= Nevado del Ruiz =

The Nevado del Ruiz (Spanish pronunciation : [ne?aðo ðel ?rwis]) , also known as La Mesa de Herveo (English : Mesa of Herveo (the nearby town)) , or Kumanday in the language of the local pre @-@ Colombian indigenous people , is a volcano located on the border of the departments of Caldas and Tolima in Colombia , about 129 kilometers (80 mi) west of the capital city Bogotá . It is a stratovolcano , composed of many layers of lava alternating with hardened volcanic ash and other pyroclastic rocks . Nevado del Ruiz has been active for about two million years , since the early Pleistocene or late Pliocene epoch , with three major eruptive periods . The current volcanic cone formed during the present eruptive period , which began 150 thousand years ago .

The volcano usually generates Plinian eruptions , which produce swift @-@ moving currents of hot gas and rock called pyroclastic flows . These eruptions often cause massive lahars (mud and debris flows) , which pose a threat to human life and the environment . The impact of such an eruption is increased as the hot gas and lava melt the mountain 's snowcap , adding large quantities of water to the flow . On November 13 , 1985 , a small eruption produced an enormous lahar that buried and destroyed the town of Armero in Tolima , causing an estimated 25 @,@ 000 deaths . This event later became known as the Armero tragedy ? the deadliest lahar in recorded history . Similar but less deadly incidents occurred in 1595 and 1845 , consisting of a small explosive eruption followed by a large lahar .

The volcano is part of Los Nevados National Natural Park , which also contains several other volcanoes . The summit of Nevado del Ruiz is covered by large glaciers . The volcano continues to pose a threat to the nearby towns and villages , and it is estimated that up to 500 @,@ 000 people could be at risk from lahars from future eruptions .

= = Geography and geology = =

Nevado del Ruiz , which lies about 129 kilometers (80 mi) west of Bogotá , is part of the Andes mountain range . The volcano is part of the Ruiz ? Tolima volcanic massif (or Cordillera Central) , a group of five ice @-@ capped volcanoes which includes the Tolima , Santa Isabel , Quindio and Machin volcanoes . The massif is located at the intersection of four faults , some of which still are active .

Nevado del Ruiz lies within the Pacific Ring of Fire , a region that encircles the Pacific Ocean and contains some of the world 's most active volcanoes . It is the third most northerly of the volcanoes lying in the North Volcanic Zone of the Andean Volcanic Belt , which contains 75 of the 204 Holocene @-@ age volcanoes in South America . The Andean Volcanic Belt is produced by the eastward subduction of the oceanic Nazca Plate beneath the South American continental plate . As is the case for many subduction @-@ zone volcanoes , Nevado del Ruiz can generate explosive Plinian eruptions with associated pyroclastic flows that can melt snow and glaciers near the summit , producing large and sometimes devastating lahars (mud and debris flows) .

Like many other Andean volcanoes , Nevado del Ruiz is a stratovolcano : a voluminous , roughly conical volcano consisting of many strata of hardened lava and tephra including volcanic ash . Its lavas are andesitic ? dacitic in composition . The modern volcanic cone comprises five lava domes , all constructed within the caldera of an ancestral Ruiz volcano : Nevado El Cisne , Alto de la Laguna , La Olleta , Alto la Pirana , and Alto de Santano . It covers an area of more than 200 square kilometers (77 sq mi) , stretching 65 kilometers (40 mi) from east to west . The mountain 's broad summit includes the Arenas crater , which is one kilometer in diameter and 240 meters (790 ft) deep .

The summit of the volcano has steep slopes inclining from 20 to 30 degrees . At lower elevations , the slopes become less steep ; their inclination is about 10 degrees . From there on , foothills stretch almost to the edge of the Magdalena River north of the volcano and the Cauca River to the west . On the two major sides of the summit , headwalls show where past rock avalanches occurred . At times , ice on the summit has melted , generating devastating lahars , including the continent 's deadliest eruption in 1985 . On the volcano 's southwest flank is the pyroclastic cone La Olleta ,

which is not currently active , but may have erupted in historical times .

= = = Glaciers = = =

The summit of Nevado del Ruiz is covered by glaciers (nevado means " snow @-@ covered " in Spanish) , which formed over many thousands of years , and have generally retreated since the last glacial maximum . From 28 @,@ 000 to 21 @,@ 000 years ago , glaciers occupied about 1 @,@ 500 square kilometers (600 sq mi) of the Ruiz ? Tolima massif . As late as 12 @,@ 000 years ago , when the ice sheets from the last glacial period were retreating , they still covered 800 square kilometers (300 sq mi) . During the Little Ice Age , which lasted from about 1600 to 1900 CE , the ice cap covered approximately 100 square kilometers (40 sq mi) .

Since then the glaciers have retreated further because of atmospheric warming . By 1959 , the massif 's glaciated area had dropped to 34 square kilometers (13 sq mi) . Since the 1985 eruption , which destroyed about 10 % of the summit ice cover , the area of Nevado del Ruiz covered by glaciers has halved ? from 17 to 21 square kilometers (6 @.@ 6 to 8 @.@ 1 sq mi) just after the eruption to about 10 square kilometers (3 @.@ 9 sq mi) in 2003 . The glaciers reached altitudes as low as 4 @,@ 500 meters (14 @,@ 800 ft) in 1985 but have now retreated to elevations of 4 @,@ 800 ? 4 @,@ 900 meters (15 @,@ 700 ? 16 @,@ 100 ft) .

The ice cap is approximately 50 meters (160 ft) thick on average . It is thickest in parts of the summit plateau and under the Nereides Glacier on the southwestern slopes , where it is as deep as 190 meters (620 ft) . Glaciers on the northern and , to a lesser extent , the eastern slopes lost the most ice in the 1985 eruption , and therefore reach only up to 30 meters (100 ft) deep . The deep ice covering the summit plateau may hide a caldera . Five domes ringing the summit plateau have emerged as the ice has retreated .

The meltwater from the glaciers drains primarily to the Cauca River and Magdalena River via the western and eastern flanks of the volcano , respectively . Runoff from these glaciers and those on the surrounding volcanoes is a source of fresh water for forty surrounding towns , and Colombian scientists and government officials are concerned about the towns ' water supply should the glaciers melt completely .

= = Flora and fauna = =

Nevado del Ruiz is generally poorly forested because of its high elevation , and its forest cover decreases with increasing elevation . At lower elevations , well @-@ developed mesic forests (20 ? 35 meters / 66 ? 110 ft high) are present . Above these but below the tree line , parts of the volcano are covered with dwarf forests 3 ? 8 meters (10 ? 30 ft) high . Above the tree line , in the Páramo zone , the vegetation is dominated by plants such as bunchgrass and Espeletia . Regional vegetation consists of different families of woody plants , including Rubiaceae , Leguminosae , Melastomataceae , Lauraceae , and Moraceae . Flowers such as Polypodiaceae s.l. , Araceae , Poaceae , Asteraceae , Piperaceae , and Orchidaceae are also present in the region .

Animals living on the volcano include the mountain tapir and spectacled bear , both of which are designated as threatened . Other animals inhabiting the surrounding region include the rufous @-@ fronted parakeet , bearded helmetcrest , and Herveo plump toad . The volcano is home to 27 species of birds endemic to Colombia , with 14 of these species confined to the region around the volcano . 15 bird species in the area are considered threatened .

= = Los Nevados National Park = =

Nevado del Ruiz is one of several stratovolcanoes within Los Nevados National Natural Park , a national park located west of Bogotá in the centre of the Colombian Andes . The park is a popular tourist destination and contains several tourist shelters . The slopes of the volcano are used for winter sports , and nearby Lake Otún offers trout fishing . A number of commercially operated spas can be found nearby . In 1868 ? 1869 , German geologists Wilhelm Reiss and Alphons Stübel were

the first to attempt to climb Ruiz . In 1936 , W. Cunet and Augusto Gansser @-@ Biaggi made the first successful ascent , partly by ski ; they repeated the ascent in 1939 .

= = Eruptive history = =

The first eruptions of Nevado del Ruiz occurred about 1 @.@ 8 million years ago at the beginning of the Pleistocene epoch . Three primary eruption periods in the history of the massif have been identified : ancestral , older and present . During the ancestral period between one million to two million years ago , a complex of large stratovolcanoes was created . Between 1 @.@ 0 million and 0 @.@ 8 million years ago , they partially collapsed , forming large (5 ? 10 km wide) calderas . During the older period , which lasted from 0 @.@ 8 million to 0 @.@ 2 million years ago , a new complex of large stratovolcanoes developed (including Older Ruiz , Tolima , Quindio , and Santa Isabel) . Once again explosive summit calderas formed from 0 @.@ 2 million to 0 @.@ 15 million years ago .

The present period began about 150 @,@ 000 years ago and involved the development of the present volcanic edifice through the emplacement of lava domes made of andesite and dacite (igneous rocks) inside older calderas . During the past 11 @,@ 000 years , Nevado del Ruiz passed through at least 12 eruption stages , which included multiple slope failures (rock avalanches) , pyroclastic flows and lahars leading to partial destruction of the summit domes . During the past several thousand years , eruptions of the volcanoes in the Ruiz ? Tolima massif have mostly been small , and the pyroclastic flow deposits have been much less voluminous than during the Pleistocene . Since the volcano 's earlier eruptions are not recorded , volcanologists have used tephrochronology to date them .

During recorded history , eruptions have consisted primarily of a central vent eruption (in the caldera) followed by an explosive eruption , then lahars . Ruiz 's earliest identified Holocene eruption was about 6660 BC , and further eruptions occurred in 1245 BC ± 150 years (dated through radiocarbon dating) , about 850 BC , 200 BC ± 100 years , 350 AD ± 300 years , 675 AD ± 50 years , in 1350 , 1541 (perhaps) , 1570 , 1595 , 1623 , 1805 , 1826 , 1828 (perhaps) , [b] 1829 , 1831 , 1833 (perhaps) , [b] 1845 , 1916 , December 1984 ? March 1985 , September 1985 ? July 1991 , and possibly in April 1994 . [b] Many of these eruptions involved a central vent eruption , a flank vent eruption , and a phreatic (steam) explosion . Ruiz is the second @-@ most active volcano in Colombia after Galeras .

= = = 1595 lahar = = =

On the morning of March 12 , 1595 , Nevado del Ruiz erupted . The episode consisted of three Plinian eruptions , which were heard up to 100 kilometers (62 mi) from the summit of the volcano . A large amount of ash was ejected , which completely darkened the surrounding area . The volcano also erupted lapilli (a form of tephra) and pumice bombs . In total , the eruption produced 0 @.@ 16 km3 of tephra . The eruption was preceded by a large precursor earthquake three days before . The eruption caused lahars , which traveled down the valleys of the nearby Gualí and Lagunillas rivers , clogging up the water , killing fish and destroying vegetation . More than 600 people died as a result of the lahar . The 1595 eruption was the last major eruption of Nevado del Ruiz before 1985 . The 1595 and 1985 eruptions were similar in many respects , including in the chemical composition of the erupted material .

= = = 1845 lahar = = =

On the morning of February 19 , 1845 , a large earthquake resulted in a substantial mudflow . This mudflow flowed down the valley of the Lagunillas River for approximately 70 kilometers (43 mi) , spilling out of the river channel and killing much of the local population . After reaching an alluvial fan , the mudflow split into two branches . The larger portion of it joined the Lagunillas River and flowed into the nearby Magdalena River , while the smaller portion was diverted by hills in front of

Lagunillas Canyon , turned 90 degrees to the north until it reached the Sabandija River , and then flowed east with the Sabandija River , until it rejoined the other branch of the mudflow at the junction of the Sabandija and the Magdalena . It is estimated that 1000 people were killed in the mudflows .

= = = Eruption (1985) = = =

Beginning November 1984 , geologists observed an increasing level of seismic activity near Nevado del Ruiz . Other signs of a forthcoming eruption included increased fumarole activity , deposition of sulfur on the summit of the volcano , and small phreatic eruptions . In the latter , hot magma came in contact with water , resulting in explosions as the water was almost instantly turned into steam . The most notable of these events was an ash ejection on September 11 , 1985 . The activity of the volcano decreased in October 1985 . The most likely explanation of the events is that new magma rose into the volcanic edifice before September 1985 .

An Italian volcanological mission analyzed gas samples from fumaroles along the Arenas crater floor and proved them to be a mixture of carbon dioxide and sulfur dioxide , indicating a direct release of magma into the surface environment . The mission 's report , delivered on October 22 , 1985 , judged the risk of lahars to be very high . The report proposed various simple preparedness techniques to local authorities .

In November 1985 , volcanic activity once again increased as magma neared the surface . The volcano began releasing increasing quantities of gases rich in sulfur dioxide and elementary sulfur . The water content of the fumaroles ' gases decreased , and water springs in the vicinity of Nevado del Ruiz became enriched in magnesium , calcium and potassium , which were leached from the magma . The thermodynamic equilibration (stationary heat energy) temperatures , corresponding to the chemical composition of the discharged gases , were from 200 ° C (400 ° F) to 600 ° C (1 @,@ 000 ° F) . The extensive degassing of the magma caused pressure to build up inside the volcano , which eventually resulted in the explosive eruption .

= = = = Eruption and lahars = = = =

At 3 : 06 pm , on November 13 , 1985 , Nevado del Ruiz began to erupt , ejecting dacitic tephra more than 30 kilometres (19 mi) into the atmosphere . The total mass of the erupted material (including magma) was 35 million tonnes ? only 3 % of the amount that erupted from Mount St. Helens in 1980 . The eruption reached a value of 3 on the Volcanic Explosivity Index . The mass of the ejected sulfur dioxide was about 700 @,@ 000 tonnes , or about 2 % of the mass of the erupted solid material , making the eruption atypically sulfur @-@ rich .

The eruption produced pyroclastic flows that melted summit glaciers and snow , generating four thick lahars that raced down river valleys on the volcano 's flanks . It also destroyed a small lake that was observed in Arenas crater several months before the eruption . Water in such volcanic lakes tends to be extremely salty and contain dissolved volcanic gases . The lake 's hot , acidic water significantly accelerated the melting of the ice ; this effect was confirmed by the large amounts of sulfates and chlorides found in the lahar flow .

The lahars , formed of water , ice , pumice , and other rocks , mixed with clay as they travelled down the volcano 's flanks . They ran down the volcano 's sides at an average speed of 60 km per hour , eroding soil , dislodging rock , and destroying vegetation . After descending thousands of meters down the side of the volcano , the lahars were directed into all of the six river valleys leading from the volcano . While in the river valleys , the lahars grew to almost 4 times their original volume . In the Gualí River , a lahar reached a maximum width of 50 meters (200 ft) .

One of the lahars virtually erased the small town of Armero in Tolima , which lay in the Lagunilla River valley . Only one quarter of its 28 @,@ 700 inhabitants survived . The second lahar , which descended through the valley of Chinchiná River , killed about 1 @,@ 800 people and destroyed about 400 homes in the town of Chinchiná , in the department of Caldas . In total , over 23 @,@ 000 people were killed and approximately 5 @,@ 000 were injured . More than 5 @,@ 000 homes were destroyed . The Armero tragedy , as the event came to be known , was the second @-@ deadliest

volcanic disaster in the 20th century , being surpassed only by the 1902 eruption of Mount Pelée , and is the fourth @-@ deadliest volcanic eruption in recorded history . It is also the deadliest known lahar , and Colombia 's worst natural disaster .

The loss of life during the 1985 eruption was due partly to the fact that scientists did not know precisely when the eruption would occur , and the authorities would not take costly preventative measures without clear warnings of imminent danger . Because the volcano 's last substantial eruption occurred 140 years ago , it was also hard for many to accept the danger the volcano presented ; locals even called it the " Sleeping Lion " . Hazard maps showing Armero would be completely flooded after an eruption were distributed more than a month before the eruption , but the Colombian Congress criticized the scientific and civil defense agencies for scaremongering . Local authorities failed to alert people to the seriousness of the situation , with Armero 's mayor and a priest both reassuring the populace after an ash eruption on the afternoon of November 13 and the consequent ashfall early that evening . Another factor was the storm that hit that evening , causing electrical outages and hindering communications . Civil defense officials from four nearby towns tried to warn Armero the lahar was approaching in the hour or so before it reached Armero , but failed to make radio contact .

Scientists later looked back to the hours before the eruption and noticed that several long @-@ period earthquakes , which start out strong and then slowly die out , had occurred in the final hours before the eruption . Volcanologist Bernard Chouet said that , " the volcano was screaming ' I 'm about to explode ' " , but the scientists who were studying the volcano at the time of the eruption were not able to read this signal .

= = Current threats and preparedness = =

The volcano continues to pose a serious threat to nearby towns and villages . The most likely hazard is small @-@ volume eruptions , which might destabilize glaciers and trigger lahars . Despite the significant retrenchment of the volcano 's glaciers , the volume of ice atop Nevado del Ruiz and other volcanoes in the Ruiz ? Tolima massif remains large . Melting merely 10 % of the ice would produce mudflows with a volume of up to 2 @,@ 000 @,@ 000 cubic meters (70 @,@ 629 @,@ 333 cu ft) ? similar to the mudflow that destroyed Armero in 1985 . Such lahars can travel up to 100 kilometers (62 mi) along river valleys in a matter of few hours . Estimates show that up to 500 @,@ 000 people living in the Combeima , Chinchiná , Coello @-@ Toche , and Guali valleys are in danger , and 100 @,@ 000 of these are considered to be at high risk . Lahars poses a threat to nearby towns of Honda , Mariquita , Ambalema , Chinchiná , Herveo , Villa Hermosa , Salgar and La Dorada . Although small eruptions are more likely , the two million @-@ year eruptive history of the Ruiz ? Tolima massif includes numerous large eruptions , indicating that the threat of a large eruption cannot be ignored . A large eruption would have more widespread effects , including the potential closure of Bogotá 's airport due to ashfall .

As the Armero tragedy was exacerbated by the lack of early warnings , unwise land use , and the unpreparedness of nearby communities , the government of Colombia created a special program (Oficina Nacional para la Atencion de Desastres , 1987) to prevent such incidents in the future . All Colombian cities were directed to promote prevention planning in order to mitigate the consequences of natural disasters , and evacuations due to volcanic hazards have been carried out . About 2 @,@ 300 people living along five nearby rivers were evacuated when Nevado del Ruiz erupted again in 1989 . When another Colombian volcano , the Nevado del Huila , erupted in April 2008 , thousands of people were evacuated because volcanologists worried that the eruption could be another " Nevado del Ruiz " .

In 2006 , heavy rains on Ruiz sent a mudslide down the Chinchiná River , killing nine youths aged 12 ? 19 on a scouting expedition near the volcano .

= = = Recent activity = = =

During September and October 2010 , INGEOMINAS (Colombian Institute of Mining and Geology)

noted gradual increases in seismic activity near the Arenas crater . Sulfurous odors and phreatic eruptions reported at Nevado del Ruiz prompted an alert level of Yellow on October 1 . Chemical analysis of the volcano demonstrated deformative changes and geochemical alterations . Over the next four months a smattering of long @-@ period earthquakes , considered pseudo @-@ Tornillo events , raised worries that the volcano might erupt . In 2010 , tilt increased , and on average 890 volcanic tremors were recorded monthly , roughly eight times as many as had been recorded from 2009 ? 2010 . 2010 marked the beginning of increases in sulfur dioxide emissions accompanying small eruptions at the volcano , which both peaked in February 2012 correspondent to a dramatic increase in earthquakes .

Scientists flying over the volcano on March 8 , 2012 noted fresh ash deposits on the east flank of the volcano near the crater , likely from an phreatic eruption on February 22 . Later that day , a small ash plume erupted from the crater ; by March 13 , scientists detected ash deposits at the head of the Gualí River . After seismicity continued to increase , the alert level was raised to Orange , and in April Nevados National Natural Park authority closed the reserve , fearing lahars and ashfall hazards . The sudden activity peak in March did not culminate in a major eruption , and activity declined enough that the alert level was lowered to Yellow on May 3 . On May 29 , seismicity rapidly increased , and the alert level was restored to Orange because ash fell into more than 20 nearby communities . Over the next few months ash fell frequently until earthquakes increased again in June . Because of the severity of these tremors , evacuations were ordered by the Emergency Committee of Caldas on news media for 300 ? 1500 people near the volcano . The alert level was raised to Red , indicating an imminent major volcanic event , and an eruption 7 @.@ 5 kilometers (4 @.@ 7 mi) in diameter took place on July 2 , 2012 , continuing intermittently until the end of August . Ash plumes and sulfur dioxide emissions recurred until January 2013 .