

# k a r s t

IN BRITISH COLUMBIA



A Complex Landscape  
Sculpted by Water



BRITISH  
COLUMBIA

Ministry of Forests  
Forest Practices Branch

## What is Karst?

Karst is a distinctive topography in which the landscape is largely shaped by the dissolving action of water on carbonate bedrock (usually limestone, dolomite, or marble). This geological process, occurring over many thousands of years, results in unusual surface and subsurface features ranging from sinkholes, vertical shafts, disappearing streams, and springs, to complex underground drainage systems and caves.

## How Karst is Formed

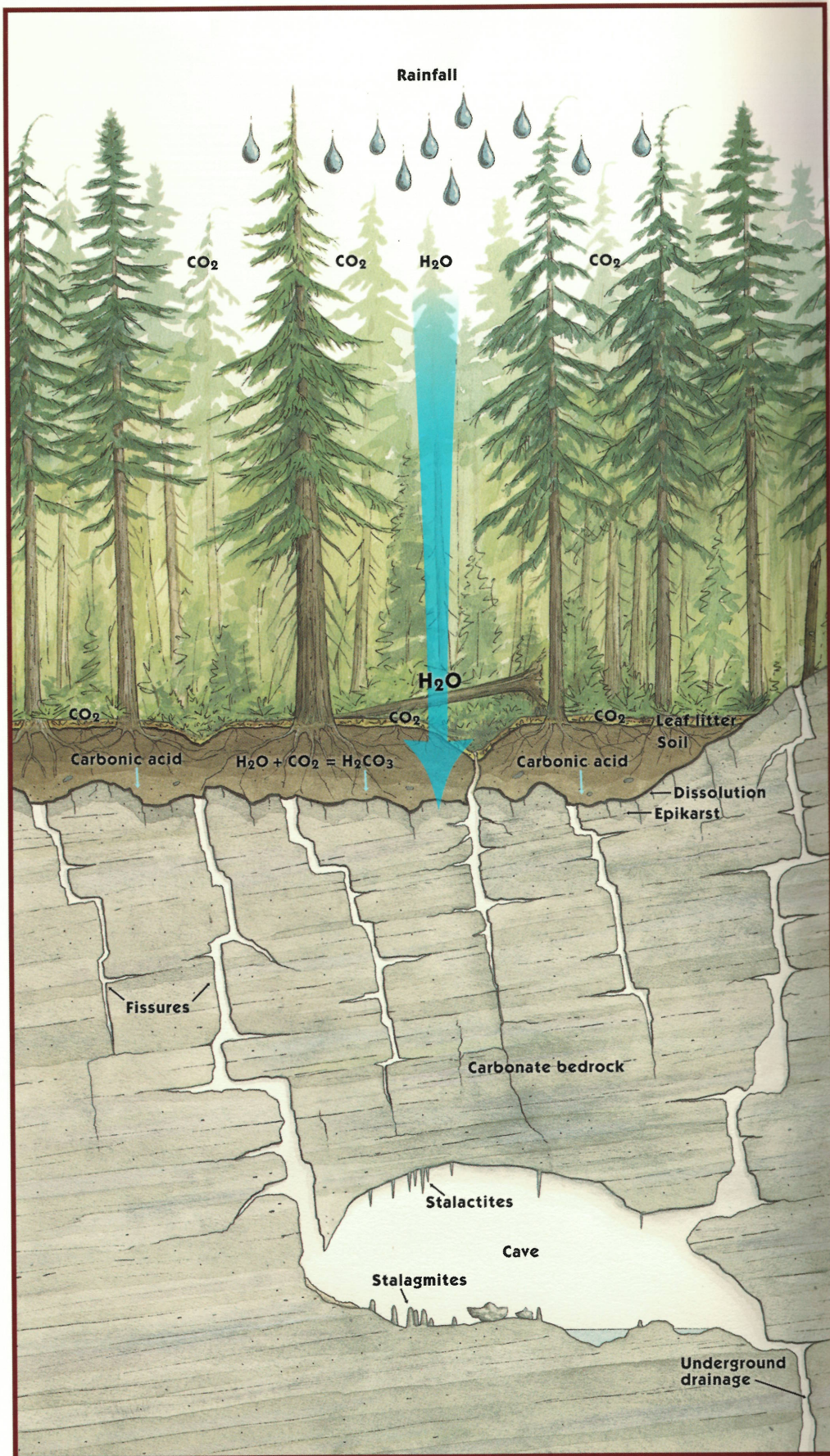
The process of karst formation involves what is referred to as “the carbon dioxide (CO<sub>2</sub>) cascade.” As rain falls through the atmosphere, it picks up CO<sub>2</sub> which dissolves in the droplets. Once the rain hits the ground, it percolates through the soil and picks up more CO<sub>2</sub> to form a weak solution of carbonic acid:  $H_2O + CO_2 = H_2CO_3$ . The infiltrating water naturally exploits any cracks or crevices in the rock. Over long periods, with a continuous supply of CO<sub>2</sub>-enriched water, carbonate bedrock begins to dissolve. Openings in the bedrock increase in size and an underground drainage system begins to develop, allowing more water to pass, further accelerating the formation of karst. Eventually this process leads to the development of subsurface caves.

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The upper layer of karst topography is called epikarst, a network of intersecting fissures and cavities that collect and transport surface water and nutrients to the underground drainage system.

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M. Nyhof



## Distribution of Karst in British Columbia

British Columbia is blessed with an abundance of world-class karst, particularly in the Rocky Mountains and on Vancouver Island. Other areas of karst development occur on the Queen Charlotte Islands, along the coastal mainland, in the interior mountain ranges, the Cariboo Mountains, and in northwest BC.

The Rocky Mountains contain the most extensive areas of soluble rock in the province, as well as Canada's longest and deepest documented caves. Subsurface drainage systems, springs, and surface features, such as sinkholes, are common throughout the Rockies, with some of the most notable karst terrain occurring on plateaus as high as 2000 metres.

The full extent and significance of karst in the Rocky Mountains and other parts of the interior are not well understood. Isolated locations, limited ground access, and extreme winter climates have made the exploration and documentation of interior karst lands difficult.

More is known about BC's coastal karst, particularly on Vancouver Island. The high concentration of karst features on Vancouver Island, combined with a long history of cave exploration and the unique association of karst with the coastal temperate rain forest, has focused a great deal of international attention on these coastal forest karst ecosystems.

## Distribution of Soluble Bedrock (Potential Karst) in British Columbia\*



\* Not all soluble bedrock in BC is karstified.

P. Griffiths



*Surface stream flowing into sinkhole.*

## Coastal Forest Karst Ecosystems

Several environmental factors favour the development of karst on BC's coast:

- geology—large units of very pure carbonate bedrock,
- heavy rainfall—a plentiful and steady supply of water,
- steep topography—creates higher energy sinking stream systems for underground drainage development,
- tectonic activity—uplifting, tilting, faulting, and folding limestone beds cause weaknesses and fractures in the rock for exploitation by infiltrating water,
- vegetation cover—extensive forests provide a high level of organic matter, increasing CO<sub>2</sub> in the soil as it decomposes,
- glacial history—deglaciation released great quantities of water to dissolve susceptible bedrock.

Most of the karst on the coast occurs within the coastal western hemlock biogeoclimatic zone where the major tree species are western hemlock and amabilis fir, with some western redcedar, Sitka spruce, and yellow-cedar. These coastal forest karst ecosystems are often characterized by large mature trees, diverse plant and animal communities, highly productive aquatic systems, well-developed subsurface drainage, and extensive surface karst and underlying cave resources.

Coastal forest karst ecosystems are commonly more productive than similar forest sites on non-karst terrain. This increased productivity can be largely attributed to well-drained soils and the nutrient cycling associated with karst. As carbonate bedrock is dissolved by penetrating water, it releases CO<sub>2</sub>, calcium carbonate, and micro-nutrients into the soil, encouraging plant growth and development. The level of productivity appears to be directly related to the extent of surface and subsurface connections.



*Coastal forest karst ecosystem.*

*When entering any cave, care must be taken not to disturb the wildlife living there, especially bats and troglobites or troglaphiles, which are highly susceptible to even minor disturbances in their environment.*

## Aquatic Systems

Research conducted in southeast Alaska suggests that karst stream systems play a significant role in the productivity of downstream aquatic habitat. The research indicates that karst can increase fish productivity in the following ways:

- the leaching of calcium carbonate from bedrock has important buffering effects on acidic streams,
- the groundwater associated with karst results in cool, even stream temperatures throughout the year,
- the storage capacity in karst stream systems buffers seasonal flow rates to produce lower peak flows and higher low flow periods,
- karst streams tend to supply more nutrients and encourage more algae and moss growth,
- aquatic insect populations within karst streams are larger and more diverse,
- karst stream systems provide more protective sites for fish to rest, breed, and avoid predators.

In addition, karst aquifers contribute to human water supplies in many parts of the world. Although relatively little is known about BC's karst groundwater systems, it is likely that they too play an important role in some community watersheds.

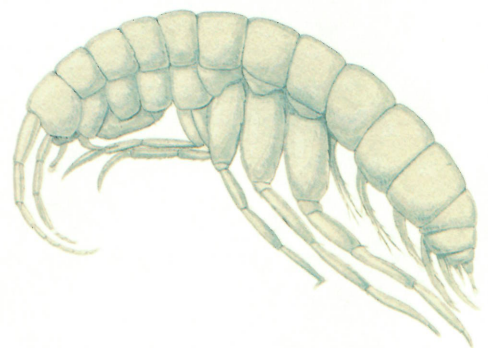
The subsurface drainage systems of karst lack many of the natural cleansing and filtering mechanisms of surface streams. As a result, harmful substances or materials introduced into karst waters have the potential to seriously affect karst environments, human water supplies, and important fish-rearing streams.

## Plant and Animal Habitat

Karst ecosystems often support unusual or rare plant and animal species, both on the surface and underground. Certain species of ferns and mosses prefer or, in some cases, require a limestone substrate on which to grow. Other fern species have adapted to growing in the cool, moist twilight conditions of cave entrances.

Many wildlife species use various karst features for habitat. Caves are used intermittently by large carnivores for shelter or resting. Birds and small mammals, such as woodrats, often nest in caves and other cavities. Elk and deer commonly bed down in the vicinity of cave entrances during summer when the air from caves is cooler, and during the winter when cave air is generally warmer than surrounding temperatures. Caves, and their stable environments, can be critically important habitat for bat species that depend on them for roosting and hibernation.

Some karst-dependent species, known as troglobites, have evolved to living exclusively in the total darkness of caves. In BC, the only troglobite identified to date is a freshwater crustacean found in underground pools in caves on Vancouver Island. More common are troglaphiles, which are species found living both inside and outside caves. Some individual troglaphiles may complete their entire life cycle within a cave, while other members of the same species live their lives outside caves. Examples of troglaphiles in BC include certain species of salamanders, spiders, and crickets.



*The tiny amphipod crustacean Stygobromus quatsinensis is BC's only confirmed troglobite.*

About 4% of Vancouver Island's land surface is underlain by soluble bedrock.



*Large quantities of water can be transported in subsurface drainage systems.*

### Scientific and Educational Values

Karst environments offer a variety of scientific and educational opportunities. Karst provides scientists with a relatively undisturbed window into landform evolution, past environments, and climate change through the study of cave morphology and sediments.

In the fields of archaeology and paleontology, BC karst caves have made some significant contributions. The natural environment of karst caves—alkaline conditions, cool temperatures, the absence of light, and difficult access—usually makes for undisturbed archaeological sites and well-preserved animal remains.

On northern Vancouver Island, mountain goat bones carbon-dated at 12 000 years old have been found in two karst caves. What makes this discovery so remarkable is that mountain goats are no longer found on Vancouver Island. In other karst caves on Vancouver Island, 2500- to 8000-year-old bones from the endangered Vancouver Island marmot have been found. These caves are in locations where no Vancouver Island marmots live today, suggesting that the marmots once occupied a much wider range.

In addition, some of the marmot bones found in the Vancouver Island caves exhibit cut markings that could only have been made by human tools. These archaeological sites are the first on the northwest coast discovered in the mountainous subalpine region—all others have been coastal sites.

*Archaeological sites are legally protected under the Heritage Conservation Act. Most paleontological sites are protected under the Heritage Conservation Act, the Park Act, or other legislation.*



*Vancouver Island cave with 2500-year-old marmot bones.*

## Aboriginal Use

As the archaeological evidence suggests, karst played a significant role in the lives of many aboriginal peoples in the past. Karst caves were not only used for shelter, but were also considered by some groups to be sacred places for burial and ceremonial purposes.

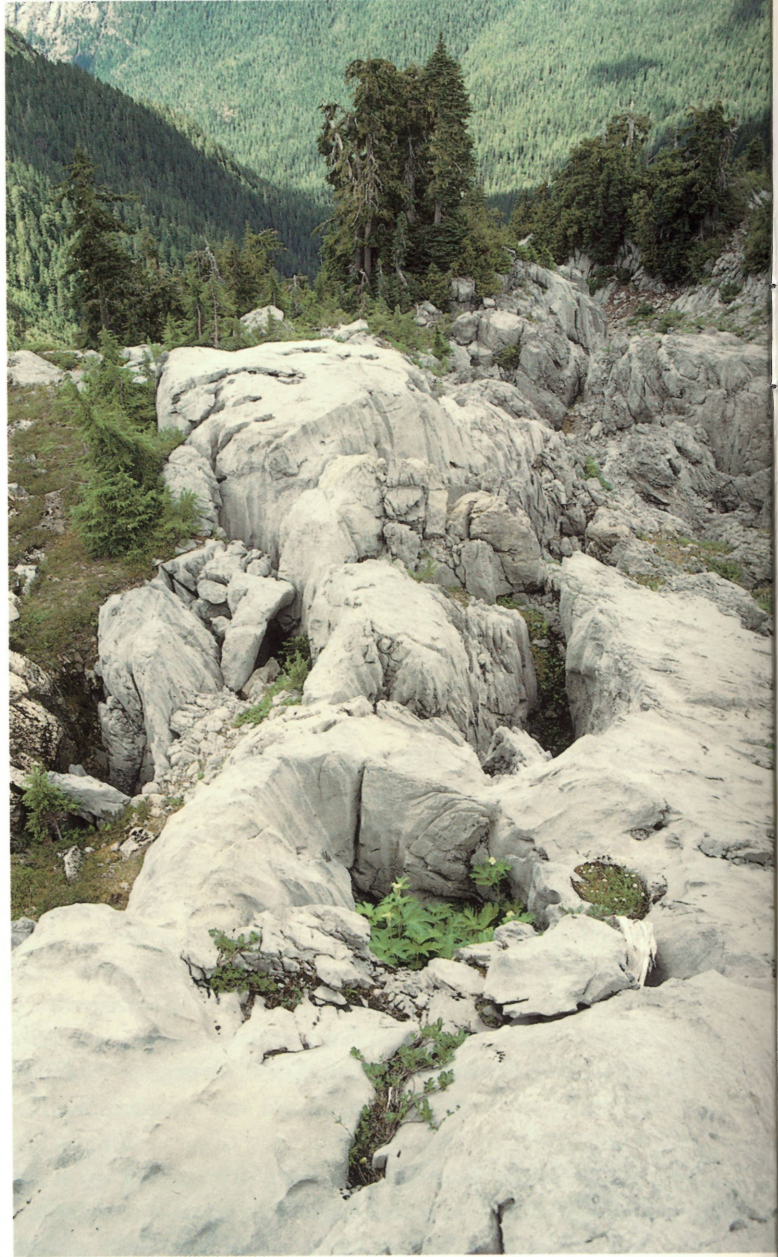
Unusual limestone surface features often played a role in aboriginal mythology, and the water from karst springs was viewed as having special properties. In many cases, the productivity of karst terrain also benefited aboriginal peoples by supplying large trees for dugouts, construction materials, or totem poles, and by providing excellent growing sites for various shrubs and herbs used for food and medicines.

Many present-day aboriginal cultures continue to value karst for ancestral, heritage, and cultural reasons.

## Recreation and Tourism

The unique karst features of BC attract recreationists and caving enthusiasts from around the world. The extensive karst systems in the Rocky Mountains are very popular with local and international visitors. Vancouver Island is also a popular destination, attracting visitors from around the globe to view surface and subsurface karst. In fact, together with southeast Alaska, it is one of the last places on earth where areas of undisturbed coniferous coastal temperate rain forest can be experienced along with such a diverse range of karst resources.

P. Griffiths



*Rugged karst topography.*

Each year, more and more people visit BC's provincial forests, parks, and recreation areas for self-guided or commercially guided karst and cave experiences. Horne Lakes Caves Provincial Park on Vancouver Island alone attracts more than 55 000 visitors annually. As people continue to seek more rewarding and educational wilderness experiences, the enormous attraction of karst will likely expand even further.



J. Marc

*Cave pearls.*



J. Marc

*Cave stalactites.*

## Sensitivity of Karst Ecosystems

Karst is recognized as a highly valuable, non-renewable resource that can be especially vulnerable to disturbance, more so than many other land resources. The primary reason for this higher level of sensitivity is the three-dimensional nature of karst. The intricate relationship between karst's unique surface characteristics and the subsurface caves and hydrology make for a delicately balanced system. Industrial activities, such as rock quarrying or forestry, if not properly conducted, can lead to excessive soil erosion, destruction of surface and subsurface karst features, changes in groundwater flows, and contamination, sedimentation, or clogging of underground and surface streams.

When conducting forestry operations in forest karst ecosystems or associated upland areas, extra care must be taken to ensure that karst values and forest productivity remain intact. Recreational pursuits in karst terrain also need to be monitored and managed to protect the resource from overuse or other damage.

*When viewing karst and caves, the fragile nature of these systems and the potential hazards associated with them must be recognized. Visitors should be aware of the numerous vertical openings and irregular terrain of surface karst. Inexperienced visitors wishing to view caves should consider joining a caving club or signing up for a guided tour.*

J. Marc



*Cave explorers.*

## Management of Karst Resources

In British Columbia, the responsibility for managing karst resources in provincial forests lies with the Ministry of Forests. Under the Forest Practices Code, several provisions have been made for managing sensitive areas such as karst. The Code requires identified sensitive areas to be treated in a way that protects or conserves special resource values. To accommodate some of the unique requirements of managing karst, the ministry is developing interim karst management guidelines that will provide direction on managing forestry and recreational activities in karst landscapes.

The guidelines will address road construction and maintenance, timber harvesting, reforestation, and stand tending practices, as well as recreation issues such as site and trail selection, access, and commercial opportunities. Options for suitable activities and management objectives, including preservation, will be included in the guidelines.

Once completed, the interim karst management guidelines will be field tested and revised as necessary. The final guidelines, once approved, will be integrated with existing regional cave management guidelines and incorporated into a comprehensive Forest Practices guidebook addressing all aspects of karst and cave management.

To facilitate this process, the ministry is developing educational programs on karst management to raise the awareness of karst issues to Forest Service staff, the forest industry, and the public.

D. Herdimer



*Field assessment in a karst area.*



## **Suggested Areas for Viewing Karst and Caves in BC**

### **Vancouver Island**

Horne Lakes Caves Provincial Park near Qualicum Beach  
Upana Caves Recreation Site near Gold River  
Little Hustan Caves Regional Park (south end of Nimpkish Lake)  
Karst Creek Trail in Strathcona Provincial Park

### **Interior**

Cody Caves Provincial Park near Nelson  
Nakimu Caves in Glacier National Park  
Top of the World Provincial Park near Canal Flats  
Kakwa Provincial Park near Prince George

For more information on karst, please contact a provincial or national park office, or your local Forest Service office.