

= Cerro Azul ( Chile volcano ) =

Cerro Azul ( Spanish pronunciation : [ ?sero a?sul ] , blue hill in Spanish ) , sometimes referred to as Quizapu , is an active stratovolcano in the Maule Region of central Chile , immediately south of Descabezado Grande . Part of the South Volcanic Zone of the Andes , its summit is 3 @, @ 788 metres ( 12 @, @ 428 ft ) above sea level , and is capped by a summit crater that is 500 metres ( 1 @, @ 600 ft ) wide and opens to the north . Beneath the summit , the volcano features numerous scoria cones and flank vents .

Cerro Azul is responsible for several of South America 's largest recorded eruptions , in 1846 and 1932 . In 1846 , an effusive eruption formed the vent at the site of present @-@ day Quizapu crater on the northern flank of Cerro Azul and sent lava flowing down the sides of the volcano , creating a lava field 8 ? 9 square kilometres ( 3 ? 3 @. @ 5 square miles ) in area . Phreatic and Strombolian volcanism between 1907 and 1932 excavated this crater . In 1932 , one of the largest explosive eruptions of the 20th century occurred at Quizapu Crater and sent 9 @. @ 5 cubic kilometres ( 2 @. @ 3 cu mi ) of ash into the atmosphere . The volcano 's most recent eruption was in 1967 .

The South Volcanic Zone has a long history of eruptions and poses a threat to the surrounding region . Any volcanic hazard ? ranging from minor ashfalls to pyroclastic flows ? could pose a significant risk to humans and wildlife . Despite its inactivity , Cerro Azul could again produce a major eruption ; if this were to happen , relief efforts would probably be quickly organized . Teams such as the Volcano Disaster Assistance Program ( VDAP ) are prepared to effectively evacuate , assist , and rescue people threatened by volcanic eruptions .

= = Geography and geology = =

= = = Regional setting = = =

Volcanism in the Chilean Andes is caused by subduction of the Nazca and Antarctic tectonic plates under the South American Plate . Volcanoes in Chile occur in the Central ( CVZ ) , South ( SVZ ) , and Austral Volcanic Zones ( AVZ ) . The gap that separates the Central and South Volcanic Zones is caused by shallow @-@ angle subduction in the Pampean flat @-@ slab segment where the more buoyant Juan Fernández Ridge subducts under the South American continent . This buoyant region prevents the slab ( subducting tectonic plate ) from diving deep into the mantle , where the heat and pressure would destabilize the mineral chlorite , releasing water that would in turn cause melting and volcanism . The Patagonian Volcanic Gap , which separates the South and Austral Volcanic Zones , is caused by the subduction of the Chile Ridge , though it is less clear whether this gap also is due to flat @-@ slab subduction ; it may instead arise because melting of the subducting slab there produced felsic igneous rocks instead of volcanoes .

Offshore volcanism also occurs in Chile . Intraplate volcanism generated from the Easter and Juan Fernández hotspots has formed many Chilean islands , including Isla Salas y Gómez , Easter Island , and the Juan Fernández Islands . Underwater volcanism occurs due to seafloor spreading along the Chile Ridge .

Nearly 100 Quaternary ( Pleistocene- or Holocene @-@ age ) independent volcanoes exist in the country , in addition to 60 volcanic complexes and caldera systems . Of the 200 historically active volcanoes in the Andean Range , 36 are found in Chile .

= = = Local setting = = =

Cerro Azul is part of the South Volcanic Zone , which runs through central and western Chile and extends south to Argentina . This range includes at least nine caldera complexes , more than 70 of Chile 's stratovolcanoes and volcanic fields that have been active in the Quaternary , and hundreds of minor eruptive centres . The South Volcanic Zone is the most volcanically active region in Chile , and produces around one eruption per year . Its largest historical eruption was at Quizapu Crater ,

located on the north side of Cerro Azul 's summit ( see below ) , and its most active volcanoes are Llaima and Villarrica .

Cerro Azul , just 7 kilometres ( 4 @. @ 3 mi ) south of Descabezado Grande volcano , is part of the Descabezado Grande ? Cerro Azul eruptive system , a volcanic field which comprises its two large namesake volcanic edifices and several smaller vents , including 12 Holocene calderas . Both volcanoes lie on top of the Casitas Shield , a plateau built of over 100 lava flows that erupted in at least 12 volcanic episodes during the Quaternary period . The upper lava layers are dated at 340 @, @ 000 years .

As with the majority of the Andean volcanoes , Cerro Azul is a stratovolcano , meaning that it consists of layers , or strata , of volcanic ash and lava flows . The cone of Cerro Azul has a total volume of about 11 cubic kilometres ( 3 cu mi ) , and is a young feature , formed in the Holocene . It is made of agglutinated pyroclasts and some dacite ? andesine lavas . The cone has a few volcanic craters ; the majority of its eruptions in recorded history have originated from Quizapu Crater on the northern flank of Cerro Azul 's cone . Other craters lying on the flanks of the main cone are Caracol ( " Snail " ) , Crater los Quillayes , Crater la Resolana , and Crater sin Nombre ( " Nameless Crater " ) . All of the craters lie between 2 @, @ 000 and 3 @, @ 000 metres ( 6 @, @ 600 and 9 @, @ 800 ft ) in elevation , except Quizapu , which is 3 @, @ 292 metres ( 10 @, @ 801 ft ) up the volcano . The summit of Cerro Azul is crowned by an asymmetric crater about 500 metres ( 1 @, @ 640 ft ) in diameter . Pleistocene glacial activity is evident in the form of 500 meter ( 1 @, @ 640 ft ) deep struts in the volcanoes ' sides . These deep cuts have revealed strata of older rock .

= = = Quizapu Crater = = =

Quizapu , which formed during the 1846 eruption , is the most prominent crater . It is also known as Cerro del Medio ( " Middle Hill " ) or Volcan Nuevo ( " New Volcano " ) . The volcanic vent formed during an effusive eruption involving hornblende ? dacite flows accompanied by tephra , and the crater was excavated by phreatic and Strombolian eruptions between 1907 and 1932 . Pent @- @ up pressure within the volcano spawned an enormous Plinian eruption in 1932 . The volume of lava ejected during this single event is roughly equal to that ejected during the rest of the eruptive history at Quizapu , since its formation in 1846 . Although 9 @. @ 5 cubic kilometers ( 2 @. @ 3 cu mi ) of material was ejected , no subsidence was detected from the removal of magma . Because of aerodynamic drag , a Plinian eruption excavates a circular crater . As the earlier eruptions had already formed an approximately circular caldera , the Plinian eruption was able to proceed efficiently , with minimal drag and minimal reshaping of the crater .

The Quizapu Crater is almost perfectly circular , and rises to a prominence of 150 to 250 meters ( 490 to 820 ft ) above the surrounding portions of the volcano . Cresting at 3 @, @ 292 meters ( 10 @, @ 801 ft ) in elevation , Quizapu is one of the highest known Plinian craters . The radius of the crater floor , which is the current inner vent , is around 150 meters ( 500 ft ) , while the radius of its rim is 300 ? 350 meters ( 980 ? 1 @, @ 150 ft ) . The crater floor lies at 2 @, @ 928 meters ( 9 @, @ 606 ft ) , and the rim lies 150 ? 300 meters ( 500 ? 1 @, @ 000 ft ) above that , giving the walls an average slope of 34 ? 35 degrees ( close to the angle of repose ) . The western wall is cut by two long , dacitic lava flows : probably the remnants of a dome or an eruption . The crater is surrounded by debris from its 1932 eruption , and topped by layers ? 50 meters ( 160 ft ) thick ? of mafic scoria and ash .

= = Climate and vegetation = =

Cerro Azul is situated in a Mediterranean climate zone , characterized by hot and dry summers but mild and wet winters . The temperatures and precipitation are strongly dependent on topography . In the Andes the annual average maximum temperatures lie in the range 20 to 25 ° C ( 68 to 77 ° F ) , while minimum temperatures are below 0 ° C ( 32 ° F ) . Annual precipitation is up to 800 mm ( 31 @. @ 5 inches ) .

Vegetation in the Andes varies with elevation . Above 1 @, @ 600 meters ( 5 @, @ 249 ft ) the

slopes of mountains are covered by Alpine @-@ like steppe , while below there are zones of Nothofagus forest , Hygrophilous forest , Sclerophyllous forest , and matorral . The number of plant species is likely to exceed 2 @, @ 000 , although no comprehensive study of the flora of Central Chile has been undertaken .

= = Eruptive history = =

Cerro Azul has a history of eruptions dating back to at least 1846 . The known events include effusive eruptions ( lava flows ) , which created the Quizapu vent , explosive eruptions , and phreatic eruptions . Pyroclastic flows have also been observed as a result of some of these explosive eruptions . The earliest recorded eruption began on November 26 , 1846 , while the volcano 's last eruption began on August 9 , 1967 . The volcano has produced two of the largest eruptions in South America in recorded history , in 1846 and 1932 . Both released 4 ? 5 cubic kilometers ( 1 @. @ 0 ? 1 @. @ 2 cu mi ) of the dacitic magma .

= = = First record of activity , 1846 = = =

On November 26 , 1846 , Cerro Azul erupted . This was the first report of activity at the volcano , and no trace of fumaroles , adjacent vents , or pre @-@ eruptive activity exists . Most descriptions of the eruption come from the backcountry herdsmen ( arrieros ) . One , who was camped in a valley approximately 7 kilometers ( 4 mi ) east of Quizapu , heard " a great noise and a cloud of ash " emanate from the mountain in the late afternoon . No precursor activity was reported , and the herdsman claimed that there were no earthquakes during the late afternoon eruption .

That night , two herdsmen near the site heard a continuous roar , punctuated by loud bangs and crackling sounds " like that of great rockslides " . Lightning and thunder accompanied the spectacle . They saw many blue flames , and were choked by sulfurous gas . Observers in Talca 85 kilometers ( 53 mi ) away heard the eruption noises , and the sulfurous odors reached them the day after the eruption . None of the reports mention earthquakes or ash fall , though the crackling and banging sounds could be from block lavas ( ?a?? ) .

This first recorded eruption of Cerro Azul was effusive , and formed the volcanic vent at Quizapu . Hornblende ? dacite lava erupted with small masses of tephra , which had been degassed shortly before the eruption . Lava flowed over the Estero Barroso Valley and westward into the Río Blanco Valley . By November 28 , the volcano appeared at rest , and the herdsman returned to the place of first observation . There , they found a blocky lava field . The lava was still hot , fuming and crackling with gas and flame . Fascinated by the volcano , Ignacy Domeyko traveled to Chile to study the field and found its width to be 8 ? 9 square kilometers ( 3 @. @ 1 ? 3 @. @ 5 sq mi ) . By 1992 the field had grown to twice that size .

= = = Early 20th century = = =

Cerro Azul was quiet from 1846 to the beginning of the 20th century . After a possible precursor explosive event in 1903 , Cerro Azul once again erupted in 1907 . Between 1907 and 1914 , plumes and clouds of ash frequently rose out of the caldera , and at least a few of these events were explosive . On September 8 , 1914 , an explosive eruption sent a plume 6 or 7 kilometers ( about 4 mi ) into the air over 8 minutes . By 1916 , these eruptions had produced a caldera nearly identical to the one in existence today .

The volcano also erupted phreatically several times , as recorded by Vogel in 1913 and 1920 , with its activity increasing from 1916 to 1926 . During these years , the eruptions grew more frequent and more violent . A major outburst on November 2 , 1927 started a period of nearly continuous violent eruptions that lasted until 1929 . During this period , Cerro Azul sometimes erupted daily , sending columns of ash as far as 6 or 7 kilometers ( about 4 mi ) into the air . Quizapu Crater grew slightly during this eruptive period .

Pre @-@ 1932 volcanism was largely phreatic or fumarolic , as evidenced by the lack of tephra

generated by these eruptions . Photographs from 1912 show vapor plumes containing little ash , rising 1 ? 2 kilometers ( 0 @ . @ 6 ? 1 @ . @ 2 mi ) above the crater .

= = = Major eruption , 1932 = = =

By 1932 , Quizapu had produced many phreatic events and one effusive eruption , but no large Plinian eruptions . This frequency of minor eruptive activity proved to be a precursor for a major eruption . On 25 January 1932 , observers in Malargue saw a large black cloud over the summit . By 9 April , the volcano emitted green gas and started to " bellow like a bull " . On April 10 , Cerro Azul finally erupted , releasing a towering column or plume of white gas . After 10 AM , the plume turned black with ash and began to form an umbrella shape . The ash was carried by wind into Puesto El Tristan in Argentina , about 47 kilometers ( 29 mi ) away , where beginning at 1 PM it rained down for hours . At 4 PM , coarser sandy material and some pumice lapilli began to fall .

Cerro Azul 's April 1932 eruption was one of the largest of the 20th century . Releasing 9 @ . @ 5 cubic kilometers ( 2 cu mi ) of lava , the volcano ejected primarily dacitic tephra , accompanied by rhyodacite , andesite , and minuscule amounts of andesitic and basaltic scoria . At least one eruptive period lasted for 18 hours , creating an " exceptionally uniform " deposit . Eruption columns , extending 27 ? 30 kilometers ( 17 ? 19 mi ) into the air , were sighted . Phenocrysts were similar to the effusive eruption in 1846 . Soon after , both the Tinguiririca and Descabezado Grande volcanoes began erupting , sending clouds of ash 800 kilometers ( 500 mi ) into Argentina . The eruption had a Volcanic Explosivity Index ( VEI ) of at least 5 .

Since the eruption of 1932 Quizapu has been quiet . In 1949 and 1967 small ash clouds were reported , while in the 1980s there were no signs of activity other than fumaroles .

= = Threats and preparedness = =

Cerro Azul is in the South Volcanic Zone , where many volcanoes pose a threat to human life . Among the other active volcanoes of the South Volcanic Zone are Mount Hudson , Llaima , and Villarrica . Villarrica and Llaima together have more than 80 reported episodes of volcanism since 1558 , and at least 40 South Volcanic Zone volcanoes have had Holocene @ - @ age eruptions .

Every known type of eruption ( Hawaiian , Strombolian , Plinian , subplinian , phreatic , phreatomagmatic , and Vulcanian ) has occurred at some point in the range . Cerro Azul itself has experienced phreatic , Strombolian , and Plinian activity in human history . The type of eruption tends to correspond with lava composition . Strombolian eruptions at Llaima , Antuco , Villarrica , and elsewhere have been produced by basaltic to basaltic ? andesitic activity . Dacitic to rhyolitic lavas have been linked to subplinian and Plinian eruptions , such as those at Quizapu ( 1932 ) and Hudson ( 1991 ) . Because of this variability , volcanic hazards from Cerro Azul and the surrounding region could come in many different forms . Historical eruptions typically have produced lahars , lava flows , and ashfalls . Lava flows and lahars could wipe out entire cities or towns . Ashfall produced by explosive eruptions could interfere with air traffic . Most threatening of all is the risk of pyroclastic flows or avalanches , which have historically traversed as far as 100 kilometers ( 62 mi ) in the region .

Past eruptions of Quizapu Crater ejected enormous amounts of ash that traveled as far as Brazil . After the 1932 eruption , the local vegetation was devastated , and the area remained barren until the 1990s , though human life was not impacted . Despite the extent of its eruptions , the threat to humans from Quizapu is relatively small because of the remote location of Cerro Azul . Nevertheless , the size of past eruptions is large enough for scientists to be worried . Evidence of a potentially deadly threat lies in a lahar at Descabezado Grande . Historically , lahars have killed thousands in the Andes . There is , however , a possibility that a large reservoir of rhyodacite magma may exist under the Azul ? Descabezado complex . If this is the case , all previous eruptions in 1846 ? 1967 were only preliminary , preclimactic leaks from the large magma chamber beneath , and a large caldera @ - @ forming eruption may be expected in the future .

If Cerro Azul were to erupt , relief efforts could be orchestrated . The Volcanic Disaster Assistance

Program ( VDAP ) formed in response to the famous eruption of Nevado del Ruiz in Colombia , and responded to the 1991 eruption of Mount Hudson in Chile . The team 's stated aim is to " reduce eruption @-@ caused fatalities and economic losses in developing countries " . Made up of various USGS offices ( such as the Cascades Volcano Observatory ; CVO that are responsible for monitoring Mount St. Helens ) , the team is outfitted with equipment capable of monitoring any volcano . This equipment allows them to predict volcanic eruptions effectively and rapidly , and to evacuate nearby homes .