



An active Rock Glacier at Gibbs Peak flowing into Kidney Lake, just over the ridge from Dana Glacier, California Sierra Nevada.
photo source: Connie Millar

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**Rock Glaciers, the Periglacial Environments and the Related Hydrology
of the Sierra Nevada Mountains of California**

*This is a draft document in evolution. For more information, including Google Earth files of these rock glacier forms
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Rock Glaciers and Periglacial Environments in California's Sierra Nevada

This brief (a draft document in evolution) focuses on California's *invisible* sub-surface rock glaciers... and mountain permafrost, mostly in the Sierra Nevada Mountains, that are *critical* to local water supply and particularly important as *visible* surface glaciers melt away. Rock glaciers are significant contributors to water to their downstream basins, not only because they will survive glaciers, but because they provide significant water volumes at key moments of the year after seasonal snow has melted and yet, little or nothing is known about them by policy makers, key environmental agencies or civil society working on environmental protection of the Sierra Nevada region.

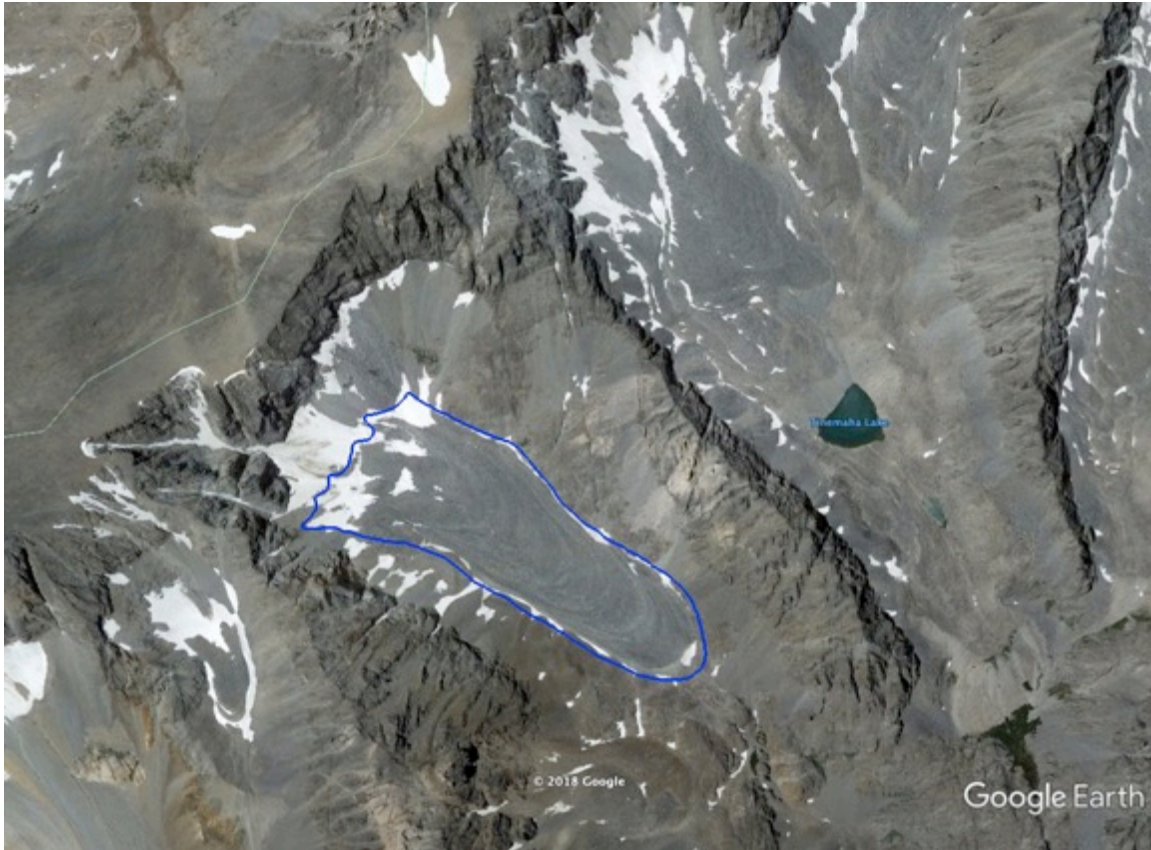
You may or may not have ever heard of "the periglacial environment" or about these "invisible" glaciers--technically called "rock glaciers" ... but they are plentiful and hidden away in many high mountain environments like the Sierra Nevada, mostly invisible to people living near them or that depend on them for water supply. They are not actually *invisible*, as their forms can be identified on the surface, nonetheless, unless you know what you are looking for you are likely to overlook them unless someone points them out to you. One of the main reasons they are invisible to most is because little information exists about them, few scientific experts of hydrology or that study the frozen environment, study rock glaciers or the periglacial environment more generally (people that do are called "geo-cryologists"). So unless someone points rock glaciers out to you, *you don't realize they are there*. Many confuse rock glaciers as *moraines*, or remnants of once existing visible glaciers, but rock glaciers are an entirely different natural ice-rich element. While they may look like moraines to the untrained eye, they are actually much more similar to uncovered visible glaciers in their dynamics and hydrological function. From a hydrological standpoint, these incredible ice bodies can be hundreds of feet thick of solid ice, sometimes more than a mile long and half a mile wide, and they lie in reserve as natural dams, underneath the surface of the earth. Rock glaciers and other features of the periglacial environment are critical to our mountain hydrology, particularly during summer months and extended dry spells. A single large rock glacier can have more ice than an entire city will drink for many years.

Before we start talking about definitions and details about rock glaciers and periglacial areas, let's see some examples of their presence and form. To get a sense of the overall cover of rock glaciers in the Sierra Nevada, the following aerial Google Earth photo is self-explanatory. The photo runs South (left) to North (right). Mono Lake is at bottom right. All of those little blue dots are *hundreds* of rock glaciers.

(birds eye view of mapped glaciers and rock glaciers [\[blue\]](#), Mono Lake is bottom right)



Here is one of those rock glaciers up close. Note that it is more than 3,500 feet long, over 1,000 feet wide and over 100 feet thick! It is the tongue-like shaped rock form in the middle of the image that looks like an oozing rock-flow (we've outlined it in blue to make it more evident). This rock glacier is actually moving very slowly, creeping down the terrain. Yes, rock glaciers flow, just like a regular uncovered glacier. They might be mistaken for rock slides or from afar, even former lava flow, or as glacier moraines, but they are not simply rock, there's ice in there and lots of it. If you look closely at the image below, there are at least *four* more rock glaciers that are clearly visible, three to the right of this rock glacier (in the next two mountain niches), and one small one in the mountain niche to the left. Can you see them?



Now that you know rock glaciers exist, you can begin to appreciate the colossal size of these natural water reserves. The outlined rock glacier in the previous image is so large and so visible that it can be viewed clearly on your smart phone, simply by opening *Maps*, selecting "satellite view" and typing the following GPS address exactly as shown into the search box, with spaces and commas as written (you'll have to zoom in once it plots the point!)

37 2 5.22 N, 118 25 6.83 W

Notice that for the most part, you *can't* see the ice of this rock glacier (except a little leftover winter snow/ice around the edges and at the top elevation limit at the upper extreme of the picture). This visible ice is actually *not* part of the internal rock glacier ice we are talking about. For someone who before reading this brief had never heard of a rock glacier, it's hard to believe that this is actually massive ice content (mixed with rock) dozens of feet thick, buried under rock and in between rocks. Look at the next image. It is of a similar land/ice form called a *debris-covered* glacier, which is similar (not exactly the same) to this California "rock glacier". This debris-covered glacier is in the Andes of South America. In the image you can see how there is a mantle of rock covering solid thick ice. I've used a "debris-covered" glacier to demonstrate the ice content, because generally, you never get to see the ice in a true *rock glacier*, making it very hard to illustrate the ice content. Only by drilling an ice core many feet into the ground, could you see or grasp the amount of ice actually in a rock glacier.

In the image below, if you were above this debris-covered glacier you would see no ice! As the rock mantle breaks apart you can see ice revealed. You can also see a small glacier lake forming in the forefront, a telltale sign that this ice body is feeding water into the ecosystem.



Rock glaciers are part of the permafrost environment, or more specifically, the “periglacial environment”, existing in many high mountain areas, where there are visible *uncovered* glaciers (that most of us know about). In a place like the California Sierra Nevada, there are *hundreds* of rock glaciers! And thousands of ice rich (and also invisible) periglacial features (most of which we will not discuss these in this brief).

A debris-covered glacier in South America reveals rich ice core

We talk a lot about the Sierra Nevada's vanishing *visible* glaciers, but no one ever mentions the many thriving *invisible* rock glaciers that exist. Well, maybe not *thriving*--due to climate change, but still actively contributing



to California's and the greater region's water supply and reserves! At the Center for Human Rights and Environment (CHRE) we have been documenting them one by one, mapping their location, and also mapping their relationship to mountain streams/waterways that feed California's critical hydrology. Below is a close-up of a mountainside of the Sierra Nevada with many rock glaciers. They are outlined in blue. Notice the *many* rock glaciers in many of the mountain cirques or *niches* and the many small lakes formed at their base, or in their vicinity. These rock glaciers as well as other mountain permafrost features are continuously feeding water into the ecosystem.

Sierra Nevada Hydrology

The Sierra Nevada mountains are 450 miles long, 40 to 50 miles wide, and includes rich and lush ecosystems supporting life throughout the Western United States. There are over 2000 freshwater lakes in the Sierra Nevada Range and nearly 100 named rivers, not to mention the many more hundreds or even thousands of creeks and streams that have their origins high up in the frozen environments where rock glaciers and other periglacial environment features thrive.

On average, 60% of California's total water precipitation—in the form of rain and snow—falls in the Sierra Nevada and a portion of the southern Cascades. Snowmelt from the Sierra provides water for irrigation for farms that produce half of the nation's fruit, nuts and vegetables, and also is a vital source for dairies, which have made California the largest milk producer in the country. In addition, Sierra snowmelt provides drinking water to Sierra Nevada residents and a portion of drinking water to 23 million people living in cities stretching from the San Francisco Bay Area to Southern California. The Mokelumne River, which originates in the high Sierra, provides more than 90 percent of the East Bay's water and the Owen's Valley in the eastern Sierra serves as a key source of water for Los Angeles. The Sierra Nevada provide water to most of California's key rivers such as the Sacramento and San Joaquin rivers (Water Education Foundation).

[and from Wikipedia]

The [Sierra Nevada] range is drained on its western slope by the Central Valley watershed, which discharges into the Pacific Ocean at San Francisco. The northern third of the western Sierra is part of the Sacramento River watershed (including the Feather, Yuba, and American River tributaries), and the middle third is drained by the San Joaquin River (including the Mokelumne, Stanislaus, Tuolumne, and Merced River tributaries). The southern third of the range is drained by the Kings, Kaweah, Tule, and Kern rivers, which flow into the endorheic basin of Tulare Lake, which rarely overflows into the San Joaquin during wet years.

The eastern slope watershed of the Sierra is much narrower; its rivers flow out into the endorheic Great Basin of eastern California and western Nevada. From north to south, the Susan River flows into intermittent Honey Lake, the Truckee River flows from Lake Tahoe into Pyramid Lake, the Carson River runs into Carson Sink, the Walker River into Walker Lake; Rush, Lee Vining and Mill Creeks flow into Mono Lake; and the Owens River into dry Owens Lake. Although none of the eastern rivers reach the sea, many of the streams from Mono Lake southwards are diverted into the Los Angeles Aqueduct which provides water to Southern California.

Immediately below is an image showing the relationship of the rock glaciers to the waterways in the Sierra Nevada. Rock glaciers may not be comparatively significant to snowpack for their water provision as compared for example to the snowmelt months (when the rivers swell), but once the springtime snowmelt is gone, or during an extended drought period, rock glacier contribution to California's water supply is extremely important because it provides a minimum steady flow of water into the rivers and streams. If it weren't for rock glaciers, and the periglacial environment more generally, there would be much less water available to the ecosystem until the next snowfall and subsequent melt.



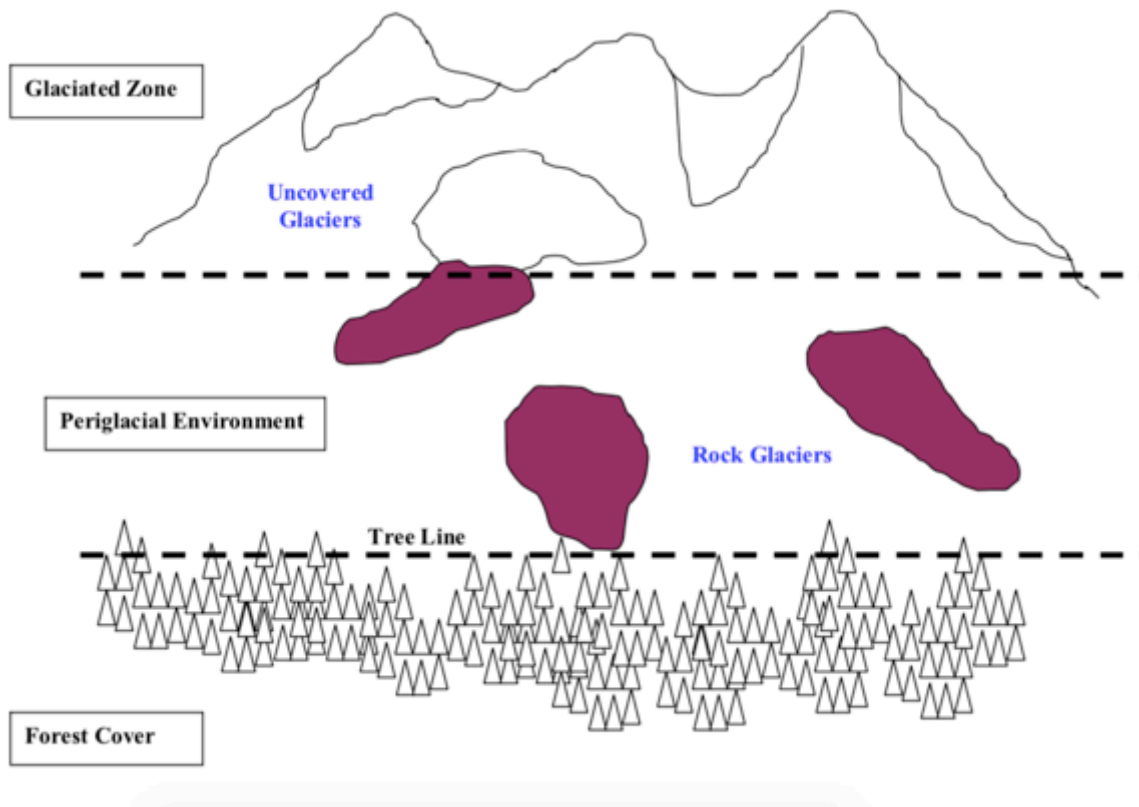
Rock Glaciers are at the top of the water basin hydrology of the Sierra Nevada

How are Rock Glaciers formed?

It is important to understand *how* rock glaciers are formed, because in that understanding, we unveil an intricate function and adaptation of Mother Nature that few of us ever knew existed. It is a function conceived to trap water in the winter and deliver it to the ecosystem in warmer months beyond the snowmelt phase. By understanding this natural adaptive feature, we can come to better understand high mountain environments and truly appreciate rock glaciers and the periglacial environment and the important hydrological role they play in their ecosystems. In fact, through the periglacial environment, Mother Nature has found a way to collect water and hold it for many months, releasing it back into the environment slowly and when we need it most, so that once the springtime snowmelt has completed, our ecosystems continue to receive water at a steady flow (albeit at a lower volume) all year long. It's what some call, *basin regulation*. Rock glaciers and other features of the periglacial environment (which we will not get into in this brief) continue to provide water, not only during dry months, but during drought years, when the seasonal snow-pack and precipitation is lower than usual. Rock glaciers (and more generally, the *periglacial environment*—of which *rock glaciers are a part*), are key to providing water during dry times.

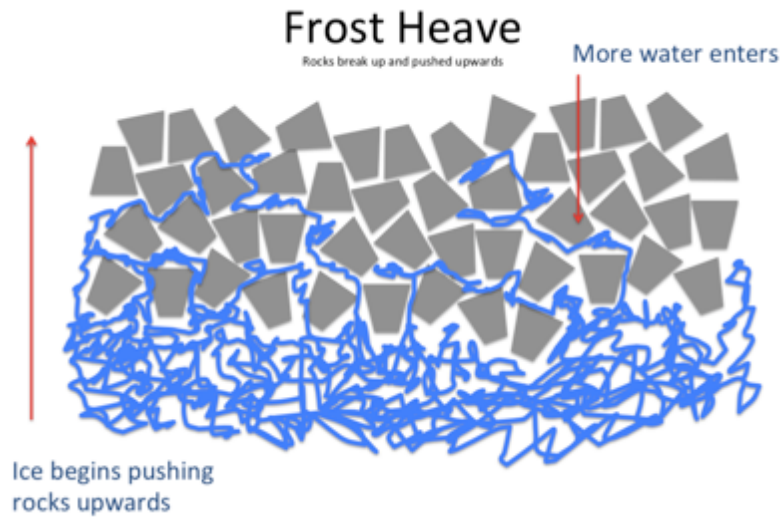
The next time you are in a high mountain environment like the Sierra Nevada, where glaciers exist (few are left due to rising global temperatures), notice that between the forest line (where the trees and plants end as you go up the mountain) and the visible glaciers begin, there is a swath of barren terrain where nothing grows, but where also there are no glaciers (see image below). Nothing grows in this area because freezing temperatures destroy roots and plants and because there is little soil development (attributable to the lack of organic matter as a result of constant freezing temperatures). And although it is freezing much of the year in this area, on average it is too warm for exposed ice to survive. What may have seemed to be a no-man's land with nothing going for it but rocks, is actually a thriving

subsurface hydrological root area that feeds our rivers and streams. The rock mantle cover in this barren terrain, helps protect rock glaciers and other periglacial features from the warm air above.



Let's be clear. We are not talking about hot air, but rather, air that is at *or just above* 32 degrees Fahrenheit. That's pretty cold, even freezing for you and me, but too warm for visible glaciers to survive year to year. Keep in mind that glacier ice needs the yearly average temperature to be *below* 32 degrees. If it is warmer, snow that falls in the winter melts and perennial ice (surviving ice) does not form. In such an environment, visible surface glaciers, if they ever existed, would melt away. Rock glaciers however, because they are beneath the ground and protected from warm air, can survive at slightly warmer surface temperatures, and that means that Mother Nature can form *and store* ice at lower elevations, which is very convenient for the regional hydrology!

This swath of land (called the Periglacial Environment; see graphic depiction above) gets very cold during the winter and at nighttime during warmer months, cold enough to freeze any precipitation (rain, sleet, snow, etc.). When it warms up during the day, the ice melts and that melt water seeps into the rocky ground. At night (or during a cold month) the temperature falls again, and the water that seeped into the ground refreezes. During each freezing cycle, as the water volume expands during the freezing cycle, surrounding rocks are pushed out and upwards by the newly forming ice (this is called frost heave). Over many freeze-thaw cycles, rocks move up towards the surface and ice is accumulated *below* the surface. Over many years, decades and even centuries, solid subsurface ice cores are formed, and as these grow in size to be many hundreds of feet thick and oftentimes many thousands of feet long, rock glaciers are formed!



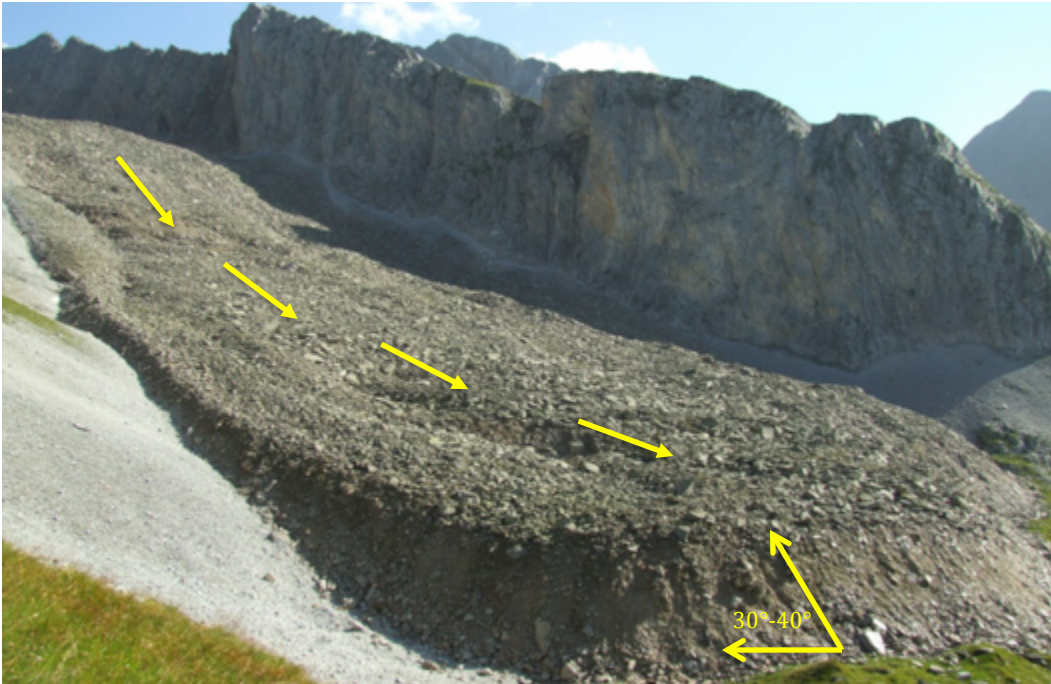
You can replicate the freeze-thaw rock glacier cycles right in your own refrigerator to see the dynamics of rock glacier formation. Simply fill a transparent Tupperware about three quarters full with small rocks. Fill the Tupperware with water to the rock level line. Put it all in the freezer and let it freeze. After a few hours, the result is a big blob of rocks and ice. Take the Tupperware out of the freezer and let it melt on the countertop for at least 30 minutes. Don't let it all melt, just about a third to half of the ice that formed! As the ice melts, the water slowly seeps down to the bottom of the Tupperware, leaving some of the ice/rock mixture at the top and water at the bottom. Reinsert the Tupperware in the freezer and let freeze again. What you are doing is replicating the freeze-thaw cycles that occur in the natural periglacial environment, which occurs generally during extremely cold nights and between cold and warm months of the year. When it's in the freezer, you're replicating sub 32 temperatures (winter and nighttime), when it's out of the freezer you're replicating spring and summer months or daytime temperatures. When you take out the Tupperware for the second time, you'll notice that there is a small layer of ice forming at the bottom, this is mixed with melt water, while a mix of ice and rock remains at the top. Repeat the cycle several times just as Nature repeats the freeze-thaw cycle. Eventually, after several times of freezing and thawing, you'll notice that when you take out the Tupperware from the freezer, all of the water has seeped to the bottom and is solid ice and that most of the rocks are at the surface. This is exactly what is occurring in the periglacial environment. Rock glaciers are formed through these freeze-thaw cycles of Nature combined with the frost heave dynamics of ice, rocks and water.



Rocks and water from snow melt mix on surface, help produce periglacial processes. Near Excelsior Rock Glacier, Sierra Nevada.
Photo source: JDTaillant

In a natural periglacial environment eventually what you get is a mass of subsurface ice covered by an enormous mantle of rock that due to weight, size, lubrication (from melting ice inside that flows to the ground), and mountain surface incline (gravity), starts to flow down the mountainside, much like a normal glacier, but in this case, we are in the presence of a rock glacier!

Below is an image of a typical rock glacier. Notice the typical tongue-like flow form of the visible rock as if it were a rockslide. There is no ice visible anywhere. The front of the lobe of an active rock glacier (active means it is moving) is typically a sharp 30-40 degree angled cut as is visible in this picture.



A typical lobe-like form of an active rock glacier flowing downhill, with a sharp 30-40 degree frontal cut

Some more examples of Rock Glaciers

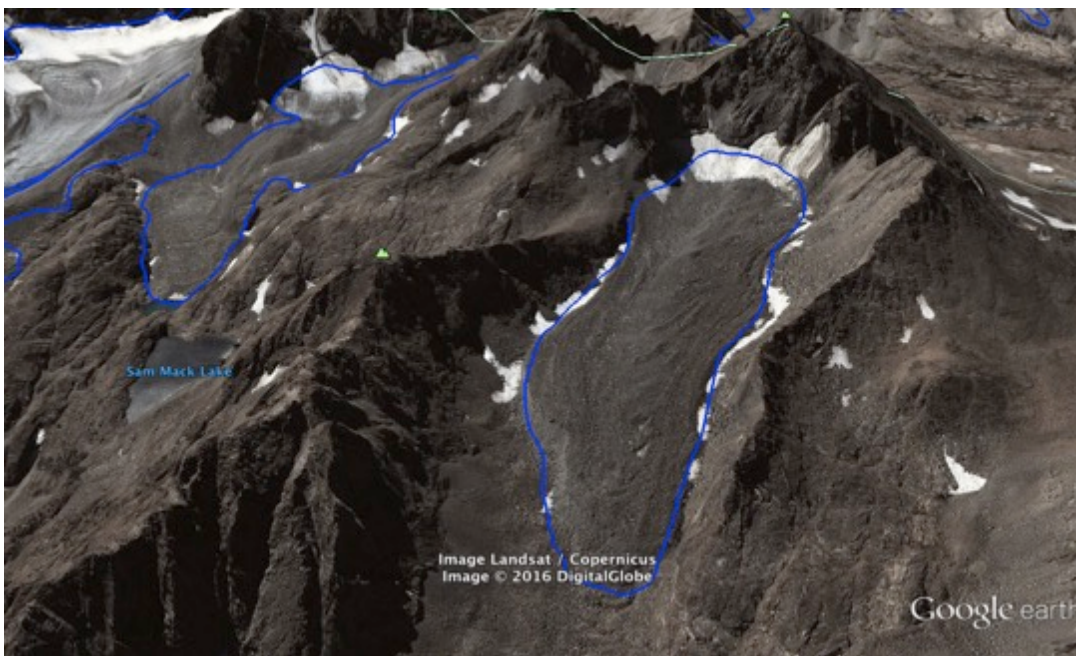


An active Rock Glacier in the Central Andes of Argentina; 32 58 09.78 S, 69 22 46.45 W



An active Rock Glacier in a ski region of Colorado, USA; 39 21 10.77 N, 106 05 19.45 W

Take a look at this image of several beautiful rock glaciers in the Sierra Nevada. Some of these subsurface ice bodies can be over 1 mile long!!



Example of a Typical Sierra Nevada Rock Glacier (several are visible in the image, outlined in blue polygons)
at: 37°07'05.72" N 118°31'14.84" W



An active rock glacier at Gibbs Peak near Dana Glacier in the Sierra Nevada at: 37 53 41.89 N, 119 12 02.03 W
(this is the same rock glacier of the cover of this publication)



A rock glacier at Deer Lake in the Sierra Nevada; Photo source: Connie Millar



Excelsior Rock Glacier, Sierra Nevada; GPS: 38 02 17.38 N, 119 18 32.14 W. Photo source: JDTaillant.



Water emanating from internal section of Excelsior Rock Glacier, Sierra Nevada; GPS: 38 02 17.38 N, 119 18 32.14 W. Photo source: JDTaillant.



On the surface of Excelsior Rock Glacier, notice no ice is visible, just large volume of rock. GPS: 38 02 17.38 N, 119 18 32.14 W.
Photo source: JDTaillant.

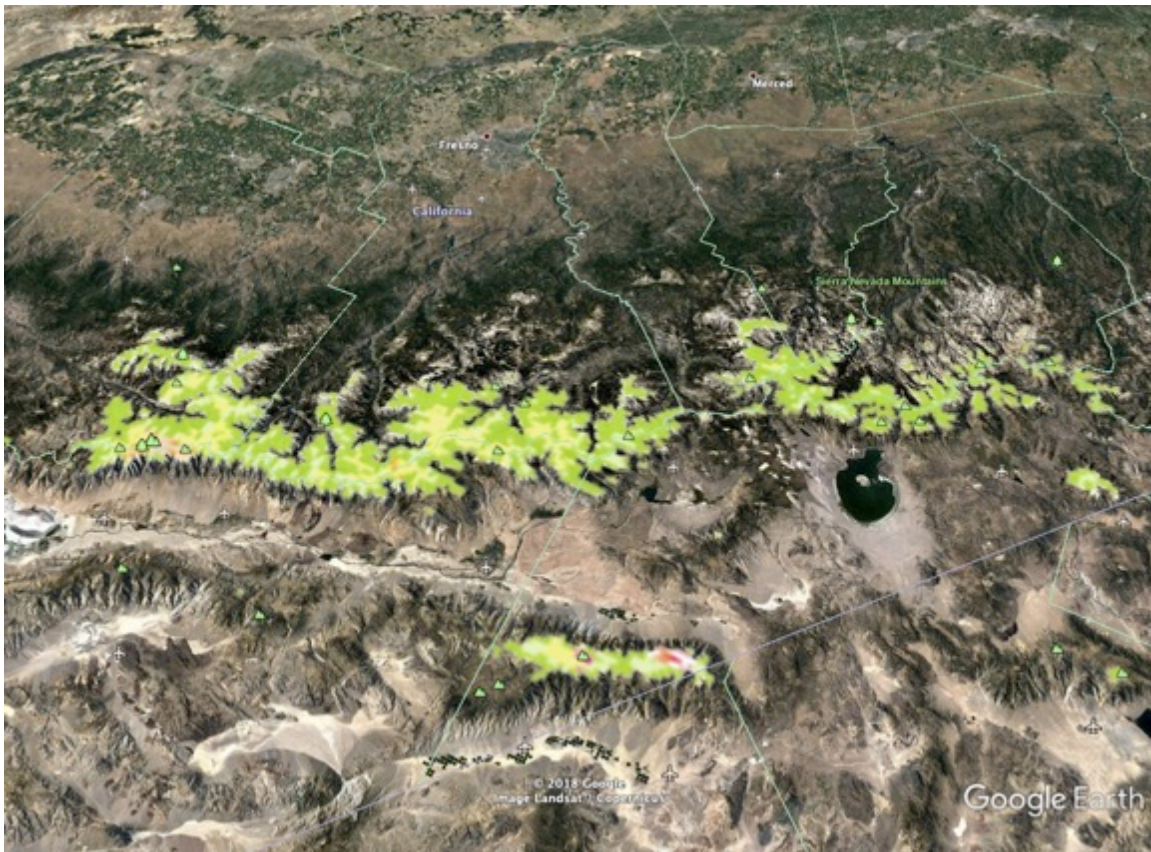
Frozen Grounds of the Periglacial Environment (including Permafrost)

The University of Zurich has a nifty online-based tool called the *Global Permafrost Zonation Index Map* that allows you to identify the presence of frozen ground anywhere on the planet. Simply download the appropriate data file, open it in Google Earth, and go to the area you wish to seek out frozen terrain.

Check it out at:

http://www.geo.uzh.ch/microsite/cryodata/pf_global/

Scroll down, click on the *.kml* file to download the tool, and open it in Google Earth. It's that simple. When in Google Earth, you may have to click on the box that appears on the left panel called "Global Permafrost Zonation Index Map", if it is unchecked (otherwise the model will not load). You can *unclick* the Legend if it bothers you. You can also unclick "ruggedness" which is not pertinent to the frozen areas and will flood the visible area in red if there is no frozen terrain in the image. If Google Earth is set at Los Angeles, you are not going to see any frozen ground. But go to a place where you suspect there is ice (Colorado Rocky Mountains or the Sierra Nevada, for example), and you can begin to seek out frozen ground. When there, let Google Earth load the model, and if you are actually in a zone with frozen ground, you'll suddenly see appear splotches of yellow, green, red, orange, blue and purple. These are frozen grounds, or *permafrost*. Below is an image of the Sierra Nevada viewed on Google Earth with the global permafrost zonation filter. You can see that the peaks of the Sierra Nevada are all yellow and green, with a few scattered orange and red splotches. The bluer the colder, red and purple also indicate very frozen grounds, while yellow and green being areas of uncertainty (which in fact are perhaps more important to us, more in a moment).



Frozen grounds of the Sierra Nevada's Periglacial Environment as mapped by a Global Permafrost Model; Source University of Zurich

So what exactly is the “Periglacial Environment”?

Let's begin with the opposite question, as logic doesn't serve our purpose in this case, since despite what most might presume, there can be a periglacial environment *without* a glacier!

So then, what **is not** the Periglacial Environment?

When most people hear the term *periglacial environment* for the first time, they imagine a simple definition, largely because of the simplicity of the term itself. We image a peripheral space (from the word “peri”) around a glacier, and we imagine that this physical space around the glacier has some relevance to the ice of the glacier. If we are environmentalists we might also imagine a sort of *buffer zone* around the glacier, necessary to protect the glacier or that may also be frozen. That is actually NOT the periglacial environment at all. In fact, there can be periglacial environment with NO glaciers present.

The Periglacial Environment, very roughly, is the area where because of low temperature of the environment, generally near 0° Celsius or less (32° Fahrenheit or less), the earth is frozen. This freezing could be at the surface, on top of the surface, and/or beneath the surface. The Periglacial Environment is important because if there is humidity in the earth, this humidity freezes (it is transformed to ice). And if there is ice in the periglacial environment, it is a water reservoir, and if this ice melts temporarily or definitely, this ice is converted to water. Periglacial Environments can exist in areas where there is no humidity in which case there is no ice and in such a case it is not a water reservoir. There can be areas in the Periglacial Environment that are permanently frozen (all the time), and others that cyclically unfreeze. Note that the permafrost model you loaded onto Google Earth does not identify ice, but rather, “freezing temperature”.

In sum, the periglacial environment can be thought of as a geographical strip of land defined by certain geographic and topographical characteristics and by temperature. It is located between the glaciated area and the tree limit line. It is frozen ground which, if containing humidity, is a water reserve in frozen state, while the lower limits of the periglacial environment are cyclically freezing and thawing, providing continuous water flow to the ecosystem below.

In this brief we will not be getting into the many types of ice-rich cryogenic features found in the periglacial environment. It suffices to stress that the ice content generally is what we are mostly interested in, since ice in the ground is water in reserve and extremely important to the hydrology of the region. Rock glaciers, which we are largely focusing on in this brief, are important features of the periglacial environment, as they are one of the most visible, and one of the largest visible and identifiable features. However, there may also be large swaths of ice-rich ground that does not form into rock glaciers, and yet still has a considerable amount of water content, possibly more than rock glaciers. Again, if you know what you're looking for, these grounds can be easily identified in some case, but in others may be more difficult to spot. Note the following picture of *creeping ground* on a mountainside in the Central Andes of Argentina, this is ice-rich permafrost moving across the surface, as if it were melting and deforming in its flow.

In the second image, we see a curious assortment of rocks, of periglacial areas of the Sierra Nevada. This assortment is also caused by the periglacial environment's freeze-thaw cycles.





Patterned grounds of the Sierra Nevada's Periglacial Environment result from freeze-thaw cycles; Photo source: Connie Millar.

Water Content of Rock Glaciers and Periglacial Environments

As is clear from the definition of periglacial environments, *and within this environment, rock glaciers*, we can understand their importance as hydrological reserves in cold and high mountain environments, contributing water to river and stream flows year round. It is important to understand that in such areas, large swaths of land are in recurring freeze-thaw cycles, and that the lower limits of these areas, the ones closer to warmer grounds, are continuously releasing water into the downstream ecosystems. While parts of the periglacial environment (the higher portions) are incorporating humidity and freezing it for storage, lower elevations are melting, converting stored frozen ice into flowing water acting as a basin regulator.

Juan Pablo Milana, one of the world's most experienced rock glacier specialists that engaged with the creation of the very first law to protect rock glaciers, says wisely, in regards to periglacial environments:

"what we're interested in knowing is the function of these environments as water reservoirs." (Milana, Ice and Desert, p.122).

Another well-known geo cryologist that has studied periglacial environments in Argentina, Dario Trombotto Liaudat, indicates in one of his works that describes diverse forms of the periglacial environment in the region (he is referring in particular to rock glaciers, one of the key elements of the periglacial environment) (unofficial translation):

"[rock glaciers] are surely the most significant cryogenic forms of the Andes. For decades their enormous hydrological value for the Central Andes have been mentioned. ... The snow that penetrates the active layer and its freezing creates a system for storing water on high mountain areas. In the summertime, the active layer melts and the discharge into the rivers increases. ... The frozen areas, with permafrost or with debris-covered ice in the Central Andes, as in other cryogenic South American regions, constitute more significant water sources than glacial areas." (Trombotto 2000, p.46).

Darren Jones in 2019 published a review of research on rock glacier mountain hydrology summing up the current academic research, concluding:

“Glacierised high mountain systems worldwide form natural ‘water towers’ that constitute a significant freshwater source for downstream regions, particularly in arid and semi-arid zones (Messerli et.al., 2004; Viviroli et. Al, 2007). Here, glacial- and snowpack-derived meltwaters buffer hydrological seasonality, contributing to streamflow in otherwise low-flow conditions during drier months (e.g., Kaser et.al., 2010). In this context, the mountain cryosphere (snow, ice and permafrost) is important for ecosystems services provision (Gre-Regamey et.al., 2012), supplying multiple societal needs within mountains and the surrounding lowlands – potable water supplies, energy generation (hydropower) and agriculture, for example (Immerzeel et.al., 2010; Viviroli et.al., 2011). In vulnerable drought-prone regions particularly, glaciers represent an important drought-resilient water source (Bolch, 2017). This has been illustrated for several high-altitude cities located in the Andes (Wouter et.al., 2017; Table 1).

The rapid near-global retreat of mountain glaciers, predominantly attributed to anthropogenic causes (Marzeion et.al., 2014), has previously been reported (Gardner et.al., 2013) and glacial retreat and mass loss is projected to continue throughout the twenty-first century (Marzeion et.al. 2012; Radié et.al., 2014; Huss and Hock, 2015). ... Rock Glaciers are landforms consisting of a continuous, thick seasonally frozen debris layer ... Intact rock glaciers ... are thought to contain ice volumes of significant water value (Azocar and Brenning, 2010; Rangecroft et.al, 2015; Jones et.al. 2018b; Munroe, 2018). Critically, due to insulating effect of the active lawer, internal thermal regimes are at least partially decoupled from external micro and meso-climate in summer (Juliussen and Humlum, 2008; Millar et.al. 2013). As a result, rock glaciers are reasonably assumed to have retarded ice melt, which suggests these landforms may prolong long-term water storage in high mountain systems and buffer losses from alternative sources (Millar et.al. 2013; Rangecroft et.al., 2015; Bosson and Lambiel, 2016; Jones et.al., 2018b). Furthermore, rock glacier presence and abundance affects the amount and properties of runoff from high mountain watersheds.” (Jones, Darren et.al. 2018)

A portion of the water supply derived from periglacial environments comes from rock glaciers that are in the area and that are but one of the elements within the periglacial environment (but not the only element). While much of the ice of a rock glacier may be permanently frozen, if the rock glacier is active (that is, if it is moving), it has an active surface layer. The ice in a rock glacier is water in reserve, while the cyclical melting and freezing of the active layer makes the rock glacier function as a water basin regulator. Even if the rock glacier is no longer active (where it is no longer moving downslope), it still may have an active layer, refreezing in the winter and melting in the summer. In the case of inactive rock glaciers, the inactive rock glacier is slowly loosing permafrost each season and over time it is melting away more ice than it gains, much like a normal, uncovered glacier.

One of the difficulties we have in valuating rock glacier water content is that we simply don't have the research and the data to draw good conclusions about their hydrology. Measuring water content in sub surface rock is a complicated matter. There is a very unique type of professional that fully understands the periglacial environment, since even glaciologists are not likely to have periglacial knowledge. Only experts that have studied geology *and cryology*, and their interaction (a field called geo-cryology), truly understand the complex dynamics happening in subsurface frozen lands, and there are unfortunately very few “geo-cryologists” on the planet. It's a small community. And amongst those, there are even fewer that focus on the hydrology of rock glaciers or of periglacial environments.

We do know that there is a lot of ice and water in rock glaciers and in other features of periglacial areas. What we don't know is how much. What we do know is that we find rock glaciers in sometimes very arid environments, and that generally there are small lakes forming at their ends, and that they are contributing to downstream hydrology.

A select few experts have looked at ice content and water flow from rock glaciers, and so there is some data available.

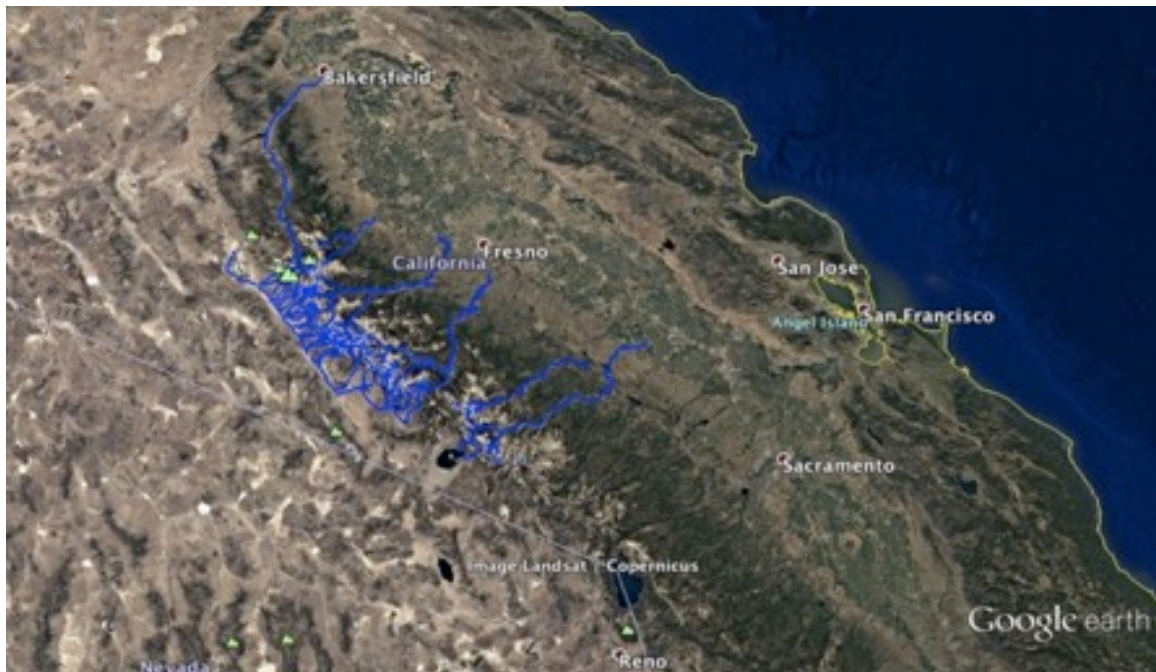
Lothar Schrott, a rock glacier specialist calculated for example, that a single rock glacier, the Dos Lenguas Rock Glacier in San Juan Argentina, discharges some 18,000 to 28,000 liters per hour (4800-7400 gallons per hour) (Schrott, 1994, cited in Trombotta 2000, p.47). (the reader can see the *Dos Lenguas* Rock Glacier via *Google earth* at: 30 14 51.83 S, 69 47 5.46 W)

Adam Riffle's recent masters thesis examining the hydrology of rock glacier environments in the Eastern Cascades opens observing:

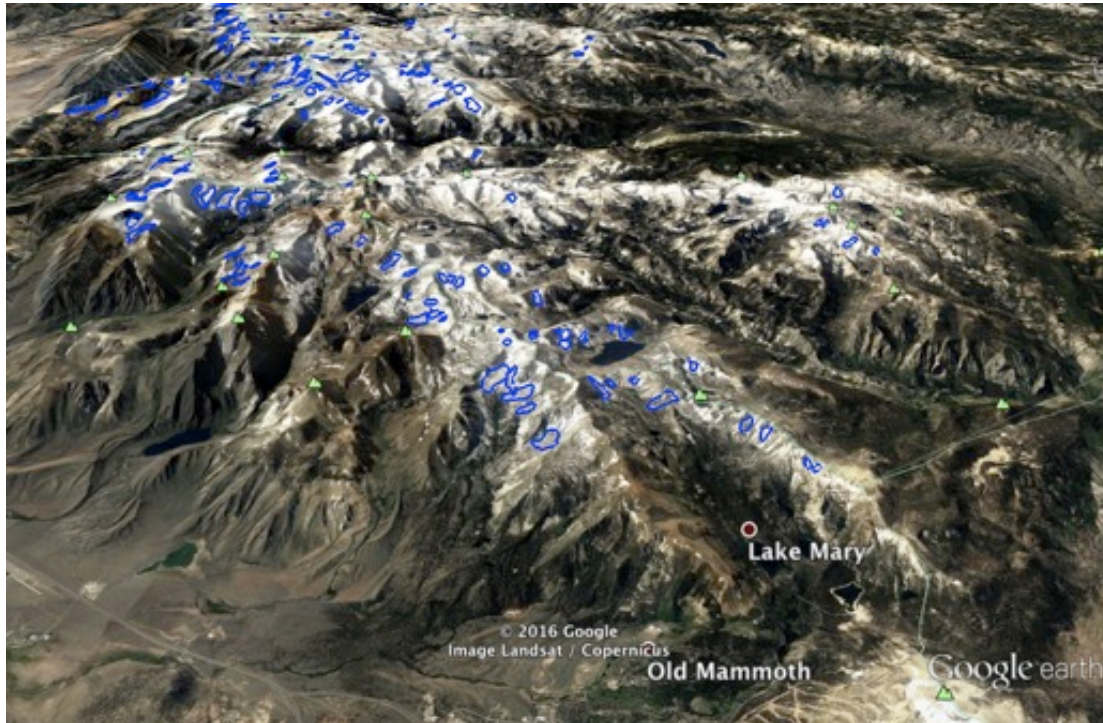
Low summer river base flow places a strain on natural and economic resources of the Eastern Cascades. A major contributor to stream flow in this region is snow pack which has declined over the past few decades because of a warming climate. In addition, glacial runoff, which contributes significantly to base flow in summer dry periods, will diminish from glacial recession. However, rock glaciers, because their internal ice (i.e., permafrost) is insulated by an outer debris layer, react slowly to climate change, thus acting as sinks for ice and liquid water storage in mountain environments. (Riffle, Adam, 2019)

More studies are needed to reveal the hydrological data that is buried beneath rock of high mountain environment, before we can really grasp the complete relevance of these obscure geo-cryological resources.

Example of River/Waterway mapping in relation to rock glaciers Near Mammoth Lake, California
at: 37°00'20.11" N 118°18'21.73" W



Close-up of Rock Glaciers mapped by CHRE Near Mammoth Lake, California (Sierra Nevada)
at: 37°33'38.21" N 118°56'53.70" W



Conclusions

If reading this brief is the first time you are reading about rock glaciers, this may all seem very esoteric to you. Or maybe you already know about rock glaciers and this brief was a waste time (I hope not), but most people have no clue about the existence of rock glaciers and periglacial environments, or that there is mountain permafrost in places like the Sierra Nevada. Avid hikers in these areas commonly confuse rock glaciers with moraines, thinking they are simply displaced rock by glaciers that are no longer in existence, but don't imagine the colossal ice cores that sit beneath the surface of the earth.

Most people know glaciers are melting, and the few that know that there are glaciers in California may also realize that as time and climate change advances, there may soon be no glaciers left. Yet, rock glaciers will (and are) surviving the visible melting glaciers, and will be around for some considerable time--*longer than the glaciers--even for hundreds of years*. We need to know more about them so that we can appreciate their role in the hydrology of the region and to ensure that we protect them appropriately. And yes, you can damage a rock glacier, in fact, the reason I became interested in protecting rock glaciers was because a mining company started dynamiting glaciers, rock glaciers and other features of the periglacial environment.

Here is another alarming reality that we need to address. You may have heard that 98% of the world's water is undrinkable (salt water), and that only two percent or so is freshwater. Seventy five percent (of that two percent) is in glacier ice. Did you know that until very recently *not a single* piece of legislation anywhere in the world specifically mentioned or targeted glaciers for protection. That's pretty alarming, and incredible, considering all of the environmental laws and norms we have on the books and the importance of glacier ice to our freshwater supply. It's at least very interesting to think about *why* there are no glacier protection laws? And that's concerning the *glaciers* that we know about. If we considered these obscure *rock glaciers*, you can imagine, we are even worse off in terms of legislation. We've been working to change this.

Our organization, the Center for Human Rights and Environment (CHRE ... or CEDHA in the Spanish namesake version) was one of the key actors that got the world's first Glacier Protection Law¹ passed in 2008, in Argentina. It was vetoed a few days later by the president explicitly to protect mining companies that wanted to mine precious metals in glacier areas. Fortunately after a lengthy campaign involving many non-profit environmental groups and social actors, we got the law back in 2010. It still stands as the world's only glacier law anywhere—and yes, the law also protects rock glaciers! We are also working to get similar laws passed in Chile, Peru and Kyrgyzstan and maybe, why not, in California as well. You can read about that story in a recent book that details that process called *Glaciers: The Politics of Ice*. It is also an intro to the world of glaciers.

We call our work, "cryoactivism", or, activism that aims to protect our cryosphere, the top of the water chain!

Where to next?

We have to spread the word that rock glaciers and the periglacial environment exists, and that it is very present and extensive in the Sierra Nevada and in many high mountain environments. We have to learn about and understand the dynamics of this very special high mountain feature that helps accumulate water supply and feed it in rations to the downstream hydrology. Only by understanding it can we expect to protect and cherish this important natural freshwater reserve.

JDT and AR.

¹ See: <http://center-hre.org/wp-content/uploads/Argentine-National-Glacier-Act-Traducci%C3%B3n-de-CEDHA-no-oficial.pdf>

CHRE's Sierra Nevada Glacier and Rock Glacier Inventory (work in progress)

CHRE's Current Glacier and Rock Glacier Inventory includes **585 ice bodies identified** (each listed below), GPR-registered, as well as drawn polygons indicating the glacier or rock glacier's exact form. Below is a table indicating the glacier with CHRE's assigned name (utilizing our own easy to use glacier naming system), the type of glacier, the GPS location and the altitudinal elevation in meters.

CHRE's glacier naming system. Scientists oftentimes have quirky ways to name glaciers that are incomprehensible to the lay observer. Generally these systems utilize obscure references to regions, quadrants, and direction. Here is a glacier name for example:

A glacier name in the World Glacier Inventory: **US2K04435001**

If you have no knowledge about glaciers or glacier inventories, there is not much you can do with this name in order to understand what it means. About the only thing that you could possibly figure out from this name, with a wild guess, is that this glacier is in the United States. The rest of the information is useless.

Our system is geared for everyone, so that even a child could use the information to find and see any glacier in our inventory. We call this same glacier: **Glacier 3744-11916**. The numbers are code for GIS reference. Simply take your phone, and type the following coordinate into your maps application (in Satellite Mode) as follows:

37 44 N, 119 16 W

Doing so puts you within a few hundred feet of Lyell Glacier, the largest glacier in California! The same goes for any of the glaciers in our inventory. As long as you know the generally area of the world (you need to know for these glaciers that they are in the Northern Hemisphere and Western Hemisphere), you can easily find the glaciers inventoried!

Identification Name	Type	GIS Location	Elevation (in Meters)
Rock Glacier 3624-11833	rock glacier	36 24 31.06 N, 118 33 26.79 W	3330-3450
Rock Glacier 3625-11832	rock glacier	36 25 10.38 N, 118 32 28.97 W	3360-3520
Rock Glacier 3327-11831	rock glacier	36 27 28.03 N, 118 31 57.22 W	3290-3490
Rock Glacier 3630-11813	rock glacier	36 30 28.00 N, 118 13 54.59 W	3460-3670
Rock Glacier 3631-11814	rock glacier	36 31 48.96 N, 118 14 36.44 W	3575-3740
Rock Glacier 3631-11816	rock glacier	36 31 32.79 N, 118 16 50.30 W	3630-3810
Rock Glacier 3631-11816 (b)	rock glacier	36 31 50.57 N, 118 16 48.13 W	3655-3770
Rock Glacier 3631-11817	rock glacier	36 31 9.95 N, 118 17 46.28 W	3695-3760
Rock Glacier 3631-11817 (b)	rock glacier	36 31 53.34 N, 118 17 28.34 W	3690-3820
Rock Glacier 3631-11817 (c)	rock glacier	36 31 49.65 N, 118 18 2.77 W	3615-3680
Rock Glacier 3632-11814	rock glacier	36 32 24.11 N, 118 14 31.57 W	3740-3915
Rock Glacier 3632-11814 (b)	rock glacier	36 32 9.43 N, 118 14 41.83 W	3800-3950
Rock Glacier 3632-11817	rock glacier	36 32 16.18 N, 118 17 18.46 W	3680-3810
Rock Glacier 3632-11818	rock glacier	36 32 15.63 N, 118 18 36.84 W	3465-3575
Rock Glacier 3632-11818 (b)	rock glacier	36 32 23.36 N, 118 18 11.95 W	3600-3700
Rock Glacier 3632-11827	rock glacier	36 32 11.12 N, 118 27 47.42 W	3505-3710
Rock Glacier 3632-11827 (b)	rock glacier	36 32 28.92 N, 118 27 20.43 W	3635-3720
Rock Glacier 3632-11829	rock glacier	36 32 23.23 N, 118 29 31.12 W	3565-3930
Rock Glacier 3632-11830	rock glacier	36 32 46.68 N, 118 30 22.42 W	3810-4040
Rock Glacier 3632-11830 (b)	rock glacier	36 32 32.52 N, 118 30 44.64 W	3710-3830
Rock Glacier 3632-11831	rock glacier	36 32 30.08 N, 118 31 15.74 W	3610-3720
Rock Glacier 3633-11814	rock glacier	36 33 19.86 N, 118 14 40.69 W	3390-3490
Rock Glacier 3633-11814 (b)	rock glacier	36 33 34.41 N, 118 14 16.09 W	3270-3390
Rock Glacier 3633-11816	rock glacier	36 33 5.57 N, 118 16 53.16 W	3750-3910
Rock Glacier 3633-11816 (b)	rock glacier	36 33 19.95 N, 118 16 13.17 W	3605-3835

Rock Glacier 3633-11817	rock glacier	36 33 36.20 N, 118 17 0.85 W	3830-3915
Rock Glacier 3633-11817 (b)	rock glacier	36 33 18.79 N, 118 17 51.30 W	3650-3785
Rock Glacier 3633-11817 (c)	rock glacier	36 33 47.88 N, 118 17 7.51 W	3675-3910
Glacier 3633-11829	uncovered	36 33 37.32 N, 119 29 25.78 W	3645-3770
Rock Glacier 3633-11830	rock glacier	36 33 33.28 N, 118 30 37.60 W	3695-3895
Rock Glacier 3633-11830 (b)	rock glacier	36 33 59.49 N, 118 30 40.32 W	3620-3900
Rock Glacier 3633-11830 (c)	rock glacier	36 33 27.88 N, 118 30 6.01 W	3695-3895
Rock Glacier 3633-11830 (d)	rock glacier	36 33 8.20 N, 118 30 14.96 W	3680-3830
Rock Glacier 3634-11817	rock glacier	36 34 38.36 N, 118 17 4.20 W	3720-3800
Rock Glacier 3634-11817 (c)	rock glacier	36 34 1.76 N, 118 17 15.96 W	3785-3875
Glacier 3634-11832	uncovered	36 34 22.60 N, 118 32 56.74 W	3415-3540
Glacier 3634-11833	uncovered	36 34 20.30 N, 118 33 10.37 W	3270-3445
Rock Glacier 3635-11815	rock glacier	36 35 50.70 N, 118 15 37.92 W	3460-3540
Rock Glacier 3635-11816	rock glacier	36 35 51.10 N, 118 16 7.81 W	3580-3655
Rock Glacier 3635-11816 (b)	rock glacier	36 35 5.26 N, 118 16 57.85 W	3660-3710
Rock Glacier 3635-11818	rock glacier	36 35 25.32 N, 118 18 37.34 W	3600-3700
Rock Glacier 3635-11819	rock glacier	36 35 7.09 N, 118 19 54.64 W	3495-3635
Rock Glacier 3635-11826	rock glacier	36 35 53.98 N, 118 26 23.59 W	3505-3605
Rock Glacier 3635-11832	rock glacier	36 35 4.14 N, 118 32 6.26 W	3430-3505
Rock Glacier 3636-11815	rock glacier	36 36 21.11 N, 118 15 42.38 W	3210-3405
Rock Glacier 3636-11816	rock glacier	36 36 2.64 N, 118 16 25.50 W	3540-3750
Rock Glacier 3636-11826	rock glacier	36 36 28.85 N, 118 26 50.15 W	3580-3645
Rock Glacier 3637-11816	rock glacier	36 37 28.38 N, 118 16 53.75 W	3205-3275
Rock Glacier 3637-11817	rock glacier	36 37 41.35 N, 118 17 51.79 W	3395-3655
Rock Glacier 3637-11817 (b)	rock glacier	36 37 11.38 N, 118 17 5.31 W	3410-3470
Rock Glacier 3637-11828	rock glacier	36 37 27.74 N, 118 28 5.25 W	3605-3700
Rock Glacier 3637-11828 (b)	rock glacier	36 37 26.18 N, 118 28 11.19 W	3630-3750
Rock Glacier 3637-11829	rock glacier	36 37 52.74 N, 118 29 37.09 W	3565-3780
Rock Glacier 3638-11828	rock glacier	36 38 54.72 N, 118 28 26.69 W	3650-3800
Rock Glacier 3638-11829	rock glacier	36 38 53.11 N, 118 29 1.69 W	3830-3920
Rock Glacier 3639-11816	rock glacier	36 39 24.64 N, 118 16 42.98 W	3130-3185
Rock Glacier 3639-11817	rock glacier	36 39 1.49 N, 118 17 17.82 W	3510-3595
Rock Glacier 3639-11817	rock glacier	36 39 36.75 N, 118 17 34.52 W	3325-3670
Rock Glacier 3639-11819	rock glacier	36 39 20.62 N, 118 19 49.77 W	3720-3885
Rock Glacier 3639-11819 (b)	rock glacier	36 39 47.15 N, 118 19 4.35 W	3500-3600
Rock Glacier 3639-11819 (c)	rock glacier	36 39 18.64 N, 118 19 14.20 W	3700-3860
Rock Glacier 3639-11819 (d)	rock glacier	36 39 33.02 N, 118 19 30.23 W	3600-3700
Rock Glacier 3639-11826	rock glacier	36 39 21.93 N, 118 26 54.20 W	3560-3660
Rock Glacier 3639-11827	rock glacier	36 39 40.28 N, 118 27 16.94 W	3410-3535
Rock Glacier 3639-11828	rock glacier	36 39 43.16 N, 118 28 58.59 W	3625-3805
Rock Glacier 3639-11828 (b)	rock glacier	36 39 42.16 N, 118 28 7.03 W	3735-3900
Rock Glacier 3639-11829	rock glacier	36 39 17.14 N, 118 29 2.79 W	3660-3850
Rock Glacier 3639-11829 (b)	rock glacier	36 39 19.64 N, 118 29 34.75 W	3450-3580
Rock Glacier 3640-11820	rock glacier	36 40 38.37 N, 118 20 34.89 W	3445-3515
Rock Glacier 3640-11821	rock glacier	36 40 34.97 N, 118 21 45.81 W	3695-3775
Rock Glacier 3640-11829	rock glacier	36 40 12.32 N, 118 29 39.16 W	3415-3560
Rock Glacier 3640-11829 (b)	rock glacier	36 40 12.60 N, 118 29 31.57 W	3420-3490
Rock Glacier 3641-11822	rock glacier	36 41 44.82 N, 118 22 5.69 W	3755-3870
Rock Glacier 3641-11822 (b)	rock glacier	36 41 19.67 N, 118 22 49.04 W	3825-3945
Rock Glacier 3641-11827	rock glacier	36 41 30.67 N, 118 27 0.69 W	3400-3545
Rock Glacier 3641-11828	rock glacier	36 41 16.18 N, 118 28 23.22 W	3505-3650
Rock Glacier 3641-11830	rock glacier	36 41 55.44 N, 118 30 1.51 W	3480-3605
Rock Glacier 3841-11831	rock glacier	36 41 57.19 N, 118 31 1.34 W	3285-3420
Rock Glacier 3642-11819	rock glacier	36 42 39.82 N, 118 19 20.98 W	3100-3270

Rock Glacier 3642-11820	rock glacier	36 42 21.51 N, 118 20 58.20 W	3600-3750
Rock Glacier 3642-11820 (b)	rock glacier	36 42 56.46 N, 118 20 22.54 W	3605-3725
Rock Glacier 3642-11820 (c)	rock glacier	36 42 46.91 N, 118 20 40.15 W	3515-3640
Rock Glacier 3642-11821	rock glacier	36 42 20.94 N, 118 21 45.55 W	3620-3745
Rock Glacier 3642-11821 (b)	rock glacier	36 42 1.39 N, 118 21 53.33 W	3740-3815
Rock Glacier 3642-11822	rock glacier	36 42 10.31 N, 118 22 36.95 W	3580-3775
Rock Glacier 3642-11823	rock glacier	36 42 22.99 N, 118 23 9.94 W	3650-3945
Rock Glacier 3642-11823 (b)	rock glacier	36 42 50.19 N, 118 23 36.17 W	3600-3820
Rock Glacier 3642-11823 (c)	rock glacier	36 42 27.51 N, 118 23 35.96 W	3810-3940
Rock Glacier 3642-11824	rock glacier	36 42 5.08 N, 118 24 44.33 W	3605-3790
Rock Glacier 3642-11824 (b)	rock glacier	36 42 9.01 N, 118 24 10.54 W	3660-3840
Rock Glacier 3642-11824 (c)	rock glacier	36 42 49.26 N, 118 24 21.37 W	3565-3720
Rock Glacier 3642-11825	rock glacier	36 42 0.71 N, 118 25 24.59 W	3385-3625
Rock Glacier 3642-11827	rock glacier	36 42 28.72 N, 118 27 49.82 W	3495-3640
Rock Glacier 3642-11828	rock glacier	36 42 22.12 N, 118 28 33.48 W	3610-3760
Rock Glacier 3642-11828 (b)	rock glacier	36 42 43.52 N, 118 28 46.32 W	3695-3940
Rock Glacier 3643-11821	rock glacier	36 43 42.14 N, 118 21 47.28 W	3355-3450
Rock Glacier 3643-11822	rock glacier	36 43 47.24 N, 118 22 58.00 W	3310-3530
Rock Glacier 3643-11823	rock glacier	36 43 21.44 N, 118 23 36.60 W	3530-3700
Rock Glacier 3643-11824	rock glacier	36 43 47.73 N, 118 24 53.59 W	3465-3600
Rock Glacier 3643-11825	rock glacier	36 43 8.87 N, 118 25 34.63 W	3430-3500
Rock Glacier 3643-11829	rock glacier	36 43 9.47 N, 118 29 53.87 W	3495-3700
Rock Glacier 3643-11829 (b)	rock glacier	36 43 47.93 N, 118 29 27.86 W	3420-3600
Rock Glacier 3643-11829 (c)	rock glacier	36 43 13.37 N, 118 29 21.27 W	3630-3770
Rock Glacier 3644-11820	rock glacier	36 44 15.89 N, 118 20 38.41 W	3470-3585
Rock Glacier 3644-11820 (b)	rock glacier	36 44 15.34 N, 118 20 38.24 W	3480-3570
Rock Glacier 3644-11821	rock glacier	36 44 46.71 N, 118 21 12.95 W	3520-3765
Rock Glacier 3644-11821 (b)	rock glacier	36 44 47.74 N, 118 21 13.51 W	3530-3770
Rock Glacier 3644-11829	rock glacier	36 44 5.91 N, 118 29 51.88 W	3385-3515
Rock Glacier 3645-11821	rock glacier	36 45 22.32 N, 118 21 28.50 W	3400-3560
Rock Glacier 3645-11821	rock glacier	36 45 21.84 N, 118 21 28.54 W	3395-3505
Rock Glacier 3647-11822	rock glacier	36 47 28.23 N, 118 22 12.13 W	3500-3635
Rock Glacier 3647-11822 (b)	rock glacier	36 47 29.36 N, 118 22 11.00 W	3505-3630
Rock Glacier 3647-11822 (c)	rock glacier	36 47 16.70 N, 118 22 12.65 W	3535-3705
Rock Glacier 3647-11823	rock glacier	36 47 3.52 N, 118 23 14.78 W	3595-3715
Rock Glacier 3647-11823 (b)	rock glacier	36 47 13.50 N, 118 23 38.78 W	3555-3685
Rock Glacier 3647-11824	rock glacier	36 47 19.12 N, 118 24 13.42 W	3465-3555
Rock Glacier 3647-11824 (b)	rock glacier	36 47 22.22 N, 118 24 15.53 W	3475-3585
Rock Glacier 3647-11825	rock glacier	36 47 56.66 N, 118 25 17.08 W	3440-3565
Rock Glacier 3648-11821	rock glacier	36 48 30.05 N, 118 21 55.47 W	3450-3590
Rock Glacier 3648-11821 (b)	rock glacier	36 48 9.59 N, 118 21 19.08 W	3280-3380
Rock Glacier 3648-11821 (c)	rock glacier	36 48 0.70 N, 118 21 58.87 W	3370-3535
Rock Glacier 3648-11826	rock glacier	36 48 14.57 N, 118 26 50.12 W	3490-3660
Rock Glacier 3649-11822	rock glacier	36 49 15.04 N, 118 22 42.28 W	3455-3550
Rock Glacier 3649-11822 (b)	rock glacier	36 49 31.66 N, 118 22 15.52 W	3285-3390
Rock Glacier 3649-11822 (c)	rock glacier	36 49 37.69 N, 118 22 39.04 W	3475-3505
Rock Glacier 3649-11822 (d)	rock glacier	36 49 27.48 N, 118 22 1.35 W	3460-3710
Rock Glacier 3649-11823	rock glacier	36 49 50.14 N, 118 23 8.84 W	3550-3625
Rock Glacier 3649-11823 (b)	rock glacier	36 49 49.13 N, 118 23 12.31 W	3555-3640
Rock Glacier 3650-11822	rock glacier	36 50 33.33 N, 118 22 56.66 W	3330-3520
Rock Glacier 3650-11823	rock glacier	36 50 21.63 N, 118 23 21.88 W	3515-3680
Rock Glacier 3650-11823 (b)	rock glacier	36 50 20.63 N, 118 23 20.94 W	3505-3670
Rock Glacier 3650-11823 (c)	rock glacier	36 50 48.29 N, 118 23 46.49 W	3280-3380
Rock Glacier 3650-11827	rock glacier	36 50 10.06 N, 118 27 6.87 W	3325-3480

Rock Glacier 3650-11827 (b)	rock glacier	36 50 17.44 N, 118 27 45.24 W	3340-3470
Rock Glacier 3651-11820	rock glacier	36 51 56.09 N, 118 20 43.38 W	3385-3550
Rock Glacier 3651-11821	rock glacier	36 51 12.42 N, 118 21 7.41 W	3205-3385
Rock Glacier 3651-11822	rock glacier	36 51 57.47 N, 118 22 22.77 W	3480-3710
Rock Glacier 3651-11822 (b)	rock glacier	36 51 42.79 N, 118 22 55.22 W	3580-3690
Rock Glacier 3651-11824	rock glacier	36 51 38.33 N, 118 24 11.17 W	3255-3430
Rock Glacier 3652-11821	rock glacier	36 52 8.38 N, 118 21 43.88 W	3520-3620
Rock Glacier 3652-11821 (b)	rock glacier	36 52 23.79 N, 118 21 20.65 W	3285-3490
Rock Glacier 3652-11821 (c)	rock glacier	36 52 43.08 N, 118 21 16.91 W	3250-3340
Rock Glacier 3652-11821 (d)	rock glacier	36 52 51.66 N, 118 21 7.08 W	3180-3260
Rock Glacier 3652-11822	rock glacier	36 52 15.89 N, 118 22 45.39 W	3525-3710
Rock Glacier 3652-11822 (b)	rock glacier	36 52 8.00 N, 118 22 13.33 W	3560-3585
Rock Glacier 3652-11822 (c)	rock glacier	36 52 32.00 N, 118 22 13.98 W	3510-3540
Rock Glacier 3652-11823	rock glacier	36 52 31.00 N, 118 23 56.83 W	3435-3570
Rock Glacier 3652-11823 (b)	rock glacier	36 52 32.46 N, 118 23 20.37 W	3440-3570
Rock Glacier 3652-11823 (c)	rock glacier	36 52 41.69 N, 118 23 5.98 W	3360-3440
Rock Glacier 3652-11823 (d)	rock glacier	36 52 44.05 N, 118 23 33.60 W	3400-3460
Rock Glacier 3653-11820	rock glacier	36 53 1.83 N, 118 20 40.61 W	3060-3220
Rock Glacier 3653-11820 (b)	rock glacier	36 53 46.78 N, 118 20 56.52 W	3015-3180
Rock Glacier 3654-11821	rock glacier	36 54 6.95 N, 118 21 38.58 W	3270-3405
Rock Glacier 3654-11821 (b)	rock glacier	36 54 18.35 N, 118 21 30.54 W	3240-3350
Rock Glacier 3654-11821 (c)	rock glacier	36 54 17.95 N, 118 21 19.09 W	3200-3285
Rock Glacier 3654-11822	rock glacier	36 54 36.50 N, 118 22 38.21 W	3335-3430
Rock Glacier 3655-11822	rock glacier	36 55 32.22 N, 118 22 23.72 W	3220-3550
Rock Glacier 3655-11822 (b)	rock glacier	36 55 50.13 N, 118 22 4.36 W	3025-3190
Rock Glacier 3655-11829	rock glacier	36 55 57.12 N, 118 29 21.39 W	3430-3520
Rock Glacier 3656-11825	rock glacier	36 56 15.32 N, 118 25 46.88 W	3460-3660
Rock Glacier 3656-11825 (b)	rock glacier	36 56 2.59 N, 118 25 8.73 W	3500-3660
Rock Glacier 3657-11822	rock glacier	36 57 2.19 N, 118 22 54.63 W	3250-3385
Rock Glacier 3657-11823	rock glacier	36 57 48.57 N, 118 23 48.52 W	3520-3590
Rock Glacier 3657-11824	rock glacier	36 57 34.85 N, 118 24 48.78 W	3535-3655
Rock Glacier 3657-11830	rock glacier	36 57 52.36 N, 118 30 38.59 W	3405-3580
Rock Glacier 3658-11824	rock glacier	36 58 12.45 N, 118 24 34.80 W	3550-3710
Rock Glacier 3658-11828	rock glacier	36 58 52.71 N, 118 28 58.85 W	3390-3550
Rock Glacier 3658-11830	rock glacier	36 58 0.49 N, 118 30 31.59 W	3280-3385
Rock Glacier 3658-11830 (b)	rock glacier	36 58 2.86 N, 118 30 5.07 W	3340-3420
Rock Glacier 3659-11824	rock glacier	36 59 11.98 N, 118 24 0.66 W	3190-3300
Rock Glacier 3659-11825	rock glacier	36 59 59.51 N, 118 25 23.26 W	3500-3720
Rock Glacier 3659-11828	rock glacier	36 59 20.65 N, 118 28 20.45 W	3670-3790
Rock Glacier 3659-11830	rock glacier	36 59 43.68 N, 118 30 51.80 W	3525-3610
Rock Glacier 370-11823	rock glacier	37 0 31.51 N, 118 23 56.28 W	3075-3500
Rock Glacier 370-11823 (b)	rock glacier	37 0 28.32 N, 118 23 42.43 W	2974-3440
Rock Glacier 370-11824	rock glacier	37 0 41.34 N, 118 24 35.04 W	3250-3660
Rock Glacier 370-11824 (b)	rock glacier	37 0 30.34 N, 118 24 24.82 W	3260-3580
Rock Glacier 370-11824 (c)	rock glacier	37 0 32.25 N, 118 24 51.20 W	3460-3625
Rock Glacier 370-11827	rock glacier	37 0 12.25 N, 118 27 43.32 W	3365-3430
Rock Glacier 370-11828	rock glacier	37 0 19.41 N, 118 28 3.40 W	3390-3675
Rock Glacier 370-11828 (b)	rock glacier	37 0 6.07 N, 118 28 33.90 W	3650-3750
Rock Glacier 370-11828 (c)	rock glacier	37 0 24.32 N, 118 28 49.60 W	3635-3700
Rock Glacier 370-11829	rock glacier	37 0 29.82 N, 118 29 13.33 W	3575-3720
Rock Glacier 370-11832	rock glacier	37 0 13.88 N, 118 32 55.40 W	3260-3350
Rock Glacier 370-11833	rock glacier	37 0 9.38 N, 118 33 4.91 W	3240-3290
Rock Glacier 371-11823	rock glacier	37 1 7.15 N, 118 23 42.22 W	3100-3165
Rock Glacier 371-11824	rock glacier	37 1 40.30 N, 118 24 57.81 W	3610-3690

Rock Glacier 371-11824 (b)	rock glacier	37 1 41.68 N, 118 24 0.94 W	3330-3550
Rock Glacier 371-11825	rock glacier	37 1 0.45 N, 118 25 52.29 W	3660-3830
Rock Glacier 371-11828	rock glacier	37 1 46.59 N, 118 28 8.83 W	3525-3670
Rock Glacier 371-11828 (b)	rock glacier	37 1 43.69 N, 118 28 25.90 W	3625-3765
Rock Glacier 371-11829	rock glacier	37 1 36.13 N, 118 29 6.87 W	3570-3680
Rock Glacier 371-11831	rock glacier	37 1 01.23 N, 118 31 14.60 W	3445-3645
Rock Glacier 371-11831 (b)	rock glacier	37 1 35.73 N, 118 31 4.65 W	3355-3540
Rock Glacier 371-11836	rock glacier	37 1 27.45 N, 118 36 37.35 W	3270-3485
Rock Glacier 372-11825	rock glacier	37 2 7.81 N, 118 25 6.88 W	3390-3580
Rock Glacier 372-11824	rock glacier	37 2 12.30 N, 118 24 35.96 W	3350-3510
Rock Glacier 372-11824 (b)	rock glacier	37 2 43.03 N, 118 24 53.90 W	3240-3520
Rock Glacier 372-11824 (c)	rock glacier	37 2 38.15 N, 118 24 12.64 W	2960-3150
Rock Glacier 372-11825 (b)	rock glacier	37 2 26.93 N, 118 25 33.89 W	3480-3760
Rock Glacier 372-11825 (c)	rock glacier	37 2 45.57 N, 118 25 55.77 W	3600-3700
Rock Glacier 372-11825 (d)	rock glacier	37 2 56.46 N, 118 25 6.75 W	3380-3765
Rock Glacier 372-11827	rock glacier	37 2 27.12 N, 118 27 20.70 W	3690-3720
Rock Glacier 372-11828	rock glacier	37 2 10.73 N, 118 28 51.70 W	3580-3785
Rock Glacier 372-11828 (b)	rock glacier	37 2 25.48 N, 118 28 54.87 W	3630-3675
Rock Glacier 372-11828 (c)	rock glacier	37 2 45.87 N, 118 28 44.32 W	3535-3645
Rock Glacier 372-11828 (d)	rock glacier	37 2 3.92 N, 118 28 36.57 W	3540-3680
Rock Glacier 372-11830	rock glacier	37 2 28.21 N, 118 30 4.77 W	3370-3460
Rock Glacier 372-11830 (b)	rock glacier	37 2 49.29 N, 118 30 18.21 W	3225-3400
Glacier 372-11836	uncovered	37 2 27.89 N, 118 36 45.35 W	3345-3515
Rock Glacier 372-11837	rock glacier	37 2 32.04 N, 118 37 17.17 W	3350-3450
Rock Glacier 373-11825	rock glacier	37 3 51.95 N, 118 25 49.27 W	3450-3780
Rock Glacier 373-11825 (b)	rock glacier	37 3 16.09 N, 118 25 22.07 W	3645-3675
Rock Glacier 373-11827	rock glacier	37 3 3.21 N, 118 27 8.61 W	3555-3650
Rock Glacier 373-11827 (b)	rock glacier	37 3 0.78 N, 118 27 27.91 W	3540-3660
Rock Glacier 373-11828	rock glacier	37 3 48.73 N, 118 28 20.43 W	3590-3800
Rock Glacier 373-11837	rock glacier	37 3 10.16 N, 118 37 56.00 W	3440-3645
Rock Glacier 373-11837 (b)	rock glacier	37 3 34.68 N, 118 37 48.27 W	3420-3670
Rock Glacier 373-11837 (c)	rock glacier	37 3 38.65 N, 118 37 1.96 W	3355-3490
Rock Glacier 374-11825	rock glacier	37 4 58.02 N, 118 25 34.17 W	3375-3525
Rock Glacier 374-11826	rock glacier	37 4 24.44 N, 118 26 33.78 W	3650-3740
Rock Glacier 374-11826 (b)	rock glacier	37 4 37.41 N, 118 26 21.46 W	3530-3620
Rock Glacier 374-11826 (c)	rock glacier	37 4 0.54 N, 118 26 10.40 W	3590-3790
Glacier 374-11827	uncovered	37 4 11.50 N, 118 27 47.53 W	3530-4010
Rock Glacier 374-11827	rock glacier	37 4 42.99 N, 118 27 1.84 W	3355-3690
Glacier 374-11828	uncovered	37 4 32.27 N, 118 28 8.51 W	3580-3910
Glacier 374-11828 (b)	uncovered	37 4 44.13 N, 118 28 47.34 W	3675-3915
Rock Glacier 374-11833	rock glacier	37 4 46.87 N, 118 33 0.03 W	3450-3615
Rock Glacier 374-11833 (b)	rock glacier	37 4 48.38 N, 118 33 47.16 W	3500-3625
Rock Glacier 374-11834	rock glacier	37 4 50.83 N, 118 34 17.11 W	3505-3615
Glacier 374-11838	uncovered	37 4 24.09 N, 118 38 22.20 W	3645-3850
Rock Glacier 374-11838	rock glacier	37 4 32.69 N, 118 38 56.70 W	3600-3710
Rock Glacier 374-11838 (b)	rock glacier	37 4 6.56 N, 118 38 1.04 W	3540-3670
Rock Glacier 374-11839	rock glacier	37 4 6.20 N, 118 39 29.92 W	3215-3475
Rock Glacier 374-11841	rock glacier	37 4 37.23 N, 118 41 25.37 W	3610-3815
Rock Glacier 375-11825	rock glacier	37 5 11.78 N, 118 25 55.36 W	3575-3640
Glacier 375-11829	uncovered	37 5 45.05 N, 118 29 55.53 W	3745-4025
Rock Glacier 375-11829	rock glacier	37 5 17.61 N, 118 29 3.25 W	3580-3880
Rock Glacier 375-11829 (b)	rock glacier	37 5 23.61 N, 118 29 55.33 W	3840-3970
Glacier 375-11830			
The North Palisade Glacier	uncovered	37 5 56.23 N, 118 30 35.61 W	3730-4080

Glacier 375-11830 (b)	uncovered	37 5 32.66 N, 118 30 28.47 W	4025-4195
Rock Glacier 375-11830	rock glacier	37 5 14.62 N, 118 30 51.88 W	3590-3815
Rock Glacier 375-11831	rock glacier	37 5 49.19 N, 118 31 43.58 W	3570-3770
Rock Glacier 375-11832	rock glacier	37 5 30.22 N, 118 32 40.93 W	3455-3640
Rock Glacier 375-11832 (b)	rock glacier	37 5 47.41 N, 118 32 16.78 W	3490-3550
Rock Glacier 375-11832 (c)	rock glacier	37 5 37.10 N, 118 32 3.32 W	3600-3690
Rock Glacier 375-11834	rock glacier	37 5 0.17 N, 118 34 24.50 W	3400-3595
Rock Glacier 375-11837	rock glacier	37 5 16.99 N, 118 37 34.41 W	3590-3670
Rock Glacier 375-11838	rock glacier	37 5 40.65 N, 118 38 8.28 W	3475-3605
Rock Glacier 375-11838 (b)	rock glacier	37 5 51.00 N, 118 38 24.20 W	3565-3740
Rock Glacier 375-11838 (c)	rock glacier	37 5 59.20 N, 118 38 0.27 W	3380-3515
Rock Glacier 375-11840	rock glacier	37 5 32.04 N, 118 40 20.98 W	3465-3720
Rock Glacier 375-11841	rock glacier	37 5 3.20 N, 118 41 7.78 W	3370-3730
Rock Glacier 376-11829	rock glacier	37 6 48.47 N, 118 29 7.71 W	3335-3470
Rock Glacier 376-11829 (b)	rock glacier	37 6 41.32 N, 118 29 50.36 W	3400-3600
Glacier 376-11830	rock glacier	37 6 34.82 N, 118 30 16.06 W	3590-3825
Glacier 376-11831	rock glacier	37 6 12.24 N, 118 31 4.21 W	3600-3940
Rock Glacier 376-11837	rock glacier	37 6 11.73 N, 118 37 40.84 W	3350-3570
Glacier 376-11838	uncovered	37 6 20.15 N, 118 38 48.51 W	3550-3745
Rock Glacier 376-11838	rock glacier	37 6 0.22 N, 118 38 24.70 W	3540-3750
Rock Glacier 376-11838 (b)	rock glacier	37 6 11.95 N, 118 38 30.29 W	3485-3750
Rock Glacier 376-11839	rock glacier	37 6 41.78 N, 118 39 6.50 W	3575-3725
Rock Glacier 376-11839 (b)	rock glacier	37 6 27.99 N, 118 39 6.75 W	3670-3825
Rock Glacier 376-11839 (c)	rock glacier	37 6 13.97 N, 118 39 44.96 W	3670-3770
Rock Glacier 376-11840	rock glacier	37 6 36.75 N, 118 40 38.81 W	3690-3770
Rock Glacier 376-11842	rock glacier	37 6 36.76 N, 118 42 49.04 W	3580-3795
Rock Glacier 376-11842 (b)	rock glacier	37 6 30.79 N, 118 42 6.97 W	3525-3920
Rock Glacier 376-11843	rock glacier	37 6 30.01 N, 118 43 7.47 W	3730-3920
Rock Glacier 376-11843 (b)	rock glacier	37 6 26.86 N, 118 43 34.07 W	3620-3820
Rock Glacier 376-11846	rock glacier	37 6 8.51 N, 118 46 18.21 W	3395-3490
Rock Glacier 377-11830	rock glacier	37 7 34.23 N, 118 30 42.07 W	3420-3630
Glacier 377-11831	rock glacier	37 7 10.87 N, 118 31 22.39 W	3585-3910
Glacier 377-11831 (b)	rock glacier	37 7 51.76 N, 118 31 39.74 W	3625-3780
Rock Glacier 377-11832	rock glacier	37 7 49.96 N, 118 32 0.68 W	3700-3830
Rock Glacier 377-11832 (b)	rock glacier	37 7 6.54 N, 118 32 22.05 W	3520-3755
Rock Glacier 377-11832 (c)	rock glacier	37 7 18.31 N, 118 32 25.08 W	3520-3770
Rock Glacier 377-11832 (d)	rock glacier	37 7 27.53 N, 118 32 40.87 W	3455-3740
Rock Glacier 377-11833	rock glacier	37 7 49.92 N, 118 33 38.62 W	3350-3785
Rock Glacier 377-11834	rock glacier	37 7 32.54 N, 118 34 49.10 W	3620-3810
Rock Glacier 377-11834 (b)	rock glacier	37 7 39.73 N, 118 34 39.29 W	3600-3610
Rock Glacier 377-11835	rock glacier	37 7 56.45 N, 118 35 0.98 W	3490-3650
Rock Glacier 377-11838	rock glacier	37 7 32.49 N, 118 38 9.49 W	3470-3690
Rock Glacier 377-11840	rock glacier	37 7 58.47 N, 118 40 38.41 W	3670-3860
Rock Glacier 377-11843	rock glacier	37 7 1.34 N, 118 43 35.27 W	3650-3690
Rock Glacier 377-11844	rock glacier	37 7 26.96 N, 118 44 6.62 W	3380-3555
Rock Glacier 378-11828	rock glacier	37 8 58.54 N, 118 28 24.03 W	3365-3445
Rock Glacier 378-11828 (b)	rock glacier	37 8 50.76 N, 118 28 37.38 W	3415-3515
Rock Glacier 378-11829	rock glacier	37 8 49.45 N, 118 29 6.22 W	3530-3660
Rock Glacier 378-11832	rock glacier	37 8 7.93 N, 118 32 17.06 W	3540-3670
Rock Glacier 378-11832 (b)	rock glacier	37 8 34.09 N, 118 32 21.57 W	3490-3630
Rock Glacier 378-11835	rock glacier	37 8 40.65 N, 118 35 43.40 W	3550-3820
Rock Glacier 378-11836	rock glacier	37 8 37.73 N, 118 36 2.85 W	3550-3930
Rock Glacier 378-11836 (b)	rock glacier	37 8 51.32 N, 118 36 59.94 W	3650-3840
Rock Glacier 378-11837	rock glacier	37 8 52.65 N, 118 37 11.65 W	3505-3820

Rock Glacier 378-11837 (b)	rock glacier	37 8 54.37 N, 118 37 51.55 W	3470-3820
Rock Glacier 378-11837 (c)	rock glacier	37 8 13.32 N, 118 37 10.72 W	3710-3840
Rock Glacier 378-11837 (d)	rock glacier	37 8 58.58 N, 118 37 23.03 W	3585-3780
Rock Glacier 378-11838	rock glacier	37 8 40.18 N, 118 38 58.11 W	3635-3730
Rock Glacier 378-11839	rock glacier	37 8 34.08 N, 118 39 34.08 W	3670-3860
Rock Glacier 378-11839 (b)	rock glacier	37 8 21.96 N, 118 39 59.62 W	3765-3960
Rock Glacier 378-11839 (c)	rock glacier	37 8 33.98 N, 118 39 38.52 W	3670-3840
Rock Glacier 378-11841	rock glacier	37 8 33.28 N, 118 41 0.80 W	3480-3610
Rock Glacier 378-11844	rock glacier	37 8 36.93 N, 118 44 9.39 W	3340-3685
Rock Glacier 378-11844 (b)	rock glacier	37 8 57.71 N, 118 44 52.89 W	3415-3625
Rock Glacier 379-11830	rock glacier	37 9 15.40 N, 118 30 1.99 W	3315-3470
Rock Glacier 379-11831	rock glacier	37 9 50.33 N, 118 31 48.27 W	3430-3550
Rock Glacier 379-11832	rock glacier	37 9 35.41 N, 118 32 11.68 W	3530-3670
Rock Glacier 379-11839	rock glacier	37 9 15.17 N, 118 39 9.25 W	3635-3820
Rock Glacier 379-11839 (b)	rock glacier	37 9 9.85 N, 118 39 29.23 W	3785-3930
Rock Glacier 379-11839 (c)	rock glacier	37 9 51.99 N, 118 39 47.51 W	3635-3885
Rock Glacier 379-11845	rock glacier	37 9 1.97 N, 118 45 5.71 W	3490-3590
Rock Glacier 379-11845 (b)	rock glacier	37 9 28.07 N, 118 45 29.86 W	3595-3690
Rock Glacier 3710-11829	rock glacier	37 10 42.17 N, 118 29 52.98 W	3300-3375
Rock Glacier 3710-11829 (b)	rock glacier	37 10 51.01 N, 118 29 28.34 W	3250-3320
Rock Glacier 3710-11831	rock glacier	37 10 0.21 N, 118 31 43.99 W	3380-3470
Rock Glacier 3710-11839	rock glacier	37 10 56.11 N, 118 39 43.80 W	3645-3775
Rock Glacier 3710-11839 (b)	rock glacier	37 10 30.30 N, 118 39 11.84 W	3510-3585
Glacier 3710-11840	uncovered	37 10 13.82 N, 118 40 18.89 W	3830-4080
Glacier 3710-11840 (b)	uncovered	37 10 14.94 N, 118 40 37.68 W	3795-4040
Rock Glacier 3710-11840	rock glacier	37 10 47.11 N, 118 40 53.45 W	3590-3905
Rock Glacier 3710-11845	rock glacier	37 10 9.86 N, 118 45 41.79 W	3380-3530
Rock Glacier 3710-11849	rock glacier	37 10 19.37 N, 118 49 19.27 W	3465-3590
Rock Glacier 3711-11841	rock glacier	37 11 7.68 N, 118 41 16.54 W	3550-3580
Rock Glacier 3711-11841 (b)	rock glacier	37 11 8.65 N, 118 41 36.80 W	3540-3585
Rock Glacier 3712-11839	rock glacier	37 12 6.86 N, 118 39 53.95 W	3500-3755
Rock Glacier 3712-11839 (b)	rock glacier	37 12 19.12 N, 118 39 10.45 W	3440-3545
Rock Glacier 3712-11840	rock glacier	37 12 19.22 N, 118 40 21.84 W	3650-3795
Rock Glacier 3712-11841	rock glacier	37 12 0.89 N, 118 41 13.40 W	3525-3660
Rock Glacier 3712-11842	rock glacier	37 12 43.26 N, 118 42 22.37 W	3570-3810
Rock Glacier 3712-11842 (b)	rock glacier	37 12 58.10 N, 118 42 5.10 W	3550-3690
Rock Glacier 3712-11842 (c)	rock glacier	37 12 52.39 N, 119 42 11.71 W	3580-3680
Rock Glacier 3713-11839	rock glacier	37 13 0.56 N, 118 39 18.96 W	3420-3540
Rock Glacier 3713-11840	rock glacier	37 13 4.00 N, 118 40 23.69 W	3545-3895
Rock Glacier 3713-11840 (b)	rock glacier	37 13 33.96 N, 118 40 33.36 W	3495-3730
Rock Glacier 3713-11840 (c)	rock glacier	37 13 3.99 N, 118 40 59.82 W	3660-3830
Rock Glacier 3713-11841	rock glacier	37 13 30.84 N, 118 41 48.89 W	3600-3695
Rock Glacier 3713-11842	rock glacier	37 13 4.32 N, 118 42 50.94 W	3650-3750
Rock Glacier 3713-11842 (b)	rock glacier	37 13 11.56 N, 118 42 1.44 W	3520-3640
Rock Glacier 3713-11843	rock glacier	37 13 27.57 N, 118 43 50.09 W	3450-3690
Rock Glacier 3713-11844	rock glacier	37 13 34.98 N, 118 44 57.61 W	3515-3730
Rock Glacier 3713-11844 (b)	rock glacier	37 13 42.31 N, 118 44 41.26 W	3420-3705
Rock Glacier 3713-11844 (c)	rock glacier	37 13 34.93 N, 118 44 18.05 W	3530-3700
Rock Glacier 3713-11844 (d)	rock glacier	37 13 28.96 N, 118 44 5.53 W	3605-3780
Rock Glacier 3713-11845	rock glacier	37 13 58.34 N, 118 45 42.78 W	3465-3640
Rock Glacier 3714-11838	rock glacier	37 14 50.26 N, 118 38 9.73 W	3250-3380
Rock Glacier 3714-11838 (b)	rock glacier	37 14 33.96 N, 118 38 26.41 W	3360-3470
Rock Glacier 3714-11845	rock glacier	37 14 0.51 N, 118 45 30.06 W	3360-3730
Rock Glacier 3714-11845 (b)	rock glacier	37 14 2.22 N, 118 45 58.90 W	3590-3705

Rock Glacier 3714-11846	rock glacier	37 14 36.47 N, 118 46 37.71 W	3355-3620
Rock Glacier 3714-11846 (b)	rock glacier	37 14 20.93 N, 118 46 13.79 W	3430-3660
Rock Glacier 3715-11838	rock glacier	37 15 0.03 N, 118 38 37.13 W	3280-3620
Rock Glacier 3715-11839	rock glacier	37 15 55.84 N, 118 39 7.62 W	3290-3600
Rock Glacier 3716-11839	rock glacier	37 16 4.29 N, 118 39 53.65 W	3605-3800
Rock Glacier 3716-11840	rock glacier	37 16 43.55 N, 118 40 4.17 W	3470-3870
Rock Glacier 3716-11843	rock glacier	37 16 43.57 N, 118 43 57.03 W	3450-3575
Rock Glacier 3717-11840	rock glacier	37 17 48.86 N, 118 40 30.27 W	3490-3640
Rock Glacier 3717-11842	rock glacier	37 17 27.33 N, 118 42 39.38 W	3550-3605
Rock Glacier 3717-11842 (b)	rock glacier	37 17 37.55 N, 118 42 22.50 W	3545-3625
Rock Glacier 3717-11847	rock glacier	37 17 15.07 N, 118 47 14.02 W	3315-3575
Rock Glacier 3717-11847 (b)	rock glacier	37 17 22.63 N, 118 47 23.21 W	3335-3404
Rock Glacier 3717-11848	rock glacier	37 17 57.01 N, 118 48 56.46 W	3670-3790
Rock Glacier 3717-11853	rock glacier	37 17 42.86 N, 118 53 49.28 W	3395-3535
Rock Glacier 3718-11840	rock glacier	37 18 53.27 N, 118 40 55.45 W	3380-3440
Rock Glacier 3718-11841	rock glacier	37 18 40.98 N, 118 41 53.06 W	3455-3650
Rock Glacier 3718-11841 (b)	rock glacier	37 18 4.20 N, 118 41 2.89 W	3325-3515
Rock Glacier 3718-11845	rock glacier	37 18 54.34 N, 118 45 48.84 W	3560-3590
Rock Glacier 3718-11845 (b)	rock glacier	37 18 22.73 N, 118 45 35.34 W	3505-3630
Rock Glacier 3718-11849	rock glacier	37 18 32.90 N, 118 49 25.24 W	3475-3650
Rock Glacier 3718-11853	rock glacier	37 18 33.44 N, 118 53 52.44 W	3360-3480
Rock Glacier 3719-11841	rock glacier	37 19 39.65 N, 118 41 43.75 W	3180-3320
Rock Glacier 3719-11841 (b)	rock glacier	37 19 2.69 N, 118 41 45.14 W	3345-3525
Rock Glacier 3719-11842	rock glacier	37 19 53.57 N, 118 42 49.95 W	3490-3655
Rock Glacier 3719-11842 (b)	rock glacier	37 19 2.89 N, 118 42 11.79 W	3430-3630
Rock Glacier 3719-11843	rock glacier	37 19 34.60 N, 118 43 39.33 W	3360-3475
Rock Glacier 3719-11844	rock glacier	37 19 30.80 N, 118 44 51.02 W	3440-3540
Rock Glacier 3719-11845	rock glacier	37 19 25.43 N, 118 45 58.54 W	3580-3780
Rock Glacier 3719-11846	rock glacier	37 19 46.99 N, 118 46 37.07 N	3650-3770
Rock Glacier 3719-11853	rock glacier	37 19 15.09 N, 118 53 47.57 W	3350-3510
Rock Glacier 3720-11842	rock glacier	37 20 22.22 N, 118 42 9.52 W	3335-3505
Rock Glacier 3720-11842 (b)	rock glacier	37 20 30.61 N, 118 42 36.88 W	3260-3500
Rock Glacier 3720-11846	rock glacier	37 20 32.89 N, 118 46 50.26 W	3590-3710
Rock Glacier 3720-11846 (b)	rock glacier	37 20 19.03 N, 118 46 36.46 W	3590-3740
Rock Glacier 3720-11847	rock glacier	37 20 55.34 N, 118 47 44.90 W	3520-3600
Rock Glacier 3721-11843	rock glacier	37 21 34.14 N, 118 43 53.51 W	3275-3365
Rock Glacier 3721-11844	rock glacier	37 21 49.51 N, 118 44 14.40 W	3345-3480
Rock Glacier 3721-11845	rock glacier	37 21 44.23 N, 118 45 35.79 W	3605-3845
Rock Glacier 3721-11846	rock glacier	37 21 39.89 N, 118 46 18.30 W	3680-3820
Rock Glacier 3721-11846 (b)	rock glacier	37 21 18.73 N, 118 46 33.23 W	3590-3810
Rock Glacier 3721-11846 (c)	rock glacier	37 21 7.37 N, 118 46 23.48 W	3535-3600
Rock Glacier 3721-11846 (d)	rock glacier	37 21 41.38 N, 118 46 33.48 W	3665-3765
Rock Glacier 3721-11846 (e)	rock glacier	37 21 55.80 N, 118 46 1.65 W	3840-3925
Rock Glacier 3721-11847	rock glacier	37 21 37.24 N, 118 47 36.64 W	3415-3545
Rock Glacier 3721-11849	rock glacier	37 21 56.00 N, 118 49 55.49 W	3545-3705
Rock Glacier 3721-11849 (b)	rock glacier	37 21 55.02 N, 118 49 13.08 W	3630-3720
Rock Glacier 3722-11843	rock glacier	37 22 52.99 N, 118 43 49.58 W	3160-3300
Rock Glacier 3722-11844	rock glacier	37 22 41.57 N, 118 44 6.74 W	3315-3420
Rock Glacier 3722-11844 (b)	rock glacier	37 22 3.86 N, 118 44 33.37 W	3425-3490
Rock Glacier 3722-11845	rock glacier	37 22 0.07 N, 118 45 2.98 W	3535-3600
Rock Glacier 3722-11845 (b)	rock glacier	37 22 42.75 N, 118 45 15.76 W	3590-3670
Rock Glacier 3722-11845 (c)	rock glacier	37 22 4.94 N, 118 45 29.43 W	3625-3700
Rock Glacier 3722-11845 (d)	rock glacier	37 22 18.38 N, 118 45 7.93 W	3530-3590
Rock Glacier 3722-11846	rock glacier	37 22 51.67 N, 118 46 12.64 W	3550-3730

Rock Glacier 3722-11846 (b)	rock glacier	37 22 31.35 N, 118 46 6.66 W	3655-3800
Rock Glacier 3722-11846 (c)	rock glacier	37 22 19.00 N, 118 46 1.78 W	3765-3910
Rock Glacier 3722-11847	rock glacier	37 22 56.80 N, 118 47 38.70 W	3640-3730
Rock Glacier 3722-11848	rock glacier	37 22 56.11 N, 118 48 24.95 W	3600-3800
Rock Glacier 3722-11849	rock glacier	37 22 15.39 N, 118 49 34.29 W	3580-3650
Rock Glacier 3722-11849 (b)	rock glacier	37 22 17.60 N, 118 49 17.66 W	3550-3690
Rock Glacier 3722-11849 (b)	rock glacier	37 22 22.37 N, 118 49 55.99 W	3590-3760
Rock Glacier 3722-11850	rock glacier	37 22 55.08 N, 118 50 54.86 W	3550-3680
Rock Glacier 3722-11850 (b)	rock glacier	37 22 40.27 N, 118 50 28.88 W	3515-3560
Rock Glacier 3723-11843	rock glacier	37 23 52.39 N, 118 43 25.83 W	3560-3650
Rock Glacier 3723-11844	rock glacier	37 23 25.30 N, 118 44 4.76 W	3370-3555
Rock Glacier 3723-11844 (b)	rock glacier	37 23 13.55 N, 118 44 51.05 W	3380-3470
Rock Glacier 3723-11844 (c)	rock glacier	37 23 40.70 N, 118 44 0.06 W	3500-3600
Rock Glacier 3723-11845	rock glacier	37 23 11.55 N, 118 45 11.11 W	3435-3465
Rock Glacier 3723-11846	rock glacier	37 23 43.30 N, 118 46 57.94 W	3615-3870
Rock Glacier 3723-11846 (b)	rock glacier	37 23 6.90 N, 118 46 36.29 W	3715-3980
Rock Glacier 3723-11846 (c)	rock glacier	37 23 38.72 N, 118 46 15.55 W	3530-3695
Rock Glacier 3723-11846 (d)	rock glacier	37 23 38.14 N, 118 46 29.63 W	3625-3800
Rock Glacier 3723-11846 (e)	rock glacier	37 23 21.08 N, 118 46 51.31 W	3820-3940
Rock Glacier 3723-11846 (f)	rock glacier	37 23 33.48 N, 118 46 47.88 W	3750-3770
Rock Glacier 3723-11847	rock glacier	37 23 18.78 N, 118 47 42.17 W	3510-3785
Rock Glacier 3723-11847 (b)	rock glacier	37 23 5.93 N, 118 47 51.08 W	3595-3865
Rock Glacier 3723-11847 (c)	rock glacier	37 23 57.70 N, 118 47 42.68 W	3680-3800
Rock Glacier 3723-11850	rock glacier	37 23 48.81 N, 118 50 59.92 W	3215-3490
Rock Glacier 3723-11851	rock glacier	37 23 52.50 N, 118 51 57.44 W	3190-3445
Rock Glacier 3723-11851 (b)	rock glacier	37 23 16.92 N, 118 51 25.18 W	3485-3715
Rock Glacier 3724-11842	rock glacier	37 24 25.35 N, 118 42 44.84 W	3600-3745
Rock Glacier 3724-11842 (b)	rock glacier	37 24 31.65 N, 118 42 59.59 W	3665-3760
Rock Glacier 3724-11842 (c)	rock glacier	37 24 57.48 N, 118 42 18.93 W	3450-3535
Rock Glacier 3724-11842 (d)	rock glacier	37 24 40.33 N, 118 42 26.38 W	3540-3590
Rock Glacier 3724-11843	rock glacier	37 24 8.29 N, 118 43 14.91 W	3620-3710
Rock Glacier 3724-11843 (b)	rock glacier	37 24 17.18 N, 118 43 22.44 W	3665-3770
Rock Glacier 3724-11844	rock glacier	37 24 5.87 N, 118 44 39.54 W	3460-3600
Rock Glacier 3724-11846	rock glacier	37 24 40.25 N, 118 46 47.27 W	3615-3750
Rock Glacier 3724-11847	rock glacier	37 24 10.03 N, 118 47 30.20 W	3605-3830
Rock Glacier 3724-11848	rock glacier	37 24 33.49 N, 118 48 13.84 W	3470-3620
Rock Glacier 3724-11848 (b)	rock glacier	37 24 54.33 N, 118 48 58.70 W	3415-3640
Rock Glacier 3724-11848 (c)	rock glacier	37 24 34.39 N, 118 48 32.37 W	3580-3630
Rock Glacier 3725-11841	rock glacier	37 25 37.83 N, 118 41 56.46 W	3290-3350
Rock Glacier 3725-11841 (b)	rock glacier	37 25 49.50 N, 118 41 42.85 W	3280-3350
Rock Glacier 3725-11842	rock glacier	37 25 32.14 N, 118 42 2.13 W	3320-3470
Rock Glacier 3725-11842 (b)	rock glacier	37 25 58.52 N, 118 42 55.84 W	3325-3380
Rock Glacier 3725-11843	rock glacier	37 25 1.94 N, 118 43 41.16 W	3445-3700
Rock Glacier 3725-11847	rock glacier	37 25 16.13 N, 118 47 54.33 W	3285-3480
Rock Glacier 3725-11849	rock glacier	37 25 8.61 N, 118 49 57.37 W	3260-3370
Rock Glacier 3726-11842	rock glacier	37 26 7.75 N, 118 42 40.66 W	3275-3320
Rock Glacier 3726-11853	rock glacier	37 26 38.90 N, 118 53 2.11 W	3140-3345
Rock Glacier 3727-11845	rock glacier	37 27 54.08 N, 118 45 16.18 W	3355-3440
Rock Glacier 3727-1191	rock glacier	37 27 8.85 N, 119 1 24.81 W	3175-3350
Rock Glacier 3728-11846	rock glacier	37 28 49.32 N, 118 46 53.73 W	3485-3630
Rock Glacier 3728-11846 (b)	rock glacier	37 28 30.40 N, 118 46 50.27 W	3465-3515
Rock Glacier 3728-11846 (c)	rock glacier	37 28 12.50 N, 118 46 1.30 W	3295-3395
Rock Glacier 3728-11846 (d)	rock glacier	37 28 30.61 N, 118 46 0.08 W	3325-3400
Rock Glacier 3728-11848	rock glacier	37 28 8.66 N, 118 48 39.21 W	3400-3500

Rock Glacier 3728-11849	rock glacier	37 28 56.84 N, 118 49 8.07 W	3440-3565
Rock Glacier 3728-11849 (b)	rock glacier	37 28 41.36 N, 118 49 5.80 W	3525-3620
Rock Glacier 3728-11850	rock glacier	37 28 45.40 N, 118 50 54.59 W	3415-3490
Rock Glacier 3728-11853	rock glacier	37 28 20.32 N, 118 53 34.15 W	3420-3580
Rock Glacier 3728-11854	rock glacier	37 28 47.71 N, 118 54 36.71 W	3340-3470
Rock Glacier 3728-1190	rock glacier	37 28 32.21 N, 119 0 55.84 W	3255-3385
Rock Glacier 3728-1191	rock glacier	37 28 36.26 N, 119 1 3.40 W	3240-3360
Rock Glacier 3729-11846	rock glacier	37 29 48.51 N, 118 46 28.46 W	3220-3330
Rock Glacier 3729-11846 (b)	rock glacier	37 29 56.02 N, 118 46 42.43 W	3275-3430
Rock Glacier 3729-11847	rock glacier	37 29 34.86 N, 118 47 55.48 W	3270-3580
Rock Glacier 3729-11847 (b)	rock glacier	37 29 30.45 N, 118 47 0.59 W	3505-3605
Rock Glacier 3729-11848	rock glacier	37 29 32.87 N, 118 48 11.58 W	3415-3530
Rock Glacier 3729-11848 (b)	rock glacier	37 29 37.26 N, 118 48 36.68 W	3200-3410
Rock Glacier 3729-11849	rock glacier	37 29 25.91 N, 118 49 15.67 W	3210-3425
Rock Glacier 3729-1191	rock glacier	37 29 14.84 N, 119 1 32.24 W	3180-3390
Rock Glacier 3729-1192	rock glacier	37 29 22.63 N, 119 2 2.80 W	3175-3270
Rock Glacier 3730-11846	rock glacier	37 30 8.17 N, 118 46 57.61 W	3390-3465
Rock Glacier 3730-11851	rock glacier	37 30 36.95 N, 118 51 31.63 W	3390-3520
Rock Glacier 3730-11852	rock glacier	37 30 56.19 N, 118 52 14.73 W	3335-3500
Rock Glacier 3731-11847	rock glacier	37 31 1.86 N, 118 47 31.39 W	3440-3610
Rock Glacier 3731-11847 (b)	rock glacier	37 31 16.74 N, 118 47 41.17 W	3315-3510
Rock Glacier 3731-11849	rock glacier	37 31 28.80 N, 118 49 47.91 W	3115-3355
Rock Glacier 3731-11850	rock glacier	37 31 58.65 N, 118 50 19.73 W	3060-3205
Rock Glacier 3731-11850 (b)	rock glacier	37 31 50.04 N, 118 50 34.20 W	3250-3330
Rock Glacier 3731-11850 (c)	rock glacier	37 31 45.01 N, 118 50 13.30 W	3190-3300
Rock Glacier 3731-11853	rock glacier	37 31 27.16 N, 118 53 8.81 W	3300-3485
Rock Glacier 3731-11853 (b)	rock glacier	37 31 40.55 N, 118 53 37.97 W	3350-3490
Rock Glacier 3731-11854	rock glacier	37 31 53.36 N, 118 54 36.13 W	3400-3470
Rock Glacier 3731-11854 (b)	rock glacier	37 31 52.46 N, 118 54 19.96 W	3410-3570
Rock Glacier 3731-11854 (c)	rock glacier	37 31 51.36 N, 118 54 27.47 W	3405-3495
Rock Glacier 3731-11854 (d)	rock glacier	37 31 35.50 N, 118 54 58.25 W	3485-3610
Rock Glacier 3731-11855	rock glacier	37 31 18.75 N, 118 55 17.80 W	3350-3450
Rock Glacier 3731-11856	rock glacier	37 31 58.02 N, 118 56 4.00 W	3200-3300
Rock Glacier 3732-11850	rock glacier	37 32 16.03 N, 118 50 39.40 W	3150-3320
Rock Glacier 3732-11853	rock glacier	37 32 20.54 N, 118 53 51.82 W	3350-3390
Rock Glacier 3732-11854	rock glacier	37 32 40.30 N, 118 54 26.90 W	3230-3360
Rock Glacier 3732-11854 (b)	rock glacier	37 32 27.81 N, 118 54 16.58 W	3320-3400
Rock Glacier 3732-11854 (c)	rock glacier	37 32 50.96 N, 118 54 38.67 W	3300-3390
Rock Glacier 3732-11854 (d)	rock glacier	37 32 49.14 N, 118 54 13.22 W	3170-3280
Rock Glacier 3732-11856	rock glacier	37 32 56.80 N, 118 56 46.76 W	3320-3490
Rock Glacier 3732-11856 (b)	rock glacier	37 32 56.16 N, 118 56 15.12 W	3270-3325
Rock Glacier 3732-11857	rock glacier	37 32 39.85 N, 118 57 44.62 W	3210-3320
Rock Glacier 3732-11857 (b)	rock glacier	37 32 36.36 N, 118 57 30.33 W	3250-3325
Rock Glacier 3732-11857 (c)	rock glacier	37 32 55.41 N, 118 57 4.49 W	3210-3335
Rock Glacier 3733-11855	rock glacier	37 33 56.21 N, 118 55 54.54 W	3080-3160
Rock Glacier 3733-11855 (b)	rock glacier	37 33 14.40 N, 118 55 55.11 W	3320-3420
Rock Glacier 3733-11855 (c)	rock glacier	37 33 1.54 N, 118 55 43.97 W	3370-3410
Rock Glacier 3733-11856	rock glacier	37 33 59.60 N, 118 56 10.95 W	3045-3250
Rock Glacier 3733-11856 (b)	rock glacier	37 33 7.84 N, 118 56 53.01 W	3270-3340
Rock Glacier 3733-11856 (c)	rock glacier	37 33 5.39 N, 118 56 17.56 W	3325-3475
Rock Glacier 3733-11857	rock glacier	37 33 48.56 N, 118 57 45.23 W	3200-3290
Rock Glacier 3733-11858	rock glacier	37 33 19.95 N, 118 58 56.78 W	3325-3420
Rock Glacier 3733-11858 (b)	rock glacier	37 33 42.88 N, 118 58 1.69 W	3145-3220
Rock Glacier 3733-11858 (c)	rock glacier	37 33 43.72 N, 118 58 4.99 W	3125-3215

Rock Glacier 3734-11856	rock glacier	37 34 10.80 N, 118 56 22.37 W	2975-3160
Rock Glacier 3734-11856 (b)	rock glacier	37 34 24.72 N, 118 56 33.65 W	3040-3125
Rock Glacier 3734-11857	rock glacier	37 34 57.41 N, 118 57 4.91 W	2975-3100
Rock Glacier 3734-11857 (b)	rock glacier	37 34 1.61 N, 118 57 42.76 W	3125-3265
Rock Glacier 3734-11858	rock glacier	37 34 3.33 N, 118 58 41.13 W	3100-3300
Rock Glacier 3734-11859	rock glacier	37 34 21.98 N, 118 59 47.54 W	3170-3305
Rock Glacier 3734-1190	rock glacier	37 34 28.76 N, 119 0 4.76 W	3110-3290
Rock Glacier 3734-1190 (b)	rock glacier	37 34 52.54 N, 119 0 40.68 W	3130-3230
Rock Glacier 3734-1190 (c)	rock glacier	37 34 57.10 N, 119 0 46.83 W	3100-3215
Rock Glacier 3738-11814	rock glacier	37 38 46.49 N, 118 14 18.09 W	3480-3795
Glacier 3739-1190	uncovered	37 39 44.94 N, 119 10 31.74 W	3340-3520
Rock Glacier 3740-10751	rock glacier	37 40 41.05 N, 107 51 46.35 W	3275-3570
Rock Glacier 3740-10752	rock glacier	37 40 9.74 N, 107 52 7.41 W	3460-3585
Rock Glacier 3740-10753	rock glacier	37 40 16.56 N, 107 53 4.75 W	3325-3500
Rock Glacier 3740-10753 (b)	rock glacier	37 40 56.26 N, 107 53 35.49 W	3230-3350
Rock Glacier 3740-10753 (c)	rock glacier	37 40 28.18 N, 107 53 7.40 W	3410-3490
Glacier 3740-11910	uncovered	37 40 12.22 N, 119 10 59.98 W	3275-3395
Glacier 3740-11912	uncovered	37 40 43.88 N, 119 12 14.04 W	3480-3560
Rock Glacier 3741-11822	rock glacier	37 41 46.03 N, 118 22 4.18 W	3750-3945
Glacier 3741-11911	uncovered	37 41 54.66 N, 119 11 34.21 W	3410-3630
Glacier 3741-11911 (b)	uncovered	37 41 54.44 N, 119 11 54.06 W	3490-3725
Glacier 3741-11911 (c)	uncovered	37 41 1.18 N, 119 11 47.11 W	3580-3735
Glacier 3741-11912	uncovered	37 41 40.20 N, 119 12 4.60 W	3400-3760
Rock Glacier 3741-11916	rock glacier	37 41 41.83 N, 119 16 50.96 W	3420-3500
Rock Glacier 3741-11916 (b)	rock glacier	37 41 35.88 N, 119 16 55.49 W	3460-3535
Rock Glacier 3741-11917	rock glacier	37 41 29.19 N, 119 17 16.45 W	3460-3520
Glacier 3742-11911	uncovered	37 42 4.45 N, 119 11 43.82 W	3455-3640
Rock Glacier 3742-10748	rock glacier	37 42 22.89 N, 107 48 34.36 W	3390-3550
Rock Glacier 3742-10751	rock glacier	37 42 29.89 N, 107 51 51.25 W	3280-3345
Glacier 3742-11913	uncovered	37 42 58.81 N, 119 13 16.18 W	3460-3595
Rock Glacier 3742-11916	rock glacier	37 42 4.00 N, 119 16 45.46 W	3320-3465
Rock Glacier 3742-11917	rock glacier	37 42 4.09 N, 119 17 37.87 W	3090-3130
Glacier 3743-11914	uncovered	37 43 44.07 N, 119 14 27.04 W	3440-3600
Glacier 3743-11915	uncovered	37 43 40.95 N, 119 15 27.80 W	3610-3730
Rock Glacier 3743-11917	rock glacier	37 43 26.22 N, 119 17 42.96 W	3265-3450
Rock Glacier 3743-11917 (b)	rock glacier	37 43 45.41 N, 119 17 6.40 W	3485-3635
Rock Glacier 3743-11917 (c)	rock glacier	37 43 24.14 N, 119 17 58.20 W	3210-3310
Glacier 3744-11915	uncovered	37 44 9.77 N, 119 15 48.55 W	3665-3755
Glacier 3744-11915 (b)	uncovered	37 44 9.84 N, 119 15 23.62 W	3510-3610
Glacier 3744-11915 (c)	uncovered	37 44 12.79 N, 119 15 7.56 W	3440-3530
Rock Glacier 3744-11915	rock glacier	37 44 45.41 N, 119 15 54.20 W	3430-3730
Glacier 3744-11916			
Lyell Glacier	uncovered	37 44 41.53 N, 119 16 24.29 W	3630-3900
Glacier 3744-11916	uncovered	37 44 46.46 N, 119 16 51.94 W	3520-3785
Rock Glacier 3744-11919	rock glacier	37 44 38.04 N, 119 19 18.37 W	3335-3555
Rock Glacier 3745-11815	rock glacier	37 45 48.13 N, 118 18 17.19 W	3475-3563
Rock Glacier 3745-11919	rock glacier	37 45 34.00 N, 119 19 37.93 W	3340-3465
Rock Glacier 3745-11919 (b)	rock glacier	37 45 30.04 N, 119 19 11.43 W	3395-3510
Rock Glacier 3746-11819	rock glacier	37 46 33.49 N, 118 19 0.11 W	3450-3705
Rock Glacier 3746-11819 (b)	rock glacier	37 46 9.21 N, 118 19 19.07 W	3660-3750
Rock Glacier 3747-11911	rock glacier	37 47 54.92 N, 119 11 30.47 W	3345-3416
Rock Glacier 3747-11819	rock glacier	37 47 9.95 N, 118 19 59.58 W	3765-3880
Rock Glacier 3747-11919	rock glacier	37 47 0.07 N, 119 19 24.63 W	3440-3555
Rock Glacier 3749-1199	rock glacier	37 49 7.13 N, 119 9 7.13 W	2915-2990

Glacier 3749-11911	uncovered	37 49 1.33 N, 119 11 46.66 W	3595-3755
Glacier 3749-11912	uncovered	37 49 4.05 N, 119 12 27.66 W	3630-3860
Rock Glacier 3750-11914	rock glacier	37 50 2.63 N, 119 14 47.78 W	3455-3570
Rock Glacier 3750-11915	rock glacier	37 50 54.42 N, 119 15 38.22 W	3415-3520
Rock Glacier 3750-11915 (b)	rock glacier	37 50 50.25 N, 119 15 29.84 W	3405-3550
Rock Glacier 3751-11915	rock glacier	37 51 1.62 N, 119 15 19.13 W	3300-3445
Rock Glacier 3753-11912	rock glacier	37 53 43.88 N, 119 12 10.60 W	3190-3490
Glacier 3753-11912	uncovered	37 53 20.50 N, 119 12 0.85 W	3550-3720
Rock Glacier 3754-11912	rock glacier	37 54 22.77 N, 119 12 17.50 W	3620-3650
Glacier 3754-11913			
Dana Glacier	uncovered	37 54 6.66 N, 119 13 6.23 W	3480-3700
Rock Glacier 3755-11912	rock glacier	37 55 40.22 N, 119 12 57.28 W	3130-3320
Rock Glacier 3755-11912 (b)	rock glacier	37 55 16.94 N, 119 12 19.53 W	3060-3320
Rock Glacier 3755-11912 (c)	rock glacier	37 55 47.04 N, 119 12 48.85 W	3105-3275
Rock Glacier 3755-11913	rock glacier	37 55 37.20 N, 119 13 37.70 W	3235-3365
Rock Glacier 3756-11918	rock glacier	37 56 52.73 N, 119 18 4.17 W	3380-3530
Rock Glacier 3757-10656	rock glacier	37 57 29.25 N, 106 56 34.87 W	3720-3865
Rock Glacier 3758-11915	rock glacier	37 58 59.91 N, 119 15 2.63 W	3050-3100
Rock Glacier 3758-11917	rock glacier	37 58 29.16 N, 119 17 34.03 W	3190-3350
Glacier 3758-11918	uncovered	37 58 3.59 N, 119 18 51.36 W	3540-3670
Glacier 3758-11919 Conness Glacier?	uncovered	37 58 4.44 N, 119 19 6.17 W	3510-3690
Rock Glacier 3759-11818	rock glacier	37 59 7.28 N, 119 18 46.92 W	3390-3575
Rock Glacier 3759-11914	rock glacier	37 59 20.10 N, 119 14 55.51 W	3000-3150
Rock Glacier 3759-11915	rock glacier	37 59 25.07 N, 119 15 17.49 W	3000-3105
Rock Glacier 3759-11916	rock glacier	37 59 52.70 N, 119 16 3.51 W	3220-3380
Rock Glacier 3759-11919	rock glacier	37 59 18.43 N, 119 19 54.34 W	3150-3340
Rock Glacier 380-11918	rock glacier	38 0 55.66 N, 119 18 58.29 W	3170-3290
Rock Glacier 380-11918 (b)	rock glacier	38 0 24.35 N, 119 18 39.19 W	3420-3490
Rock Glacier 380-11919	rock glacier	38 0 46.42 N, 119 19 11.25 W	3195-3385
Rock Glacier 381-11919	rock glacier	38 1 9.85 N, 119 19 34.63 W	3220-3450
Rock Glacier 381-11920	rock glacier	38 1 5.86 N, 119 20 3.19 W	3160-3420
Rock Glacier 382-11918	rock glacier	38 2 19.87 N, 119 18 31.24 W	3315-3495
Rock Glacier 382-11918 (b)	rock glacier	38 2 13.67 N, 119 18 17.79 W	3380-3520
Rock Glacier 383-11921	rock glacier	38 3 37.96 N, 119 21 49.55 W	3250-3365
Rock Glacier 383-11922	rock glacier	38 3 14.88 N, 119 22 3.56 W	3230-3305
Rock Glacier 384-11916	rock glacier	38 4 16.13 N, 119 16 59.26 W	2950-3100
Rock Glacier 385-11920	rock glacier	38 5 13.14 N, 119 20 44.64 W	3465-3535
Rock Glacier 385-11920 (b)	rock glacier	38 5 10.84 N, 119 20 41.11 W	3445-3500
Rock Glacier 385-11920 (c)	rock glacier	38 5 40.20 N, 119 20 54.99 W	3235-3395
Glacier 385-11921	uncovered	38 5 6.00 N, 119 21 26.80 W	3405-3600
Rock Glacier 385-11921	rock glacier	38 5 47.93 N, 119 21 41.38 W	3030-3210
Rock Glacier 386-11919	rock glacier	38 6 20.28 N, 119 19 10.18 W	3200-3305
Rock Glacier 386-11919 (b)	rock glacier	38 6 29.15 N, 119 19 21.37 W	3120-3250
Rock Glacier 386-11922	rock glacier	38 6 4.11 N, 119 22 42.41 W	3160-3470
Rock Glacier 386-11923	rock glacier	38 6 4.74 N, 119 23 12.79 W	3240-3460
Rock Glacier 386-11923 (b_	rock glacier	38 6 33.54 N, 119 23 33.24 W	3270-3480
Rock Glacier 386-11924	rock glacier	38 6 38.14 N, 119 24 8.81 W	3110-3340
Rock Glacier 386-11924 (b)	rock glacier	38 6 37.64 N, 119 24 29.94 W	3180-3330
Rock Glacier 388-11930	rock glacier	38 8 22.98 N, 119 30 48.16 W	3190-3340
Glacier 388-11932	uncovered	38 8 40.87 N, 119 32 41.24 W	3350-3480
Rock Glacier 389-11926	rock glacier	38 9 55.77 N, 119 26 34.92 W	3060-3390
Glacier 389-11930	uncovered	38 9 16.02 N, 119 30 30.94 W	3125-3180
Glacier 389-11932	uncovered	38 9 3.87 N, 119 32 56.87 W	3190-3355
Rock Glacier 389-11934	rock glacier	38 9 46.97 N, 119 34 49.00 W	3030-3340

Glacier 3811-11929	uncovered	38 11 45.44 N, 119 29 44.88 W	3300-3405
Glacier R 3815-11941	rock glacier	38 15 11.95 N, 119 41 30.00 W	2875-2910

Rivers of the Sierra Nevada Receiving Rock Glacier and Periglacier Melt Water

- [American River](#)
- [Bear River \(Feather River tributary\)](#)
- [Bear River \(Mokelumne River tributary\)](#)
- [Big Creek \(San Joaquin River tributary\)](#)
- [Big Kimshew Creek](#)
- [Big Pine Creek \(California\)](#)
- [Bishop Creek \(Inyo County\)](#)
- [Blackwood Creek \(California\)](#)
- [Bunch Creek](#)
- [Carson River](#)
- [Cherry Creek \(Tuolumne River tributary\)](#)
- [Chowchilla River](#)
- [Clavey River](#)
- [Clear Creek \(Nevada\)](#)
- [Cosumnes River](#)
- [Deer Creek \(Tulare County, California\)](#)
- [Downie River](#)
- [East Branch North Fork Feather River](#)
- [Falls Creek \(California\)](#)
- [Feather River](#)
- [Freeman Creek](#)
- [Fresno River](#)
- [Golden Trout Creek](#)
- [Honcut Creek](#)
- [Hot Creek \(Mono County, California\)](#)
- [Intake Two](#)
- [Jackson Creek \(Dry Creek tributary\)](#)
- [Kaweah River](#)
- [Kern River](#)
- [Kings River \(California\)](#)
- [Lee Vining Creek](#)
- [Lime Kiln Creek](#)
- [Little Chico Creek](#)
- [Little Truckee River](#)
- [Lone Tree Creek, San Joaquin County](#)
- [Mariposa Creek](#)
- [Merced River](#)
- [Middle Fork Feather River](#)
- [Middle Fork Kings River](#)
- [Middle Yuba River](#)
- [Mill Creek \(Mono Lake\)](#)
- [Mokelumne River](#)
- [Morgan Creek \(California\)](#)
- [North Fork American River](#)
- [North Fork Feather River](#)
- [North Fork Kings River](#)
- [Oak Creek \(Owens River\)](#)
- [Owens River](#)
- [Poso Creek](#)
- [Rock Creek \(Owens River tributary\)](#)
- [Rubicon River \(California\)](#)
- [Rush Creek \(Mono County, California\)](#)

- [South Fork Kern River](#)
- [South Fork Kings River](#)
- [South Fork Merced River](#)
- [South Yuba River](#)
- [Stanislaus River](#)
- [Middle Fork Stanislaus River](#)
- [North Fork Stanislaus River](#)
- [Stockton Creek](#)
- [Susan River \(California\)](#)
- [Tenaya Creek](#)
- [Tillie Creek](#)
- [Truckee River](#)
- [Tule River](#)
- [Tuolumne River](#)
- [Upper Truckee River](#)
- [Yosemite Creek](#)
- [Yuba River](#)

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