Los Azules, including exploratory work, project preparation, or any other activity* ***should immediately cease*** *until past, present and future impacts to rock glaciers and periglacial environments of any mining activity at the Los Azules site can be determined.*

Second, McEwen Mining must immediately produce a Glacier Impact Assessment, of past, present and future activity, as mandated by Argentine federal law as well as San Juan's provincial law.

Third, all past impacts to rock glaciers and to periglacial environments caused by Los Azules mining project should be repaired (including existing roads affecting rock glaciers or periglacial environments), and the glacier eco-systems (glaciosystems[56]) restored as best possible to their original state, prior to any mining or other anthropogenic intervention.

Fourth, McEwen Mining should publicly establish and communicate what procedures it will use in any future mining activity at Los Azules or other sites where glaciers, rock glaciers, or periglacial environments exist near operations and where any of its mining activities might potentially impact any type of glaciers, uncovered glaciers, rock glaciers, periglacial environment (permafrost), etc. This would include reconsideration of pit location and/or contours, excavation, relocation of mineral tailings waste deposit sites, infrastructure or other elements related to the project, as well as any other modifications to glacial formations and glaciosystems which might impact existing glaciers or periglacial environments.

Fifth, McEwen Mining should be absolutely transparent and share all information about its mining operations taking place in glacier territory, and any past, present or future studies on glacier impacts, including relative to operations anywhere in Argentina (San Juan, or other provinces), Chile and any other countries where it may have operations in areas with the presence of glaciers and rock glaciers or in periglacial environments. Delegating communication dissemination to a government authority that restricts public access to information, as in the case of San Juan, does not suffice.

[56] For a definition of "glaciosystems" to to the following link

Sixth, we encourage McEwen Mining to consider participating, drafting or authoring (with the collaboration of other actors) a Protocol for Mining Activities in Glacier Territory.

Finally, McEwen Mining should correct the false and misleading statement on its website indicating that there are no ice glaciers at the Los Azules site.

About the Authors

Jorge Daniel Taillant has over 15 years of experience in issues related to International Development Finance, Human Rights, Environment and Corporate Accountability. He founded CEDHA in 1999 to promote greater environmental and human rights protection, including efforts to achieve greater corporate responsibility and compliance of social and environmental norms. In 2007, CEDHA received the *Earth Care Award*, the Sierra Club's most distinguished international advocacy award for the promotion of Corporate Accountability and Human Rights. In 2006-2007 Taillant served as the Chief Strategic Advisor to the Secretary of Environment of Argentina, assisting in the design and launch of a strong push to bring contaminating industries into compliance with local and international norms, which included the creation and training of a new enforcement team at the national level, reviewing corporate and multi-jurisdictional state responsibilities in the protection of the environment. In 2008, the Argentine Congress unanimously passed a National Glacier Protection Act. That law was vetoed by the Argentine President in response to strong lobby from the mining sector. Taillant engaged directly with the Congress in 2009-2010 to help bring back the glacier law, which was reinstated in 2010, with even stricter protective measures for glaciers, including a ban on mining in glacier areas. Taillant now leads CEDHA's Mining, Environment and Human Rights Program, and is now carrying out a glacier and mining inventory and mapping with a view to draw attention to mining impacts on glaciers, rock glaciers and periglacial environments. This report is the forth produced by CEDHA in a series on "mining and glaciers" in Argentina.

Alejandro Vera. A native of San Juan Province, is Assistant Coordinator of CEDHA's Mining, Environment and Human Rights Program. He is a legal degree candidate of the National University of Córdoba's Law School. His work at CEDHA includes participation in CEDHA's Human Rights and Environment Legal Clinic. He has been active in forestry protection coordinating activities of the commission created to channel civil society's input into the recently regulated provincial adoption of the national forestry law. Alejandro is one of CEDHA's principle liaisons with the National Congress and with provincial legislatures, and was key in communications with Congress on the reintroduction, debate and vote of the recently enacted National Glacier Protection Act.

Scientific Contributors

Dr. Alexander Brenning has been conducting research on rock glaciers in the Andes since 2002, first as part of his doctoral research at Humboldt-Universität zu Berlin, which he finished in 2005, and since 2007 as an Assistant Professor at the Department of Geography and Environmental Management of the University of Waterloo, Ontario. Canada. Dr. Brenning has directed several publicly funded research projects and research collaborations related to rock glaciers, mountain permafrost, and mass movements, using remote sensing data, field instruments for monitoring, and spatial distribution models. He directed most recently a project on rock glacier dynamics, which was funded by the Dirección General de Aguas of Chile and hosted by Pontificia Universidad Católica de Chile, where Dr. Brenning is a Visiting Professor.

Mateo Martini
Mateo Martini is a Geologist and fellow of the National Council of Scientific and Technical Research (CONICET) in Argentina. He is a member of the *Centro de Investigaciones en Ciencias de la Tierra* (CICTERRA) at the National University of Córdoba, where he is studying his Ph.D. His Doctoral Thesis focuses on glaciations in the northern arid regions of Argentina, during the Quaternary Period including the study of periglacial environments and rock glaciers. He has also conducted research of periglacial environments and rock glaciers in the Antarctic region.

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Proyecto “relevamiento inicial de los glaciares de san juan” Universidad de San Juan

ANNEX:

Glacier Inventory in the Los Azules Project Area

The reader can download a Google Earth ".kmz" file to view all of these glaciers.

http://wp.cedha.net/wp-content/uploads/2011/10/Los-Azules-Glacier-Polygons-Only.zip

Glacier Inventory - Los Azules Area (Minera Andes-McEwen Mining)

(al 12 de Octubre 2011)

Color Coding	***79***	**Blue:**	**In the Project Area**
	49	**Magenta:**	**Outside Area but near/on Access Roads**
	98	**Green:**	**In the General Area outside Project**
Total de Glaciares	***226***		

#	Glacier Name	Type	Coordinates	Altitude (meters)
1	Glaciar R 312-7014	Rock	31 2 59.46 S, 70 14 53.12 W	3745-3950
2	Glaciar R 312-7015	Rock	31 2 45.07 S, 70 15 37.61 W	3827-3950
3	Glaciar R 312-7015 (b)	Rock	31 2 46.08 S, 70 15 52.75 W	3850-4040
4	Glaciar R 312-7015 (c)	Rock	31 2 59.24 S, 70 15 10.17 W	3795-3850
5	Glaciar R 312-7015 (d)	Rock	31 2 54.58 S, 70 15 21.39 W	3815-3850
6	Glaciar R 312-7015 (e)	Rock	31 2 41.82 S, 70 15 29.14 W	3860-3925
7	Glaciar R 312-7016	Rock	31 2 54.07 S, 70 16 15.12 W	3960-4010
8	Glaciar R 312-7018	Rock	31 2 41.37 S, 70 18 49.50 W	3760-3800
9	Glaciar R 312-7019	Rock	31 2 42.05 S, 70 19 2.56 W	3800-3840
10	Glaciar R 313-7014	Rock	31 3 36.74 S, 70 14 16.97 W	3640-3960
11	Glaciar R 313-7014 (b)	Rock	31 3 52.99 S, 70 14 3.49 W	3720-3900
12	Glaciar R 313-7014 (d)	Rock	31 3 36.19 S, 70 14 23.68 W	3820-3950
13	Glaciar R 313-7014 (e)	Rock	31 3 10.49 S, 70 14 55.34 W	3730-3915
14	Glaciar R 313-7016	Rock	31 3 28.20 S, 70 16 15.01 W	3860-3940
15	Glaciar R 313-7016 (b)	Rock	31 3 25.72 S, 70 16 26.66 W	3940-4015
16	Glaciar R 313-7016 (c)	Rock	31 3 36.10 S, 70 16 38.01 W	3905-3970
17	Glaciar R 313-7016 (d)	Rock	31 3 7.12 S, 70 16 8.21 W	3870-4000
18	Glaciar R 313-7016 (e)	Rock	31 3 22.32 S, 70 16 9.16 W	3900-3990
19	Glaciar R 313-7016 (f)	Rock	31 3 36.05 S. 70 16 37.77 W	3905-3970
20	Glaciar R 313-7018	Rock	31 3 16.95 S, 70 18 50.36 W	3740-3780
21	Glaciar R 314-7011	Rock	31 4 36.43 S, 70 11 16.08 W	4000-4050
22	Glaciar R 314-7011 (b)	Rock	31 4 44.70 S, 70 11 7.24 W	4030-4090
23	Glaciar R 314-7011 (c)	Rock	31 4 53.07 S, 70 11 14.29 W	4030-4155
24	Glaciar R 314-7014	Rock	31 4 3.69 S, 70 14 23.82 W	3775-3862
25	Glaciar R 314-7014 (d)	Rock	31 4 30.27 S, 70 14 37.27 W	3920-4060
26	Glaciar R 314-7014 (e)	Rock	31 4 36.17 S, 70 14 39.45 W	3900-3980
27	Glaciar R 314-7016	Rock	31 4 18.73 S, 70 16 40.27 W	3870-3960
28	Glaciar R 314-7017	Rock	31 4 28.32 S, 70 17 14.15 W	3790-4000
29	Glaciar R 314-7019	Rock	31 4 1.85 S, 70 19 16.79 W	3755-3830
30	Glaciar R 314-7019 (b)	Rock	31 4 27.80 S, 70 19 47.60 W	3790-3850
31	Glaciar R 314-7019 (c)	Rock	31 4 31.06 S, 70 19 3.55 W	3640-3700
32	Glaciar R 314-7019 (d)	Rock	31 4 25.27 S, 70 19 43.59 W	3795-3860

33	Glaciar R 314-7019 (e)	Rock	31 4 26.09 S, 70 19 43.67 W	3805-3860
34	Glaciar R 314-7020	Rock	31 4 48.15 S, 70 20 37.21 W	3890-3990
35	Glaciar R 315-7010	Rock	31 5 28.84 S, 70 10 48.64 W	3830-3890
36	Glaciar R 315-7010 (b)	Rock	31 5 32.49 S, 70 10 42.88 W	3800-3860
37	Glaciar R 315-7011	Rock	31 5 21.63 S, 70 11 23.40 W	3780-4000
38	Glaciar R 315-7011 (b)	Rock	31 5 22.07 S, 70 11 0.59 W	3880-3900
39	Glaciar R 315-7011 (c)	Rock	31 5 28.96 S, 70 11 21.01 W	3920-3980
40	Glaciar R 315-7011 (d)	Rock	31 5 33.43 S, 70 11 10.18 W	3860-3945
41	Glaciar R 315-7012	Rock	31 5 3.09 S, 70 12 43.63 W	3660-3825
42	Glaciar R 315-7017	Rock	31 5 18.69 S, 70 17 23.67 W	3590-3780
43	Glaciar R 315-7018	Rock	31 40.82 S, 70 18 58.12 W	3540-3680
44	Glaciar R 315-7019 (b)	Rock	31 5 26.26 S, 70 19 2.92 W	3535-3840
45	Glaciar R 315-7019 (c)	Rock	31 5 51.44 S, 70 19 16.41 W	3660-3760
46	Glaciar R 315-7019 (e)	Rock	31 5 42.23 S, 70 19 41.50 W	3900-3985
47	Glaciar R 315-7019 (f)	Rock	31 5 42.64 S, 70 19 23.77 W	3730-3845
48	Glaciar R 315-7019 (g)	Rock	31 5 42.53 S, 70 19 24.15 W	3730-3850
49	Glaciar R 315-7020	Rock	31 5 31.23 S, 70 20 57.86 W	3810-3930
50	Glaciar R 315-7020 (b)	Rock	31 5 39.10 S, 70 20 42.70 W	3725-3820
51	Glaciar R 316-7010	Rock	31 6 53.59 S, 70 10 23.66 W	3850-3960
52	Glaciar R 316-7011	Rock	31 6 0.03 S, 70 11 17.02 W	3845-3925
53	Glaciar R 316-7011 (b)	Rock	31 6 11.68 S, 70 11 31.54 W	3890-3930
54	Glaciar R 316-7011 (c)	Rock	31 6 24.01 S, 70 11 22.37 W	3910-3970
55	Glaciar R 316-7011 (f)	Rock	31 6 46.01 S, 70 11 47.21 W	3980-4010
56	Glaciar R 316-7011 (g)	Rock	31 6 43.27 S, 70 11 28.02 W	3950-4010
57	Glaciar R 316-7013 (e)	Rock	31 6 59.27 S, 70 13 43.18 W	3860-3920
58	Glaciar R 316-7013 (e)	Rock	31 6 55.28 S, 70 13 39.41 W	3830-3900
59	Glaciar R 316-7014 (b)	Rock	31 6 55.26 S, 70 14 5.87 W	3870-3995
60	Glaciar R 316-7014 (c)	Rock	31 6 19.10 S, 70 14 9.17 W	3860-3910
61	Glaciar R 316-7017	Rock	31 6 54.14 S, 70 17 47.41 W	3980-4130
62	Glaciar R 316-7021	Rock	31 6 20.42 S, 70 21 12.71 W	3720-3845
63	Glaciar R 317-7010	Rock	31 7 7.17 S, 70 10 53.91 W	3790-3910
64	Glaciar R 317-7011	Rock	31 7 32.30 S, 70 11 39.63 W	3860-4015
65	Glaciar R 317-7011 (b)	Rock	31 7 50.70 S, 70 11 28.38 W	3910-4050
66	Glaciar R 317-7011 (e)	Rock	31 7 50.51 S, 70 11 46.04 W	3970-4020
67	Glaciar R 317-7011 (f)	Rock	31 7 39.93 S, 70 11 46.32 W	3970-4080
68	Glaciar R 317-7011 (g)	Rock	31 7 58.25 S, 70 11 39.16 W	3950-4115
69	Glaciar R 317-7011 (h)	Rock	31 7 3.38 S, 70 11 20.42 W	3860-3950
70	Glaciar R 317-7013	Rock	31 7 37.39 S, 70 13 54.21 W	3935-4070
71	Glaciar R 317-7013 (b)	Rock	31 7 2.40 S, 70 13 50.41 W	3895-3940
72	Glaciar R 317-7013 (f)	Rock	31 7 31.37 S, 70 13 43.71 W	3915-3990
73	Glaciar R 317-7013 (g)	Rock	31 7 33.71 S, 70 13 54.67 W	3975-4015
74	Glaciar R 317-7014	Rock	31 7 11.41 S, 70 14 7.79 W	3960-4060
75	Glaciar R 317-7016	Rock	31 7 3.47 S, 70 16 56.00 W	3970-4070
76	Glaciar R 317-7016 (c)	Rock	31 7 28.78 S, 70 16 17.52 W	3770-3920
77	Glaciar R 317-7016 (d)	Rock	31 7 33.14 S, 70 16 45.96 W	3915-3995
78	Glaciar R 317-7017	Rock	31 7 25.32 S, 70 17 40.08 W	4075-4245
79	Glaciar R 317-7017 (b)	Rock	31 7 48.55 S, 70 17 11.33 W	4040-4215
80	Glaciar R 317-7017 (c)	Rock	31 7 52.82 S, 70 17 14.04 W	4075-4260
81	Glaciar R 317-7017 (d)	Rock	31 7 11.15 S, 70 17 32.37 W	4010-4090
82	Glaciar R 317-7017 (e)	Rock	31 7 11.44 S, 70 17 33.49 W	3990-4090
83	Glaciar R 317-7018	Rock	31 7 48.73 S, 70 18 6.92 W	3980-4135
84	Glaciar R 318-7010	Rock	31 8 25.11 S, 70 10 49.16 W	3940-4040
85	Glaciar R 318-7010 (b)	Rock	31 8 35.24 S, 70 10 54.23 W	3950-4150
86	Glaciar R 318-7010 (c)	Rock	31 8 45.10 S, 70 10 49.23 W	3960-4020

87	Glaciar R 318-7010 (d)	Rock	31 8 18.18 S, 70 10 38.44 W	3895-4000
88	Glaciar R 318-7010 (e)	Rock	31 8 10.56 S, 70 10 14.03 W	3850-3920
89	Glaciar R 318-7010 (f)	Rock	31 8 7.84 S, 70 10 3.50 W	3850-3930
90	Glaciar R 318-7010 (g)	Rock	31 8 50.22 S, 70 10 10.62 W	3815-4000
91	Glaciar R 318-7010 (h)	Rock	31 8 53.86 S, 70 10 28.92 W	3920-4090
92	Glaciar R 318-7011	Rock	31 8 54.92 S, 70 11 14.57 W	4100-4260
93	Glaciar R 318-7011 (c)	Rock	31 8 3.07 S, 70 11 1.34 W	4000-4075
94	Glaciar R 318-7013	Rock	31 8 39.36 S, 70 13 1.23 W	4010-4110
95	Glaciar R 318-7013 (b)	Rock	31 8 7.27 S, 70 13 46.10 W	3890-3985
96	Glaciar R 318-7013 (c)	Rock	31 8 54.28 S, 70 13 0.64 W	3930-4045
97	Glaciar R 318-7016	Rock	31 8 58.74 S, 70 16 35.40 W	4100-4200
98	Glaciar R 318-7016 (b)	Rock	31 8 18.83 S, 70 16 48.49 W	3900-4165
99	Glaciar R 318-7016 (c)	Rock	31 8 21.37 S, 70 16 38.26 W	3920-3970
100	Glaciar R 318-7016 (d)	Rock	31 8 20.15 S, 70 16 40.27 W	3920-3970
101	Glaciar R 318-7017	Rock	31 8 4.25 S, 70 17 49.63 W	3925-4025
102	Glaciar R 318-7017 (b)	Rock	31 8 23.69 S, 70 17 11.81 W	4145-4230
103	Glaciar R 318-7017 (c)	Rock	31 8 36.82 S, 70 17 27.25 W	4010-4170
104	Glaciar R 318-7017 (d)	Rock	31 8 51.82 S, 70 17 19.01 W	3940-4050
105	Glaciar R 318-7017 (e)	Rock	31 8 51.95 S, 70 17 27.35 W	3970-4070
106	Glaciar R 318-7017 (f)	Rock	31 8 23.73 S, 70 17 11.53 W	4145-4230
107	Glaciar R 318-7018	Rock	31 8 27.67 S, 70 18 11.72 W	3770-3870
108	Glaciar R 318-7018 (d)	Rock	31 8 59.58 S, 70 18 8.62 W	3800-3980
109	Glaciar R 318-7021	Rock	31 8 34.44 S, 70 21 37.75 W	3725-3985
110	Glaciar R 319-709	Rock	31 9 18.32 S, 70 9 43.76 W	3885-4030
111	Glaciar R 319-7010	Rock	31 9 34.39 S, 70 10 36.41 W	3880-4130
112	Glaciar R 319-7010 (b)	Rock	31 9 35.80 S, 70 10 14.90 W	3840-3945
113	Glaciar R 319-7011	Rock	31 9 43.85 S, 70 11 23.80 W	3925-4140
114	Glaciar R 319-7012	Rock	31 9 44.54 S. 70 12 48.37 W	3870-4090
115	Glaciar R 319-7013	Rock	31 9 34.22 S, 70 13 1.08 W	3900-3990
116	Glaciar R 319-7015	Rock	31 9 35.81 S, 70 15 38.48 W	4000-4200
117	Glaciar R 319-7015 (b)	Rock	31 9 9.63 S, 70 15 3 44.39 W	3960-4110
118	Glaciar R 319-7016	Rock	31 9 55.19 S, 70 16 0.12 W	4190-4290
119	Glaciar R 319-7016 (b)	Rock	31 9 23.73 S, 70 16 37.04 W	4110-4200
120	Glaciar R 319-7017	Rock	31 9 8.68 S, 70 17 45.64 W	3800-3910
121	Glaciar R 319-7017 (b)	Rock	31 9 4.55 S, 70 17 7.02 W	3950-4035
122	Glaciar R 319-7017 (c)	Rock	31 9 38.60 S, 70 17 32.48 W	3960-4230
123	Glaciar R 319-7017 (d)	Rock	31 9 5.54 S, 70 17 35.76 W	3875-3900
124	Glaciar R 3110-709	Rock	31 10 33.46 S, 70 9 37.79 W	4020-4160
125	Glaciar R 3110-709 (d)	Rock	31 10 39.47 S, 70 9 51.52 W	3950-4050
126	Glaciar R 3110-7010	Rock	31 10 12.63 S, 70 10 58.96 W	3995-4250
127	Glaciar R 3110-7010 (b)	Rock	31 10 20.34 S, 70 10 41.07 W	4010-4150
128	Glaciar R 3110-7010 (c)	Rock	31 10 6.91 S, 70 10 26.61 W	3910-3945
129	Glaciar R 3110-7010 (d)	Rock	31 10 51.19 S, 70 10 7.22 W	3880-4060
130	Glaciar R 3110-7011	Rock	31 10 7.13 S, 70 11 15.25 W	3975-4115
131	Glaciar R 3110-7012	Rock	31 10 54.86 S, 70 12 13.80 W	3940-4070
132	Glaciar R 3110-7012 (b)	Rock	31 10 2.80 S, 70 12 13.74 W	3980-4060
133	Glaciar R 3110-7012 (c)	Rock	31 10 17.68 S, 70 12 2.75 W	4075-4210
134	Glaciar R 3110-7012 (d)	Rock	31 10 27.03 S, 70 12 14.62 W	4095-4155
135	Glaciar R 3110-7015	Rock	31 10 59.43 S, 70 15 3.45 W	4035-4220
136	Glaciar R 3110-7015 (b)	Rock	31 10 39.80 S, 70 15 33.40 W	4085-4220
137	Glaciar R 3110-7015 (c)	Rock	31 10 34.38 S, 70 15 34.62 W	4070-4110
138	Glaciar R 3110-7015 (d)	Rock	31 10 23.08 S, 70 15 45.38 W	4080-4150
139	Glaciar R 3110-7015 (f)	Rock	31 10 34.38 S, 70 15 16.86 W	4020-4115
140	Glaciar R 3110-7016	Rock	31 10 29.94 S, 70 16 13.12 W	3980-4130

141	Glaciar R 3110-7016 (b)	Rock	31 10 27.27 S, 70 16 59.95 W	3920-4070
142	Glaciar R 3110-7016 (c)	Rock	31 10 16.26 S, 70 16 51.27 W	4110-4150
143	Glaciar R 3110-7016 (d)	Rock	31 10 27.51 S, 70 16 40.25 W	3890-4070
144	Glaciar R 3110-7016 (e)	Rock	31 10 43.58 S, 70 16 36.42 W	3895-3940
145	Glaciar R 3110-7016 (f)	Rock	31 10 48.77 S, 70 16 15.17 W	3945-4075
146	Glaciar R 3110-7017	Rock	31 10 30.68 S, 70 17 14.71 W	3990-4060
147	Glaciar R 3110-7017 (b)	Rock	31 10 40.21 S, 70 17 55.89 W	4015-4110
148	Glaciar R 3110-7017 (c)	Rock	31 10 27.74 S, 70 17 34.58 W	4030-4165
149	Glaciar R 3110-7017 (d)	Rock	31 10 11.99 S, 70 17 17.75 W	4180-4230
150	Glaciar R 3110-7017 (e)	Rock	31 10 38.22 S, 70 17 27.81 W	3970-4080
151	Glaciar R 3110-7017 (f)	Rock	31 10 25.13 S, 70 17 22.80 W	4000-4085
152	Glaciar R 3110-7017 (g)	Rock	31 10 47.86 S, 70 17 46.11 W	3990-4055
153	Glaciar R 3110-7018	Rock	31 10 13.33 S, 70 18 20.35 W	3930-3995
154	Glaciar R 3111-7010	Rock	31 11 10.75 S, 70 10 46.10 W	4050-4075
155	Glaciar R 3111-7010 (b)	Rock	31 11 3.79 S, 70 10 25.00 W	3955-4070
156	Glaciar R 3111-7010 (c)	Rock	31 11 14.10 S, 70 10 56.47 W	4045-4230
157	Glaciar R 3111-7010 (d)	Rock	31 11 7.62 S, 70 10 33.41 W	4000-4070
158	Glaciar R 3111-7010 (e)	Rock	31 11 32.20 S, 70 10 35.85 W	4065-4120
159	Glaciar R 3111-7010 (f)	Rock	31 11 40.75 S, 70 10 13.71 W	4010-4095
160	Glaciar R 3111-7011	Rock	31 11 0.26 S, 70 11 50.85 W	4115-4175
161	Glaciar R 3111-7011 (b)	Rock	31 11 8.46 S, 70 11 44.31 W	4160-4200
162	Glaciar R 3111-7011 (c)	Rock	31 11 47.73 S, 70 11 5.57 W	4170-4250
163	Glaciar R 3111-7011 (d)	Rock	31 11 32.84 S, 70 11 2.96 W	4100-4200
164	Glaciar R 3111-7012	Rock	31 11 10.43 S, 70 12 45.15 W	3850-3900
165	Glaciar R 3111-7012 (b)	Rock	31 11 4.65 S, 70 12 57.36 W	3860-3910
166	Glaciar R 3111-7012 (c)	Rock	31 11 49.13 S, 70 12 0.82 W	4000-4070
167	Glaciar R 3111-7012 (d)	Rock	31 11 12.35 S. 70 12 9.09 W	3950-4010
168	Glaciar R 3111-7014	Rock	31 11 51.51 S, 70 14 42.93 W	3845-3985
169	Glaciar R 3111-7014 (b)	Rock	31 11 42.62 S, 70 14 29.15 W	3815-3980
170	Glaciar R 3111-7014 (c)	Rock	31 11 59.53 S, 70 14 31.58 W	3805-3870
171	Glaciar R 3111-7015	Rock	31 11 32.88 S, 70 15 51.91 W	3940-4030
172	Glaciar R 3111-7015 (b)	Rock	31 11 49.23 S, 70 15 47.83 W	4025-4100
173	Glaciar R 3111-7015 (c)	Rock	31 11 47.64 S, 70 15 38.08 W	4070-4115
174	Glaciar R 3111-7016	Rock	31 11 14.75 S, 70 16 38.37 W	3850-4030
175	Glaciar R 3111-7016 (b)	Rock	31 11 19.79 S, 70 16 12.23 W	3940-4010
176	Glaciar R 3111-7016 (c)	Rock	31 11 36.15 S, 70 16 15.90 W	3890-3940
177	Glaciar R 3111-7017	Rock	31 11 45.81 S, 70 17 57.29 W	3810-3849
178	Glaciar R 3111-7017 (b)	Rock	31 11 18.16 S, 70 17 42.37 W	3850-3925
179	Glaciar R 3111-7017 (c)	Rock	31 11 31.74 S, 70 17 31.56 W	3755-3890
180	Glaciar R 3111-7018	Rock	31 11 47.78 S, 70 18 41.24 W	3795-3865
181	Glaciar R 3111-7018 (b)	Rock	31 11 37.07 S, 70 18 12.90 W	3875-3950
182	Glaciar R 3111-7018 (c)	Rock	31 11 28.86 S, 70 18 23.90 W	3990-4060
183	Glaciar R 3112-709	Rock	31 12 5.74 S, 70 9 57.77 W	3870-3970
184	Glaciar R 3112-7010	Rock	31 12 22.55 S, 70 10 58.96 W	4020-4140
185	Glaciar R 3112-7010 (b)	Rock	31 12 18.14 S, 70 10 46.70 W	3960-4110
186	Glaciar R 3112-7010 (c)	Rock	31 12 8.99 S, 70 10 22.29 W	3920-4130
187	Glaciar R 3112-7010 (d)	Rock	31 12 20.73 S, 70 10 32.62 W	3930-3985
188	Glaciar R 3112-7011	Rock	31 12 39.14 S, 70 11 6.52 W	4090-4170
189	Glaciar R 3112-7011 (b)	Rock	31 12 48.77 S, 70 11 48.53 W	3930-4350
190	Glaciar R 3112-7011 (c)	Rock	31 12 19.86 S, 70 11 14.46 W	4080-4230
191	Glaciar R 3113-702	Rock	31 13 29.15 S, 70 2 36.86 W	4040-4290
192	Glaciar R 3113-703	Rock	31 13 42.25 S, 70 3 15.10 W	4075-4335
193	Glaciar R 3113-703 (b)	Rock	31 13 57.92 S, 70 3 33.56 W	3845-3980
194	Glaciar R 3113-703 (c)	Rock	31 13 25.45 S, 70 3 53.26 W	4020-4220

195	Glaciar R 3113-709	Rock	31 13 56.42 S, 70 9 12.51 W	4110-4150
196	Glaciar R 3113-709 (b)	Rock	31 13 55.12 S, 70 9 39.29 W	4150-4190
197	Glaciar R 3113-709 (c)	Rock	31 13 49.36 S, 70 9 49.91 W	4170-4270
198	Glaciar R 3113-7010	Rock	31 13 55.30 S, 70 10 10.62 W	4190-4360
199	Glaciar R 3113--7010 (b)	Rock	31 13 26.20 S, 70 10 39.67 W	4260-4430
200	Glaciar R 3113-7011	Rock	31 13 12.97 S. 70 11 27.94 W	4360-4930
201	Glaciar R 3113-7012	Rock	31 13 40.73 S, 70 12 32.05 W	4530-4290
202	Glaciar R 3113-7012 (b)	Rock	31 13 29.21 S, 70 12 30.07 W	4195-4335
203	Glaciar R 3113-7012 (c)	Rock	31 13 5.13 S, 70 12 42.39 W	3990-4200
204	Glaciar R 3114-703	Rock	31 14 23.53 S, 70 3 50.39 W	3850-3915
205	Glaciar R 3114-704	Rock	31 14 9.61 S, 70 4 16.87 W	3940-4110
206	Glaciar R 3114-704 (b)	Rock	31 14 24.07 S, 70 4 30.34 W	3970-4160
207	Glaciar R 3114-704 (c)	Rock	31 14 25.59 S, 70 4 38.69 W	4025-4175
208	Glaciar R 3114-704 (d)	Rock	31 14 19.88 S, 70 4 1.78 W	3890-3960
209	Glaciar R 3114-705 (d)	Rock	31 14 40.06 S, 70 5 51.20 W	4160-4315
210	Glaciar R 3114-705 (f)	Rock	31 14 43.80 S, 70 5 25.23 W	3930-4120
211	Glaciar R 3114-705 (g)	Rock	31 14 47.71 S, 70 5 10.89 W	3870-4060
212	Glaciar R 3114-708	Rock	31 14 22.61 S, 70 8 43.61 W	3960-4020
213	Glaciar R 3114-7010	Rock	31 14 5.48 S, 70 10 37.35 W	4275-4460
214	Glaciar R 3114-7010 (b)	Rock	31 14 45.27 S, 70 10 59.93 W	4320-4420
215	Glaciar R 3114-7010 (c)	Rock	31 14 26.33 S, 70 10 37.05 W	4260-4415
216	Glaciar R 3114-7011	Rock	31 14 24.28 S, 70 11 21.88 W	4420-4560
217	Glaciar R 3115-701	Rock	31 15 57.52 S, 70 1 46.13 W	4030-4190
218	Glaciar R 3115-7010 Calingasta	Rock	31 15 47.43 S, 70 10 10.01 W	3950-4660
219	Glaciar R 3115-7010 (b)	Rock	31 15 24.60 S, 70 10 19.31 W	4045-4255
220	Glaciar R 3115-7010 (c)	Rock	31 15 1.45 S, 70 10 41.32 W	4130-4285
221	Glaciar 3115-7011	White	31 15 8.10 S, 70 11 55.66 W	4500-5100
222	Glaciar 3115-7011 (b)	White	31 15 52.75 S, 70 11 56.93 W	4940-5150
223	Glaciar R 3115-7011	Rock	31 15 30.40 S, 70 11 12.17 W	4330-4640
224	Glaciar R 3115-7011 (b)	Rock	31 15 14.71 S, 70 11 10.81 W	4335-4430
225	Glaciar R 3116-709	Rock	31 16 4.01 S, 70 9 51.25 W	4220-4375
226	Glaciar R 3116-7010 (b)	Rock	31 16 14.33 S, 70 10 34.05 W	4410-4490