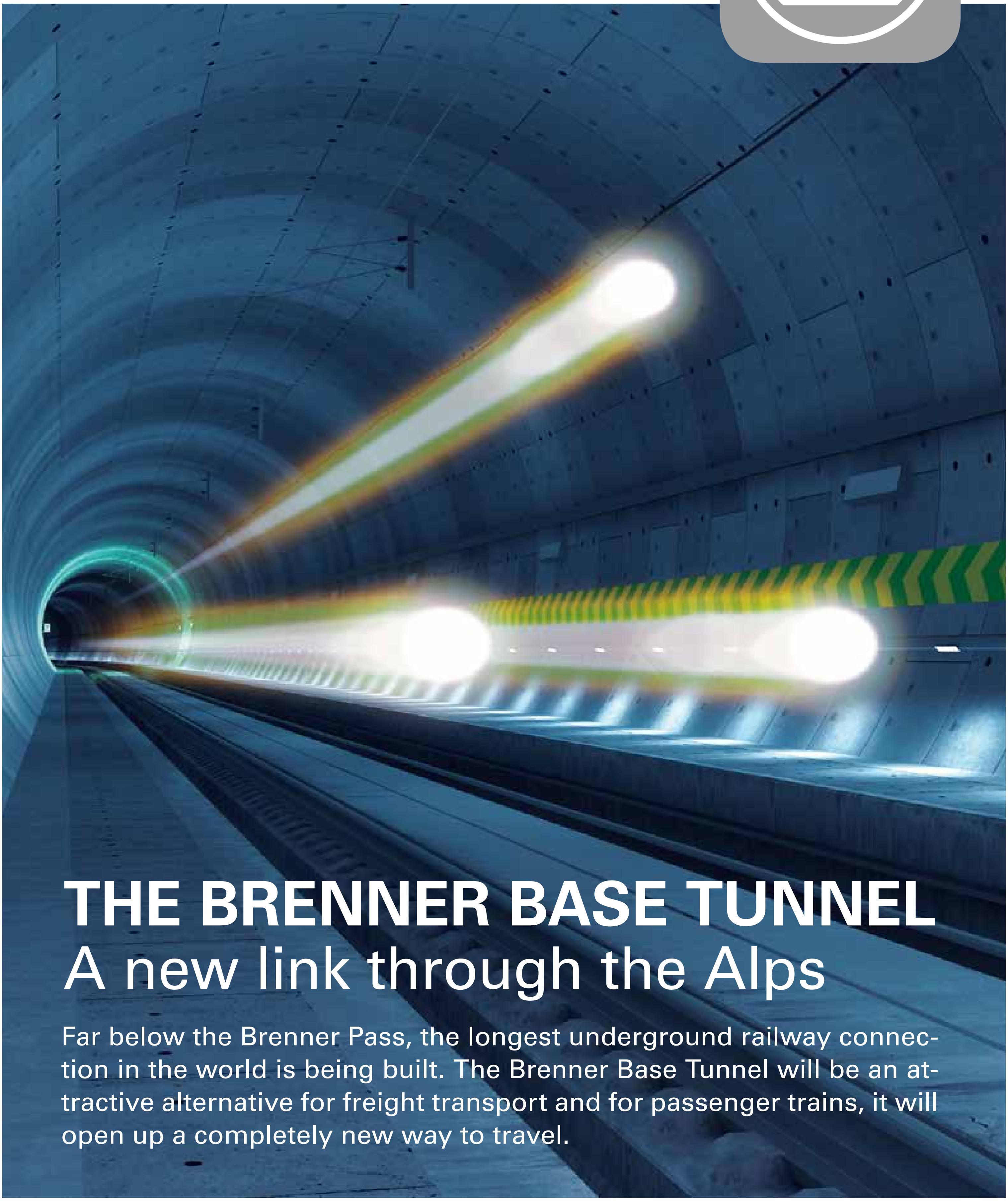
BRENNER BASISTUNNEL

GALLERIA DI BASE DEL BRENNERO

BRENNER BASE TUNNEL



THE BRENNER BASE TUNNEL

A new link through the Alps

Far below the Brenner Pass, the longest underground railway connection in the world is being built. The Brenner Base Tunnel will be an attractive alternative for freight transport and for passenger trains, it will open up a completely new way to travel.

www.bbt-se.com

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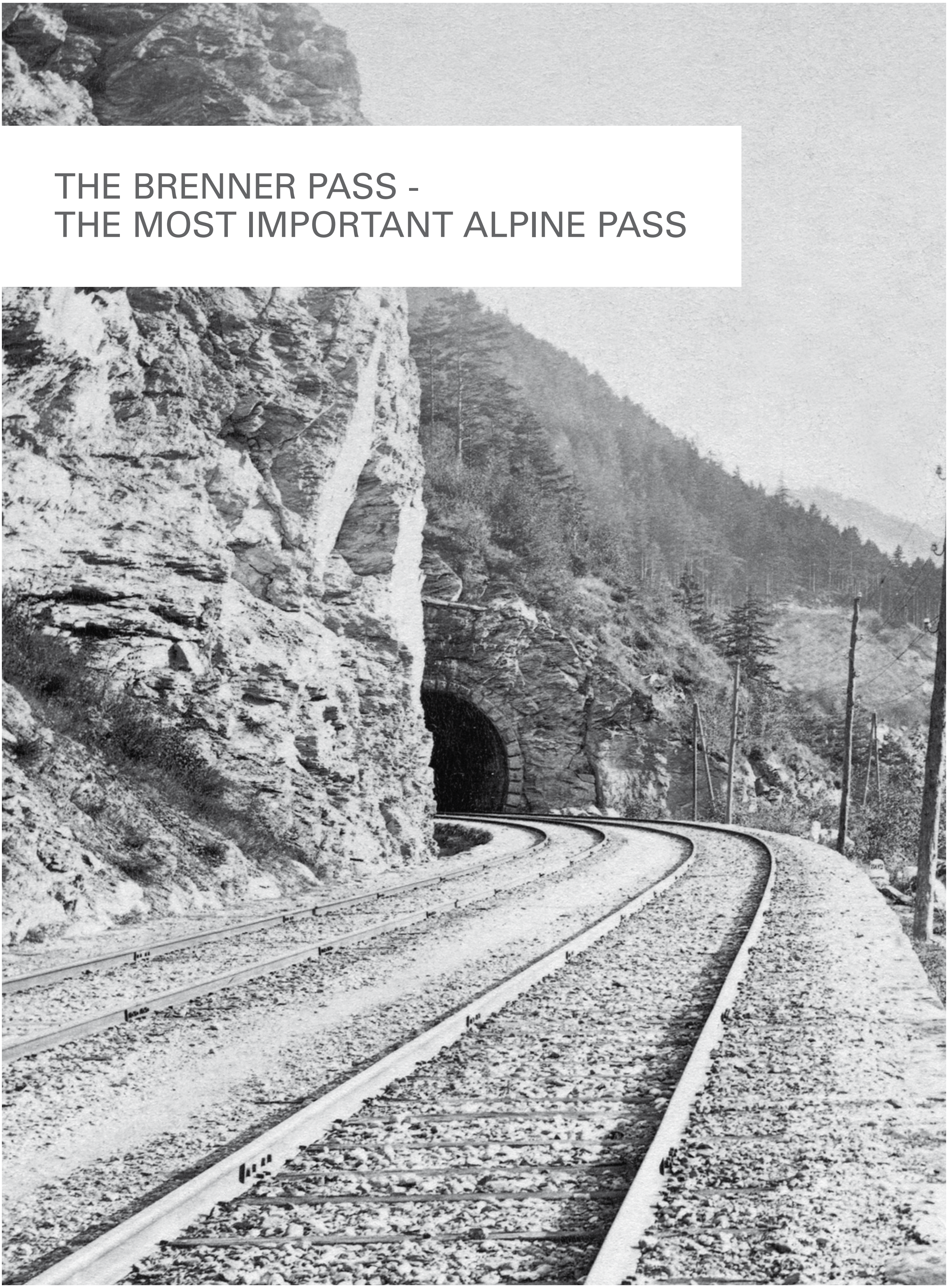
THE BRENNER PASS - THE MOST IMPORTANT ALPINE PASS



The construction of the Brenner railway line – seen here, the northern ramp at Patsch, around the year 1900 – was considered a masterful feat of technical engineering when it was opened in 1867. (Collection from the Verkehrsarchiv Tirol)

Lively railway traffic through the station at Fortezza. Passenger and freight traffic was already quite remarkable in 1900. (Collection from the Verkehrsarchiv Tirol)

A SB 34 steam locomotive at Brenner station, put into service in 1867 – at the time, it was the heaviest and strongest locomotive in Austria. (Collection from the Verkehrsarchiv Tirol)

The Brenner Pass has always been an important north-south connection over the Alps

The route over the Brenner Pass has always been one of the most important north-south connections in Europe. The Brenner Pass lies 1,370 m above sea level. It is the lowest Alpine pass and can be crossed all year round.

From beasts of burden to the most modern methods of transportation

In the early Bronze Age, around 1,700 BC, this mountain pass was an important commercial link between the North Sea and the Mediterranean area. In the 14th century, 3,000 tons of freight including spices, wine, sugar, oil and cotton were transported over the Brenner Pass.

The flow of freight over the Brenner increased constantly, so that at the beginning of the 19th century the volume of goods being carried over the Brenner every year, using horse-drawn wagons, had risen to 15,000 tons and then to 60,000 tons only 50 years later.

This led swiftly to capacity bottlenecks and the decision to build the Brenner railway line. The present-day Brenner railway line was built between 1860 and 1867.

Rail and roadways

One hundred years later, the highway was built. Since 1974, the Brenner Pass can be crossed using the Austrian A13 and the Italian A22 highways. Once the highway was completed, ten million tons of goods were freighted yearly over the Brenner.

Today, approx. 50 million tons of goods are freighted yearly over the Brenner Pass.

In 2019, 223.5 million tons of goods were transported across the Alps. The number of lorries crossing the Alps hit a new record of 11.5 million. Approximately 22 % of all trucks (2.5 million) cross the Brenner Pass every year.

Over 30% of all transalpine freight traffic travels over the Brenner Pass. 73 % of goods are transported by road, 27 % of goods travel over the Brenner by rail.

THE BRENNER PASS NOW

More than 2.5 million lorries cross yearly over the Brenner.

A “rolling highway” train at St. Jodok am Brenner. Here the trains gain height via a large bend around the village and a 481-meter-long horseshoe tunnel. The image gives an idea of the steep ascent of the Brenner north ramp.

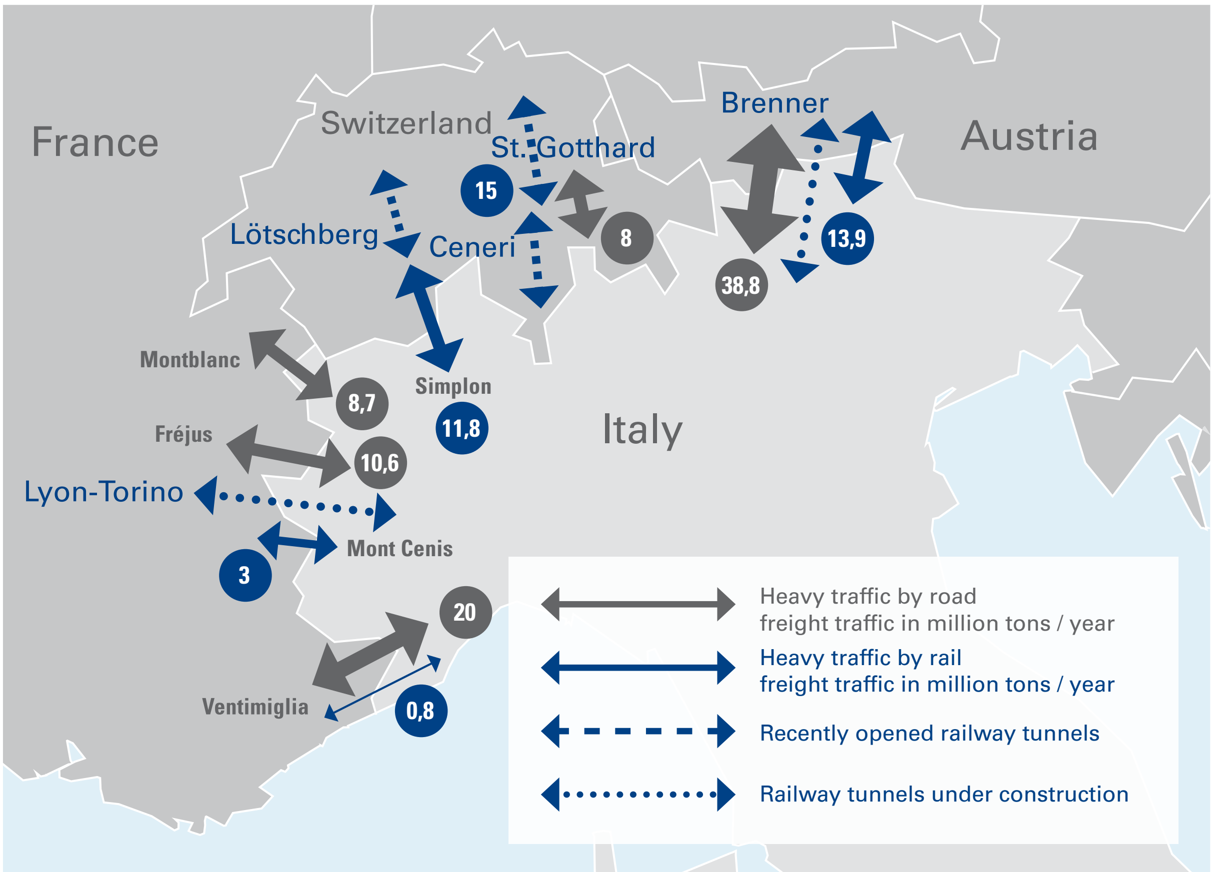
Transport routes in the European Union

The EU's goal is to guarantee swift, convenient and environmentally friendly freight transport and a new manner of travel for passenger traffic in Europe.

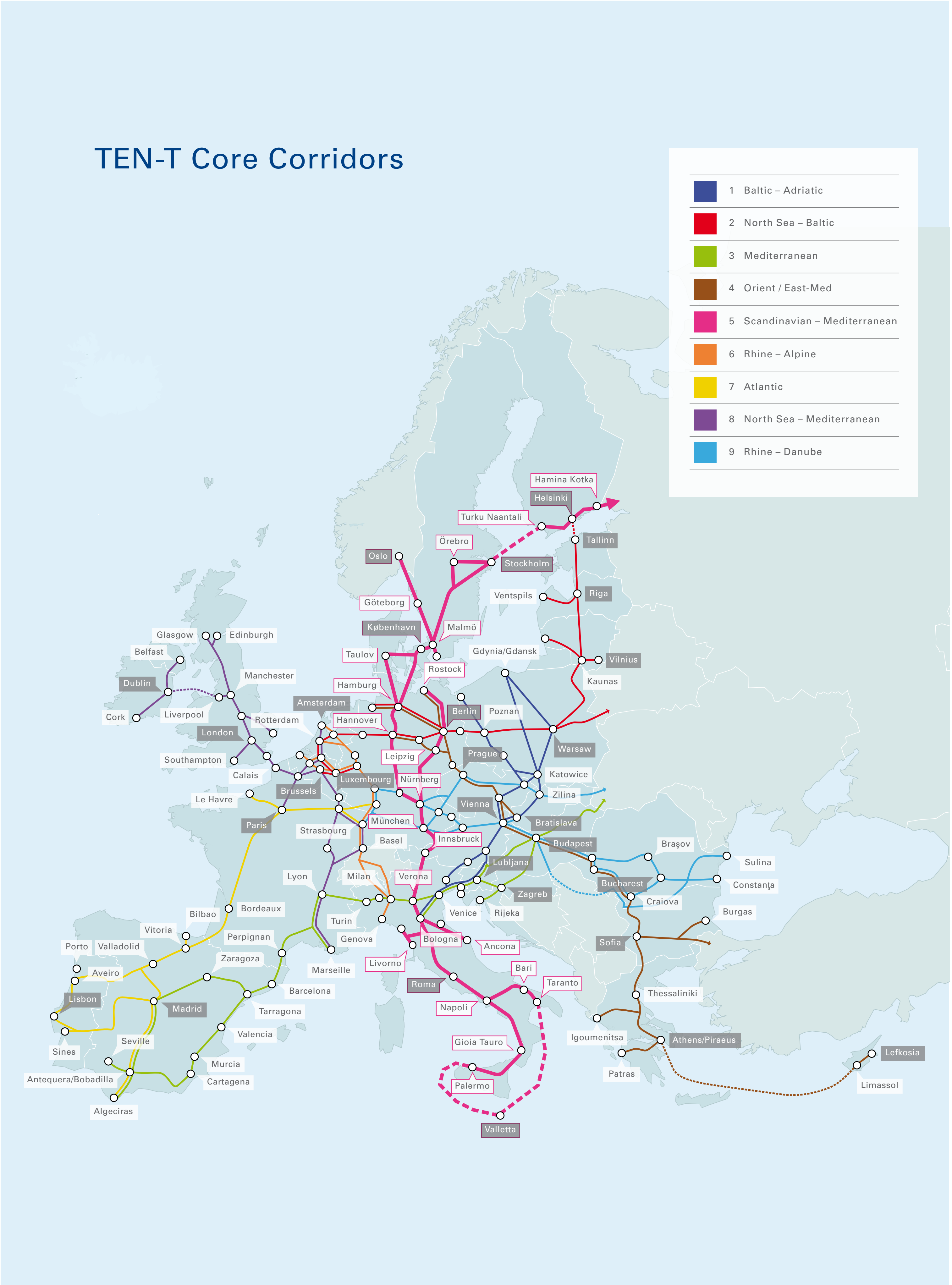
In 1994 the EU decided to take measures to counteract the increase in heavy traffic on the road and thereby promote ecological rail infrastructure and its sustainable development. The first step in this direction was taken with the development of the Trans-European Network Transport (TEN-T for short) in the 1990s.

In December 2013, the EU decided to redesign the TEN transport axis, and create transnational multi-modal transport connections. Nine TEN-T core corridors now connect Europe's major ports with the railway infrastructure and its access routes by road.

Transalpine traffic flows



Source: DG Move (2020)



TEN-T Core Corridors: Transport routes in the European Union by road, rail, air and water.

THE BRENNER RAILWAY LINE ON THE WAY TO THE FUTURE

Frecciarossa, Trenitalia's high-speed train, at the station in Fortezza.

From Finland to Malta

The longest and most important core corridor, with its significant length from north to south, is the SCAN-MED Corridor (Scandinavia - Mediterranean). This corridor is extremely important for European economy and mobility, as it links urban centres in Germany and Italy to seaports in Scandinavia and the Mediterranean. The Brenner Base Tunnel (BBT) is the most important infrastructure project along the SCAN-MED corridor, as it overcomes the natural barrier of the Alps and, as a result, it is a very high-priority project for the EU.

The existing Brenner railway line: steep gradients, exhausted capacity

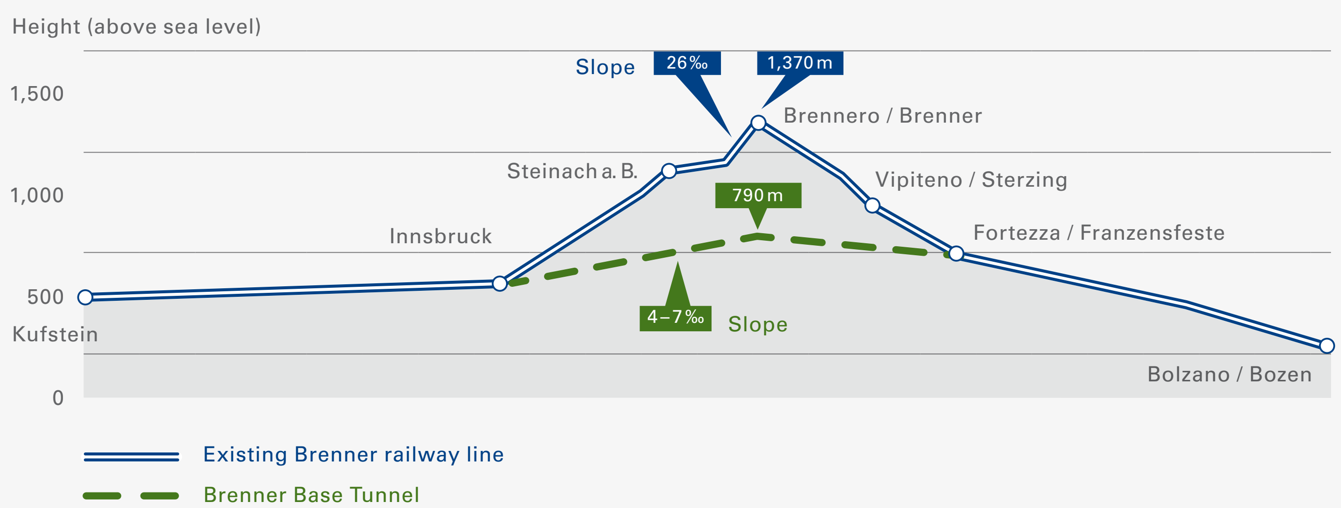
Completed in 1867, the over 150 year-old Brenner railway line crosses the Alpine pass with a slope of up to 26 ‰ and has a capacity of approximately 260 trains per day. To meet the transportation needs of the 21st century, it is necessary to expand and develop the existing railway line.

In St. Jodok, coming from the north on the Austrian side, just before the Brenner pass, the trains gain height via a large bend around the village and a 481-meter-long horseshoe tunnel.

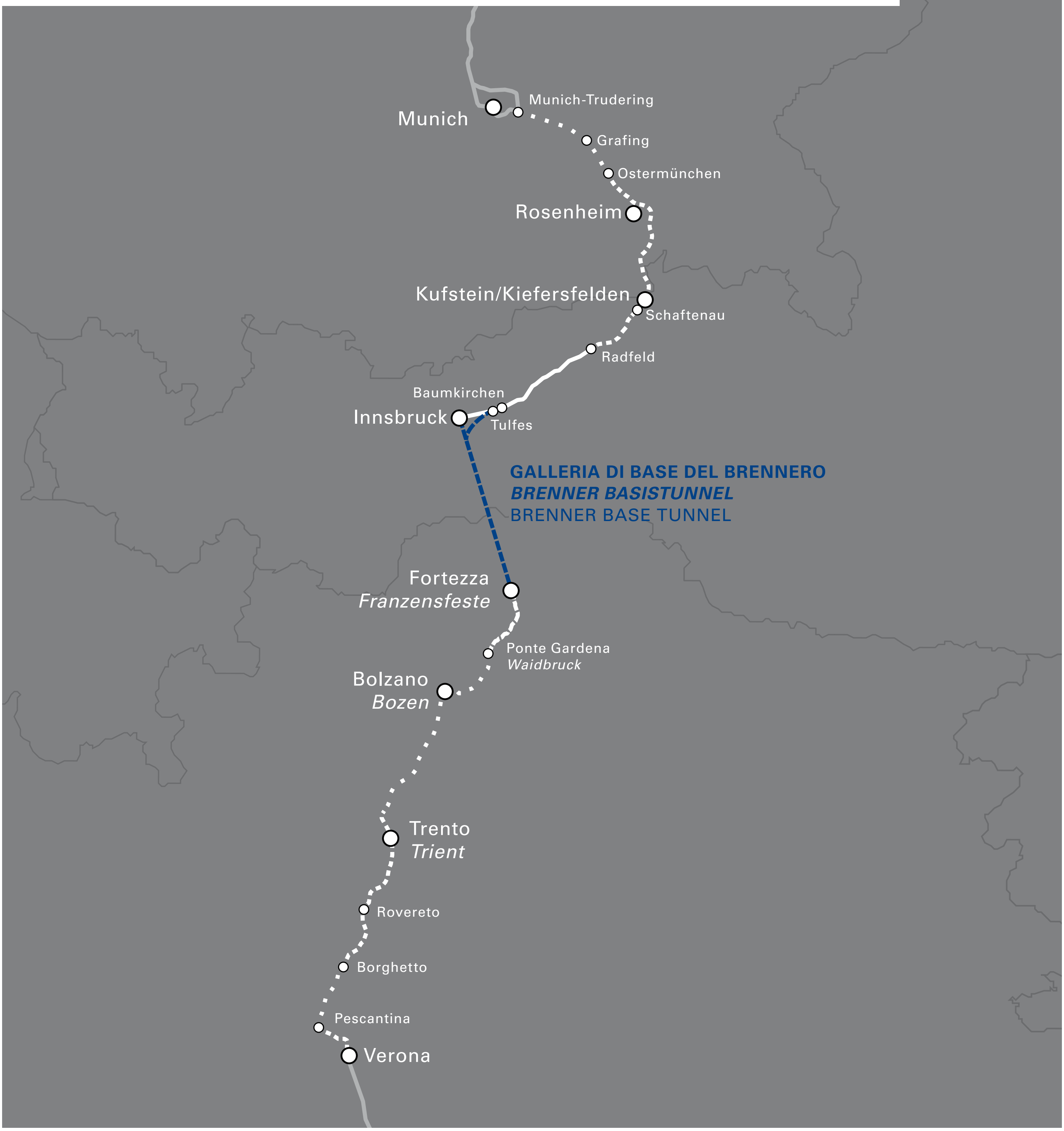
A Tunnel at the base of the mountain - the need for a flat railway

Since suitable expansion of the line is not possible, due to the steep ascent to the Brenner pass at 1,370 meters above sea level and the many curves in the current route as it winds through the landscape, a railway tunnel, the Brenner Base Tunnel, is being constructed at the very base of the Brenner massif.

Altitude profile Brenner railway line / Brenner Base Tunnel



THE BRENNER BASE TUNNEL PROJECT



Thanks to the Brenner Base Tunnel, travel time will be reduced and there will be more capacity available on the existing railway line.

The Brenner Base Tunnel is the heart of Europe's north-south link.

The desire for a modern and environmentally friendly means of goods transports on this transalpine route can only come to pass through the construction of a high-speed route through the Brenner massif, the Brenner Base Tunnel.

The Brenner Base Tunnel is a straight, flat railway tunnel connecting two countries. The BBT runs for 55 km between Innsbruck (in Austria) and Fortezza (in Italy). Thanks to the low gradient of 4 ‰ - 7 ‰ and the relatively flat course of the line, the tunnel cuts the route length between Fortezza and Innsbruck by 20 km, from 75 km down to 55 km.

In May 1994, a railway bypass was opened south of Innsbruck, known as the "Inn valley tunnel". This 12.7 km tunnel links to the Brenner Base Tunnel. Passenger and freight trains along this stretch will therefore not only travel through the BBT, but for a few kilometres, through the Inn valley tunnel as well. These 64 kilometres of tunnel (9 km Inn valley tunnel + 55 km Brenner Base Tunnel) will become the longest underground railway connection in the world.

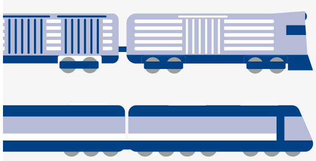
Across the Alps in 25 minutes

The BBT reduces both route length and travel time for rail traffic between Innsbruck and Fortezza. Passenger trains will travel through the tunnel at a speed of over 200 km/h. Due to the elimination of steep gradients, even more longer and heavier freight trains can travel through this stretch. They require less energy on the flat railway than on the existing railway line.

For passenger traffic, this means that in the future the stretch between Innsbruck and Fortezza will be covered in just 25 minutes using the BBT. Today, it takes 80 minutes on the existing railway line.

The Brenner Base Tunnel is considered a pioneering work of engineering and it will markedly improve passenger travel and freight transport through the heart of Europe.

Design speed:

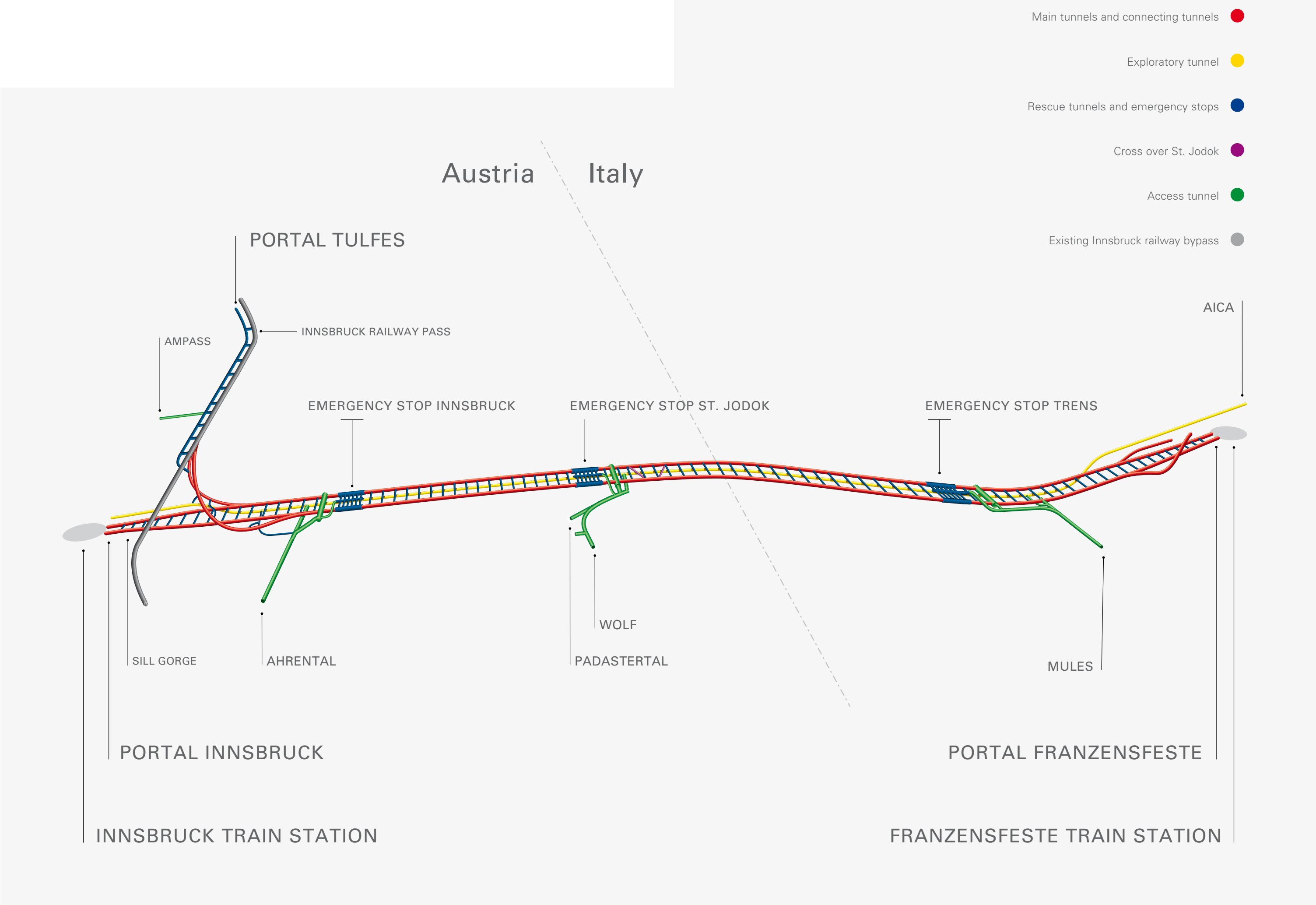


max. 160 km/h freight trains

max. 250 km/h passenger trains

Shorter travel times
Innsbruck – Fortezza:
Down to 25 minutes

THE TUNNEL SYSTEM



Basic information Brenner Base Tunnel

Length of the Brenner Base Tunnel (including the Innsbruck by-pass) Tulfes Portal - Fortezza Portal	64 km
Length of the Brenner Base Tunnel Innsbruck Portal - Fortezza Portal	55 km
Maximum overburden	ca. 1,720 m
Inner diameter of the main tunnels	8,1 m
Longitudinal slope	4–7‰
Design speed for freight transport	160 km/h
Design speed for passenger trains	250 km/h
Emergency stops (Innsbruck, St. Jodok, Trens)	3
Spoil	21.5 Mio. m³
Excavation methods	Blasting Tunnel boring machine (TBM)
Railway traction power supply	15kV 16,7Hz and 25kV 50Hz
Train control system	ETCS Level 2

The Brenner Base Tunnel consists of two main tubes, an exploratory tunnel, four emergency stops, several by-passes, connecting tunnels and four lateral access tunnels.

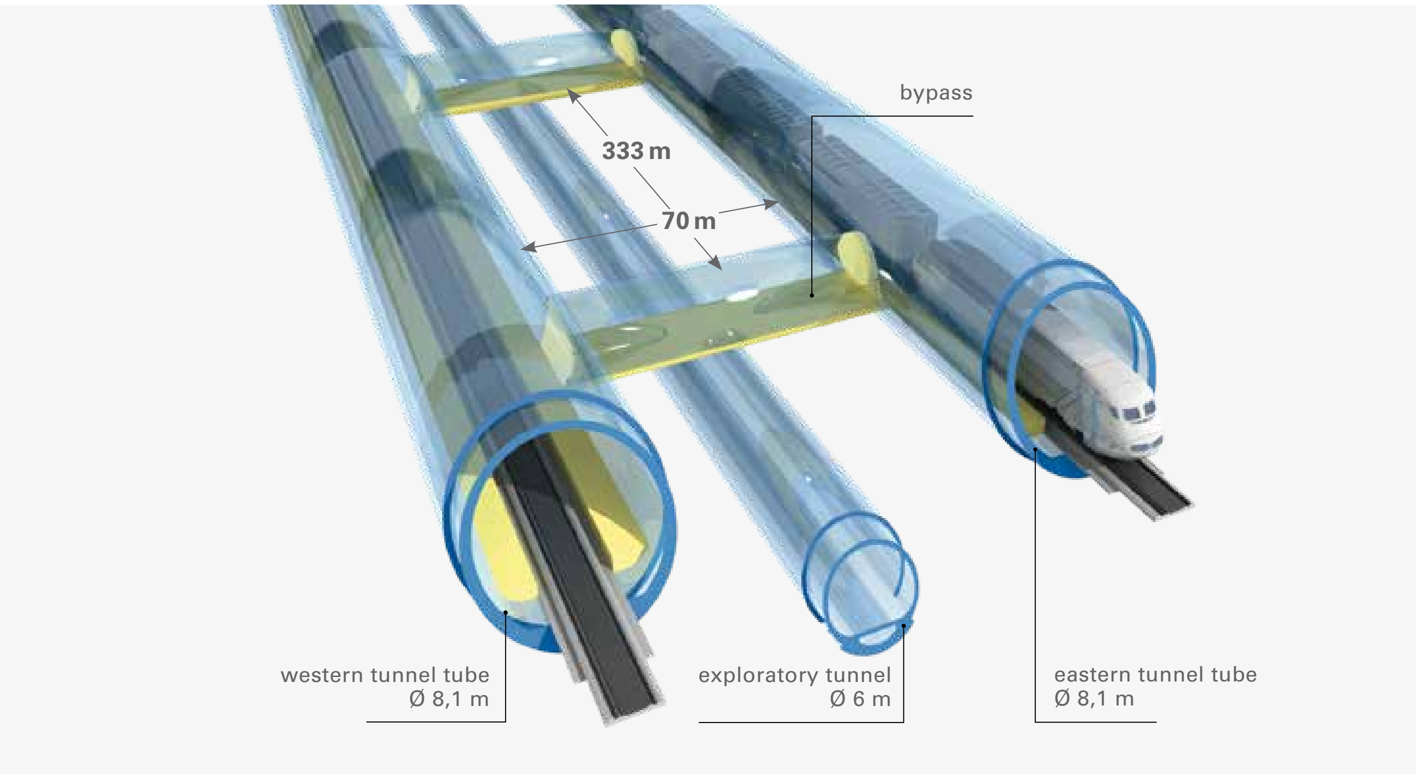
The access tunnels are located in Ampass, in Ahrental and in Wolf near Steinach am Brenner in Austria, and in Mules in Italy. They connect the tunnel tubes to the surface. During the construction phase, they are used for logistics. On the one hand, they are used to move the spoil via the access tunnels to the disposal sites. On the other hand, all material deliveries for the construction of the tunnel (concrete, iron and precast concrete elements) come in through the access tunnel.

Two large tunnels and a smaller one

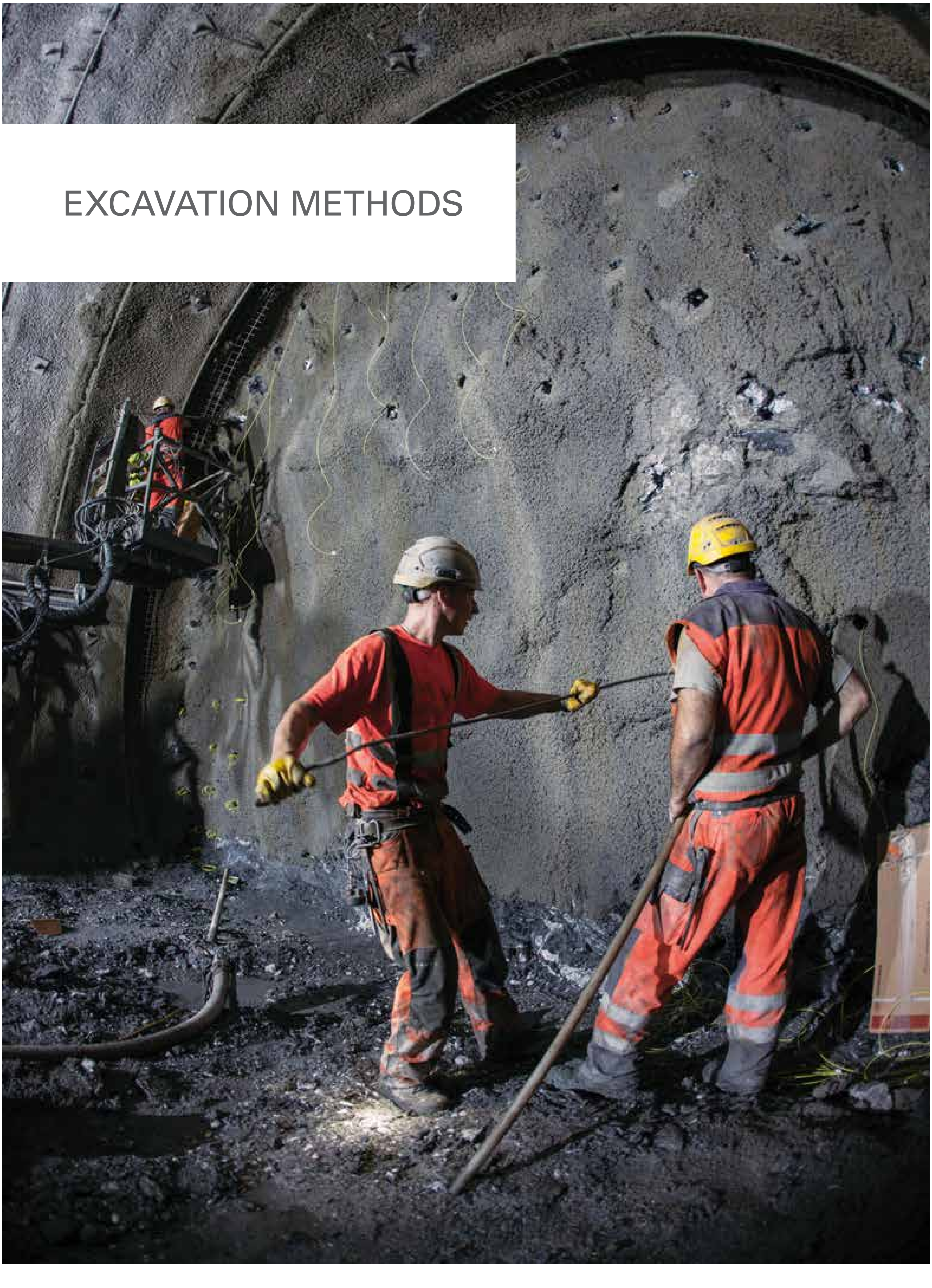
Two single-track main tubes run between Innsbruck and Fortezza, set about 40 to 70 metres apart. This distance is necessary to keep the rock mass stable. Smaller tunnels connecting the two main tubes are located every 333 m. They are used for logistics but also for emergency rescue.

A peculiar feature is the exploratory tunnel, which runs from one end to the other. This tunnel lies between the two main tunnels and about twelve metres below them. The exploratory tunnel is meant for geological prospection, as a service and logistics tunnel during the construction phase and as a maintenance and drainage tunnel during the operational phase.

In total, the tunnel system for the Brenner Base Tunnel will include about 230 km of tunnels.



EXCAVATION METHODS



Every phase of the work requires precise planning and careful deliberation.

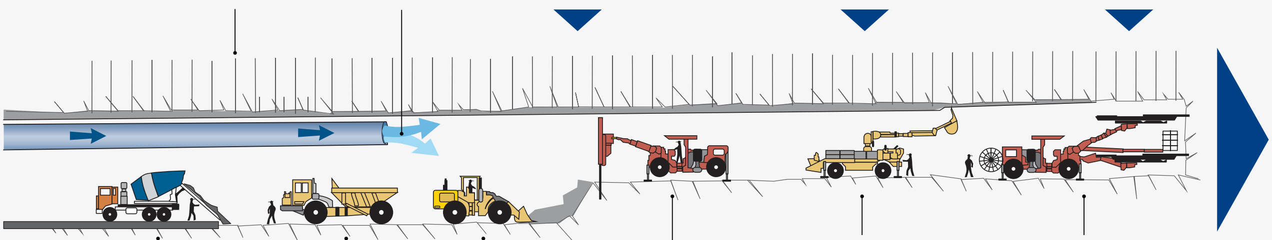
Various excavation methods are used to drive the Brenner Base Tunnel forward, using special machines and explosives.

The choice of excavation method depends on the geology of the mountain, on geotechnical findings and forecasts, and on construction logistics and economic considerations. The length of the route to be excavated and the available construction time both influence the choice of excavation method. So some sections of the tunnel are excavated by drilling and blasting whilst others are built using mechanical construction methods, i.e. with a tunnel boring machine (TBM).

Conventional or drill-and-blast excavation

Conventional excavation using shotcrete consolidation is a very flexible excavation method. It is suitable for difficult, varying rock mass conditions, for different cross-section sizes and for complex cross-sectional geometries.

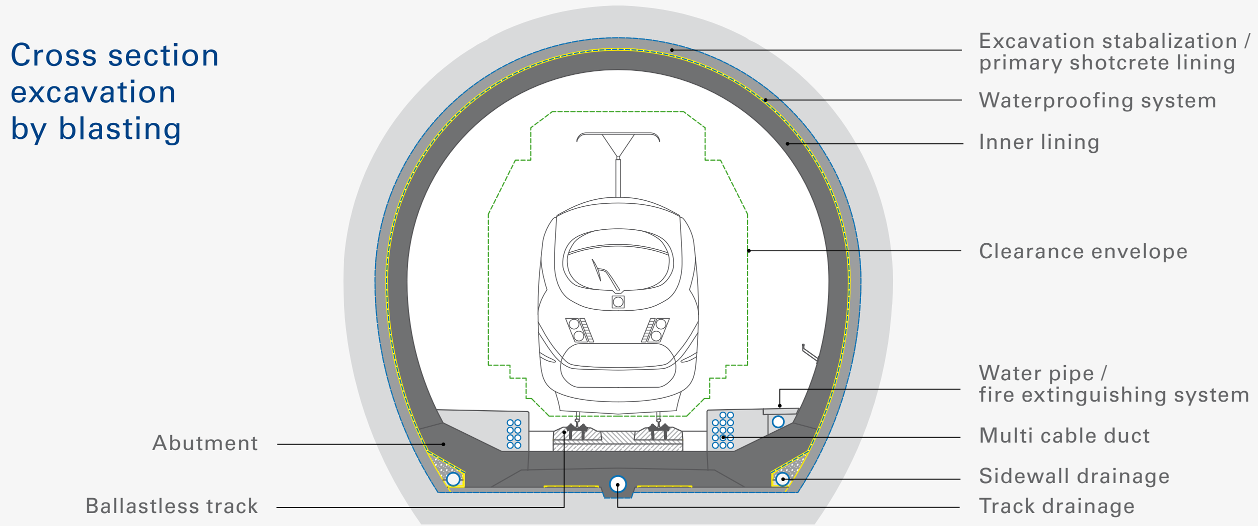
Blasting



Due to the complex excavation requirements, some sections of the main tunnels and exploratory tunnel, as well as the two connecting tunnels, all of the lateral access tunnels, ventilation and logistics caverns, cross-connecting tunnels, emergency stops and by-passes are being excavated using the so-called conventional excavation method, meaning by blasting (full and partial surface breakout) with shotcrete consolidation.

The stages for drilling and blasting are predetermined. The blast holes are drilled at first, then loaded with explosives and finally, the explosion takes place. Once the spoil has been removed, a process known as mucking, tunnel support is applied in the form of shotcrete, anchors, lattice arches and reinforcement mats.

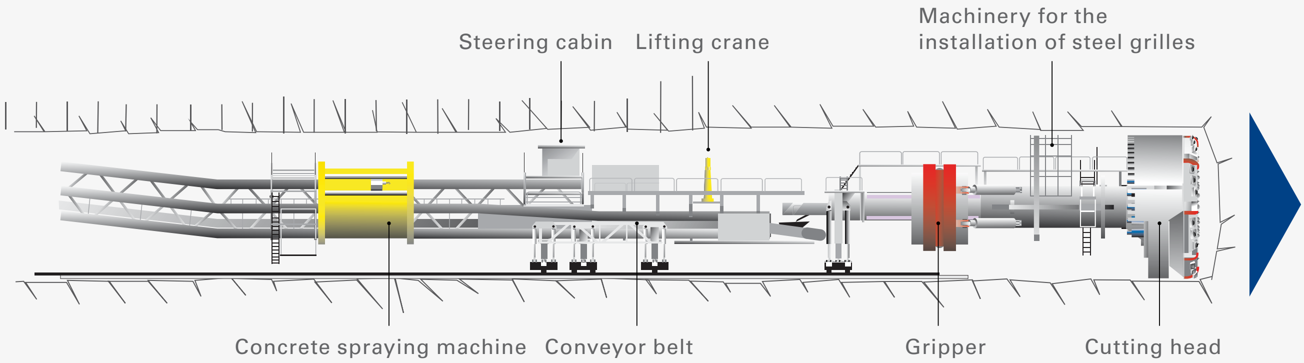
After one blasting cycle is complete, the process starts all over again. During the construction of the Brenner Base Tunnel blasting takes place every three to six hours depending on the geological composition of the rocks. Unlike in Austria, in Italy the entire cross section of the tunnel was blasted all at once.



Mechanical excavation

The tunnel boring machines used in the construction of the Brenner Base Tunnel are, depending on the prevailing requirements, approximately 180 - 400 metres long and consist of a drilling head and a trailing structure.

Excavation using a tunnel boring machine (TBM)

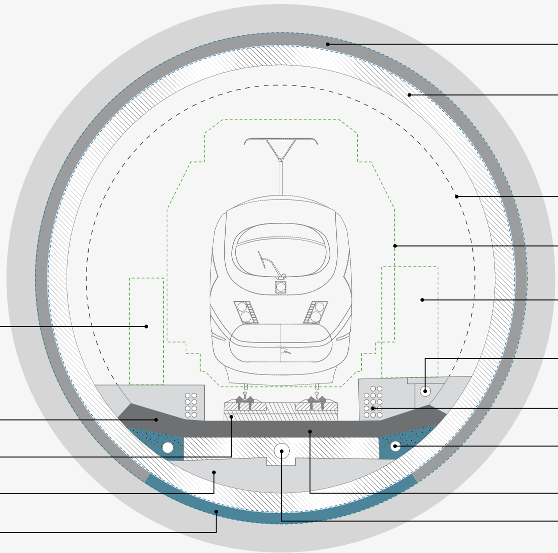


The advantage of mechanical excavation is its high daily production rate. Working with the TBM also offers the workers a relatively high standard of occupational safety. The most important part of the TBM, which is actually a high-technology underground logistics plant, is its cutter head. This has a diameter of about ten metres and consists of several drilling bits that press against the rocks and break them into small pieces.

The trailing structure behind the drilling head, or back-up, is used to supply the excavation and remove the excavated material. The machine also includes rock stabilisation, ventilation and dust collection equipment.

The tunnel boring machine called „Serena", which excavated about 14 km of exploratory tunnel between Mules and the Brenner, reached the border in november 2021.

Mechanical excavation cross section



As tunnel boring machines are very expensive and the preparation time before a machine can become fully operational is much longer than the preparation time for drill and blast, the use of a TBM is only economically viable for longer stretches.

Approximately 50% of the Brenner Base Tunnel is being excavated using the mechanical method. In the process, open TBMs (which install tunnel support using shotcrete, anchors and steel mesh) and shielded TBMs (which install tunnel support using precast concrete tubbing rings) are used.

Inner lining

The concrete support structure is meant to last 200 years.

As soon as the excavation and mucking operations are completed, the work of waterproofing the tunnel begins. Tunnel waterproofing involves the use of a protective drainage layer of geotextile fleece and an actual waterproof layer (fused plastic waterproofing strips). Once this is complete, the inner concrete lining is applied with a minimum thickness of 30 cm.

Technical outfitting of the tunnel

Once the construction work is finished, the ballastless track and the railway outfitting will be installed: the signalling and command and control systems, the telecommunications and monitoring systems, the ventilations systems, the doors and gates and all other technical systems including cabling and remote control systems.

The so-called Multiservice Vehicle was used to supply the TBM in the Ahrental-Pfons exploratory tunnel.

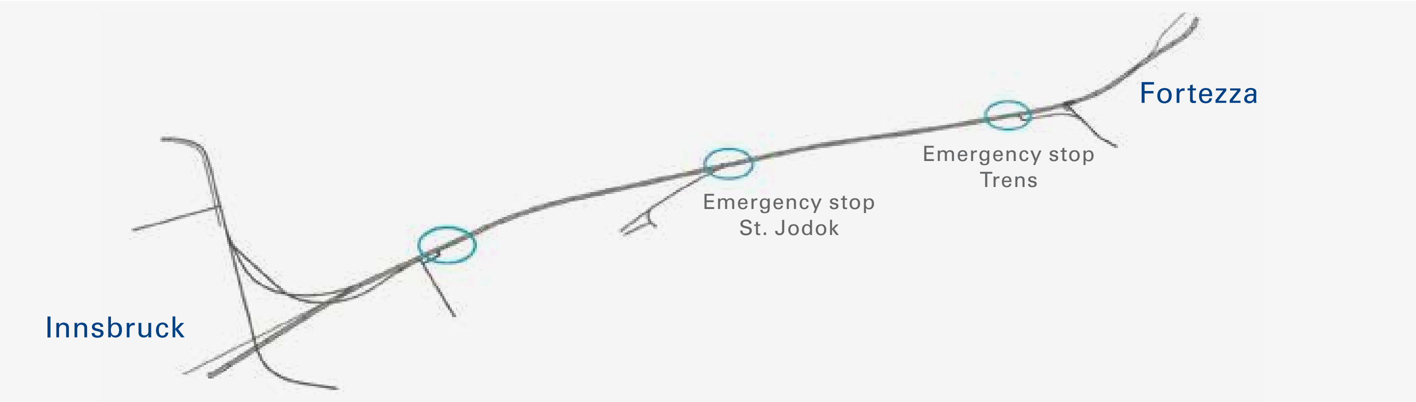
Supply train in the Mules 2-3 construction lot

SAFETY PLAN

The most modern safety standards

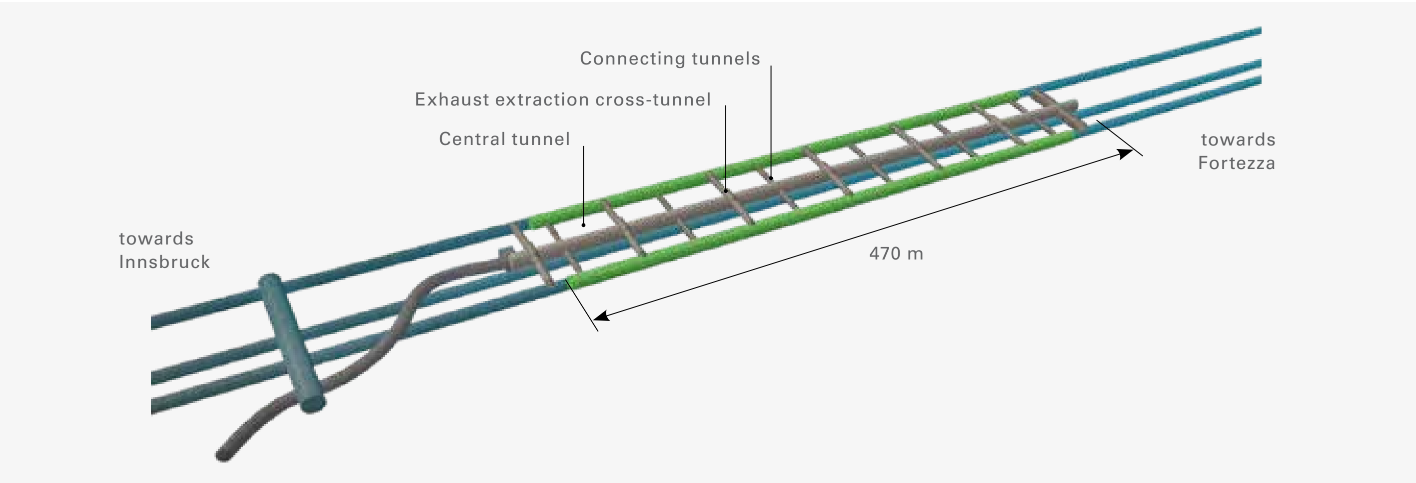
The two main tunnels in the Brenner Base Tunnel system are connected by cross-tunnels every 333 metres. These cross- tunnels, or bypasses, can be used in an emergency as escape routes.

European safety standards provide for emergency stops at 20-km intervals for tunnel structures such as the BBT. There are three in the BBT, One is located south of Innsbruck (below Igls/Patsch), one is below St. Jodok and the third lies below the town of Trens.

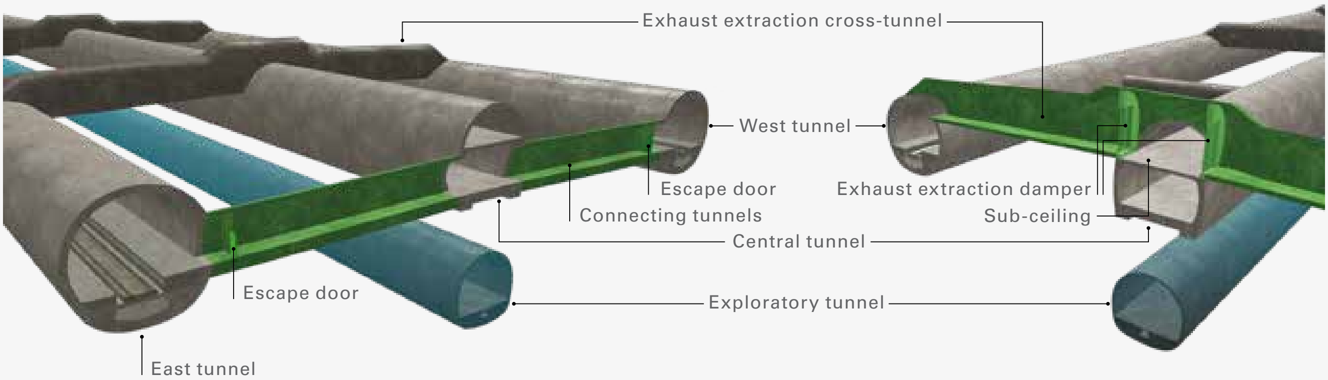


Each of the emergency stops is about 500 m long and linked to the central tunnel every 90 m via connecting tunnels. They include exhaust extraction cross-tunnels, which are staggered by 45 metres with respect to the connecting tunnels, thus also at 90-metre intervals.

The central tunnel has a sub-ceiling which divides it in a lower and an upper half. In case of an accident (e.g. fire), the gases and fumes will be extracted through the upper part, and fresh air is blown into the safe areas below.



Detailed view of connecting tunnel and exhaust extraction cross-tunnel



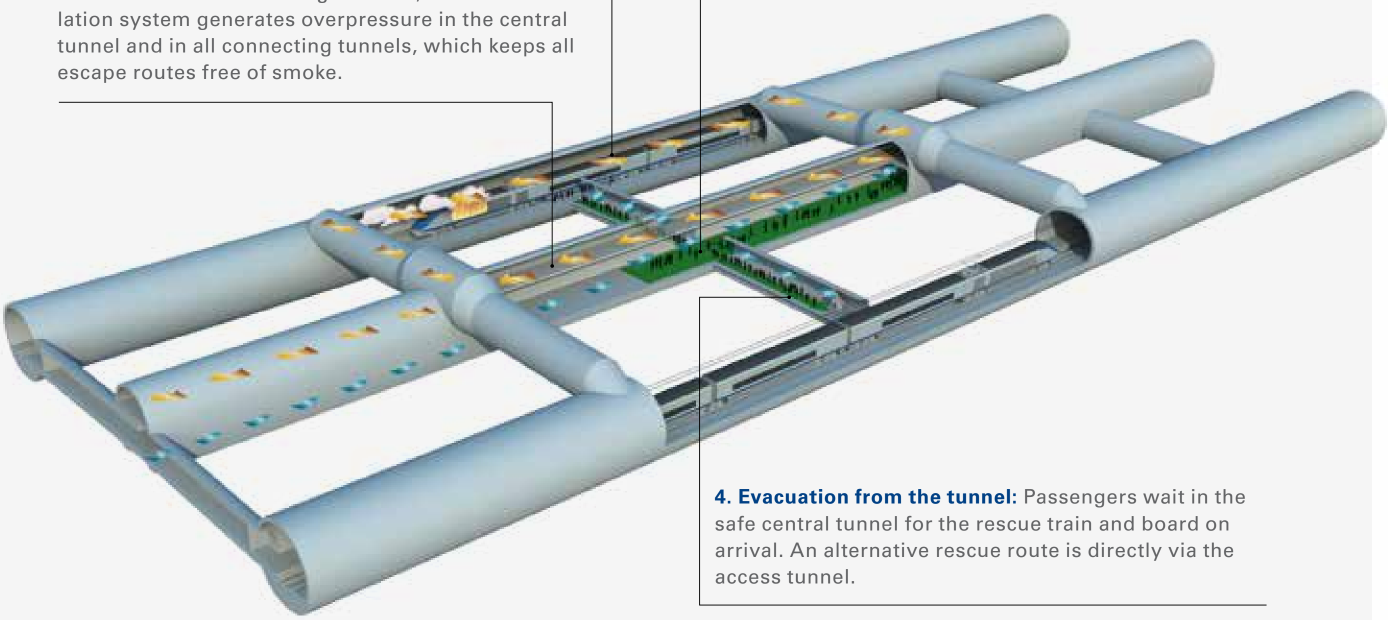
Connecting the emergency stops with the access tunnels and from these to the outside area allows fresh air intake and the generation of positive air pressure inside the tunnel, thus preventing smoke from spreading through the entire tunnel system. This ensures that there is always fresh air in the cross-tunnels and at the emergency stops.

The order of rescue measures in the tunnel in case of an accident

1. Emergency stop: In case of an accident the train tries to exit the tunnel or stops at one emergency station.

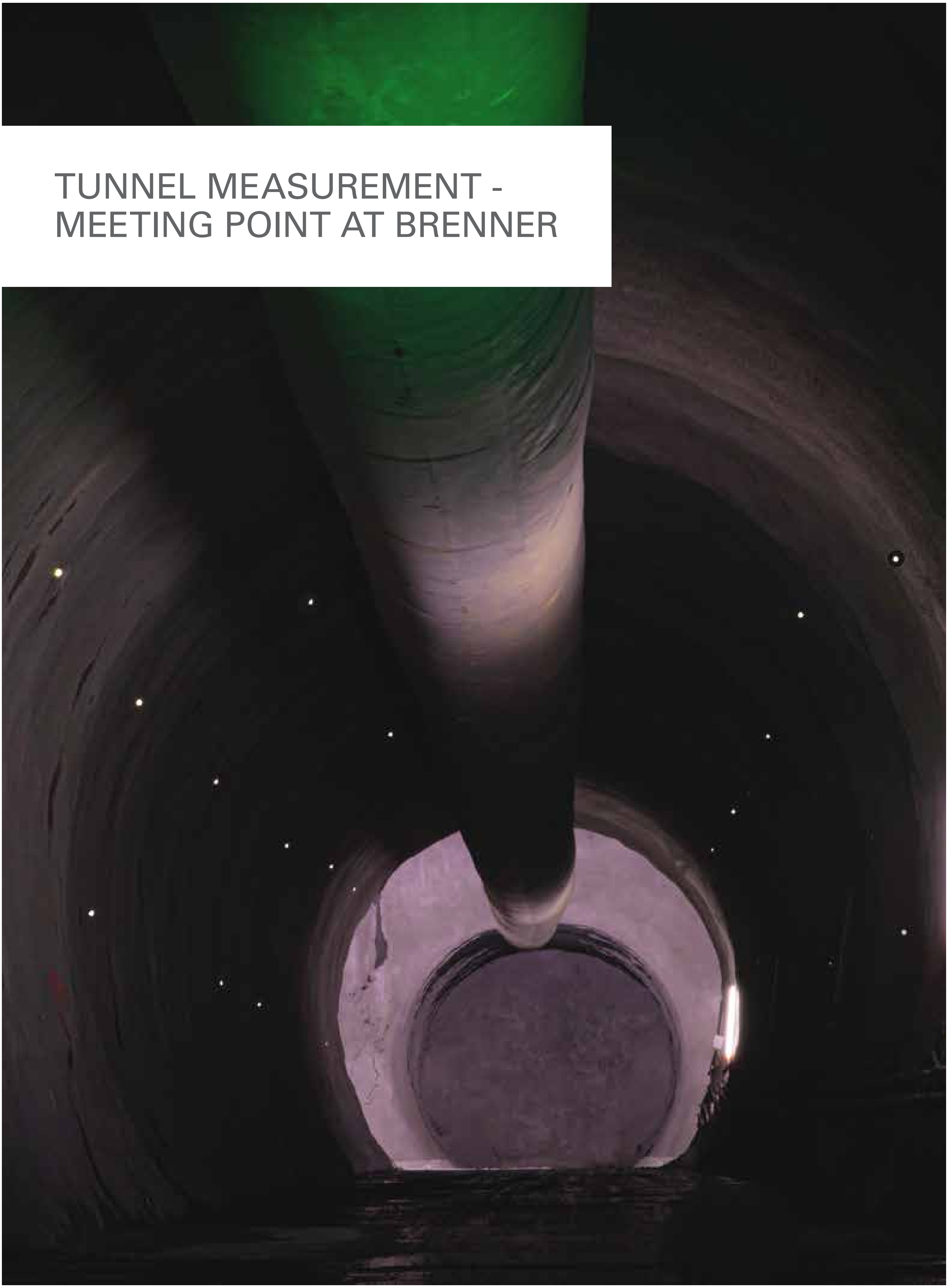
2. Smoke extraction: Using fresh air, the tunnel ventilation system generates overpressure in the central tunnel and in all connecting tunnels, which keeps all escape routes free of smoke.

3. Evacuation of the train: Passengers leave the train and proceed to the escape doors. These lead directly to the central tunnel through the connecting tunnels.

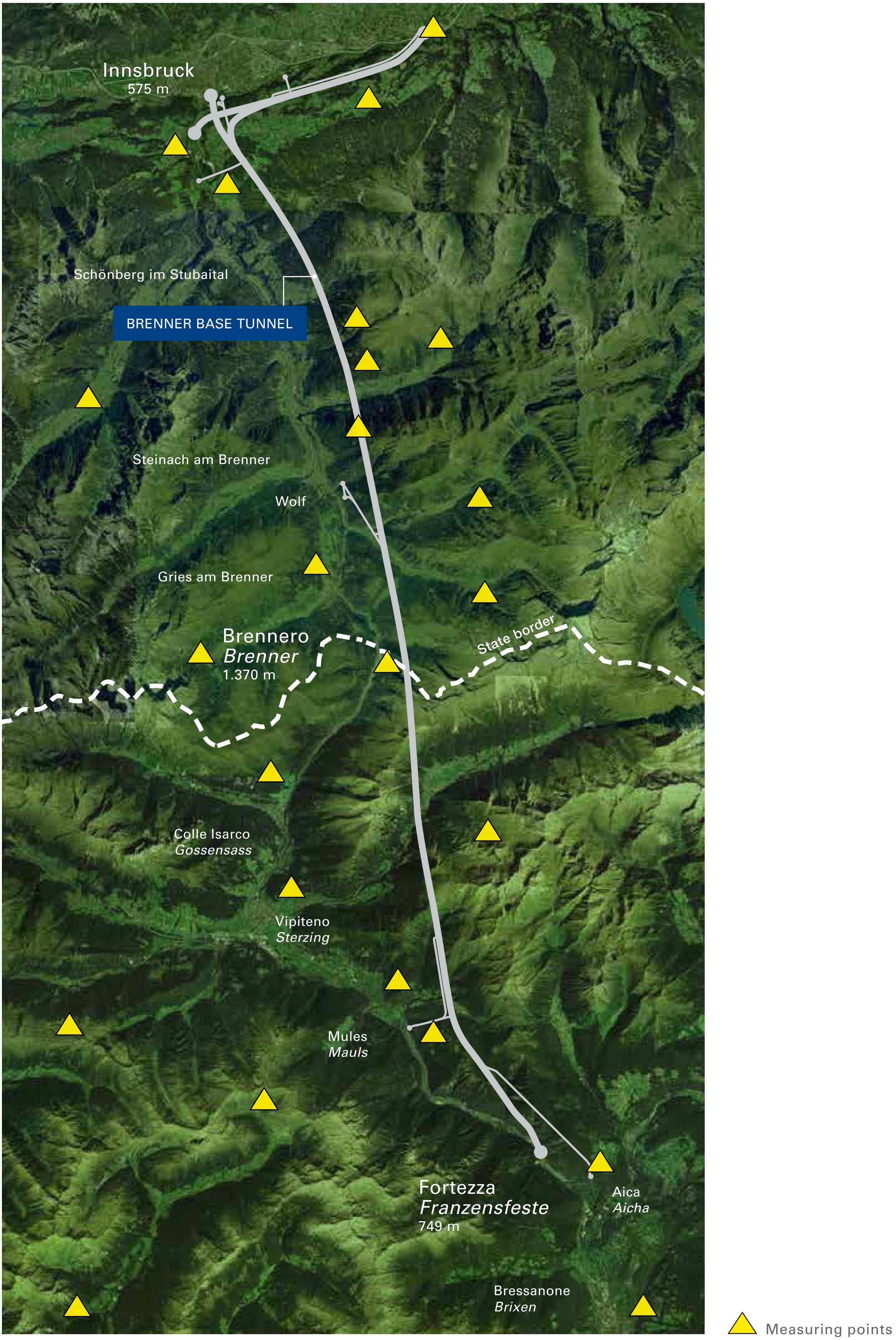


4. Evacuation from the tunnel: Passengers wait in the safe central tunnel for the rescue train and board on arrival. An alternative rescue route is directly via the access tunnel.

TUNNEL MEASUREMENT - MEETING POINT AT BRENNER



The light spots clearly visible in this picture are survey marking points in the shape of reflectors, which allow extremely accurate measurements and inspections during the entire construction period.



Geodetic reference frame

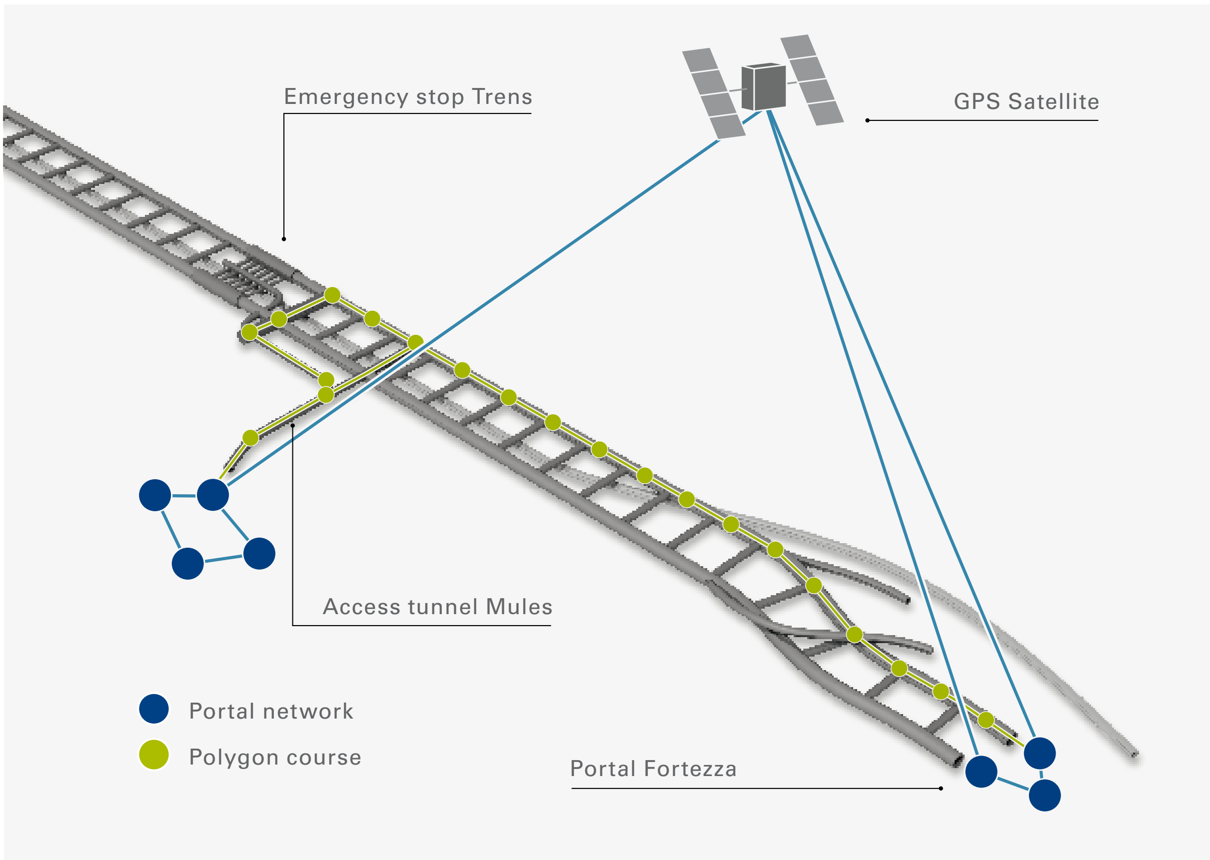
The construction of a long railway tunnel requires highest precision. Reliable and precise surveying methods guarantee the accuracy required for this task.

First of all, a geodetic reference frame was created to carry out the survey work necessary for the construction of the Brenner Base Tunnel. This creates a link between the plans and the topography and serves as a starting point for the underground tunnel construction.

The geodetic reference frame (see illustration on the opposite page) is a network made up of measurement points (highlighted in yellow), which are distributed over a wide area along the stretch of the Brenner Base Tunnel. Together with the GPS system, the geodetic measurement points form the basis for the topographic measurements of the Brenner Base Tunnel.

Using satellite measurement technology, 28 base points were established to form the geodetic reference frame. To accomplish this, the project area was measured twice for 24 hours using GPS. The achieved degree of accuracy is seven millimetres.

These 28 points, defined using satellite measurement technology, form the basis for the further topographic measurement of the tunnel. This is performed using the principle of the interlaced polygon course, whereby progressive angles and distances up into the tunnel are determined.



Principle of the interlaced polygon course

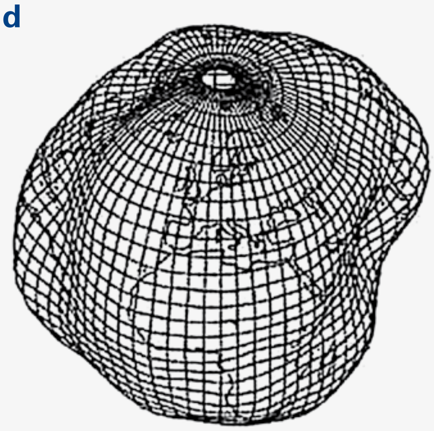
Tunnel survey measurements during construction

In addition to the principle of the interlaced polygon course, a surveying gyroscope affected by the earth's rotation indicates the direction of geographic north. The surveying gyroscope supports the measurements made with modern tachymetres. Thanks to these instruments, the orientation in the tunnel can be checked and improved. The tachymeter measures a distance of one kilometre with an accuracy of two millimetres. Tachymeters send out infrared waves aimed at reflectors.

Eliminating possible sources of error

Due to the temperature of the rock, it is usually warmer at the tunnel wall than it is in the centre of the tunnel, so measurements are performed at the centre of the tunnel. Furthermore, it must be remembered that the shape of the Earth is not an exact sphere, due to different density ratios in the Earth's interior. Sea water propagates along this geoid. For this reason, sea level is used as a worldwide reference surface for height measurements.

Geoid



This representation shows that the Earth is not a perfect sphere. This must be taken into account when taking survey measurements.

Since Austria and Italy use different official height reference points, the reference point for Italy is the sea level in Genoa, for Austria the sea level at Trieste. This leads to a difference of 12.5 centimetres at Brenner. For the construction of the Brenner Base Tunnel it was agreed to use the UELN European height system with Amsterdam as reference level.

Continuous monitoring

During the construction phase, the Brenner Base Tunnel must be constantly surveyed because tunnel deformation may occur. To that end, convergence bolts are drilled into the rock and possible movements such as subsidence, longitudinal or transverse movements in relation to the tunnel axis, are recorded using mounted prisms. The result is shown in diagrams. They enable the geotechnical expert to evaluate the rock mass and the excavation consolidation.

Tunnel scan

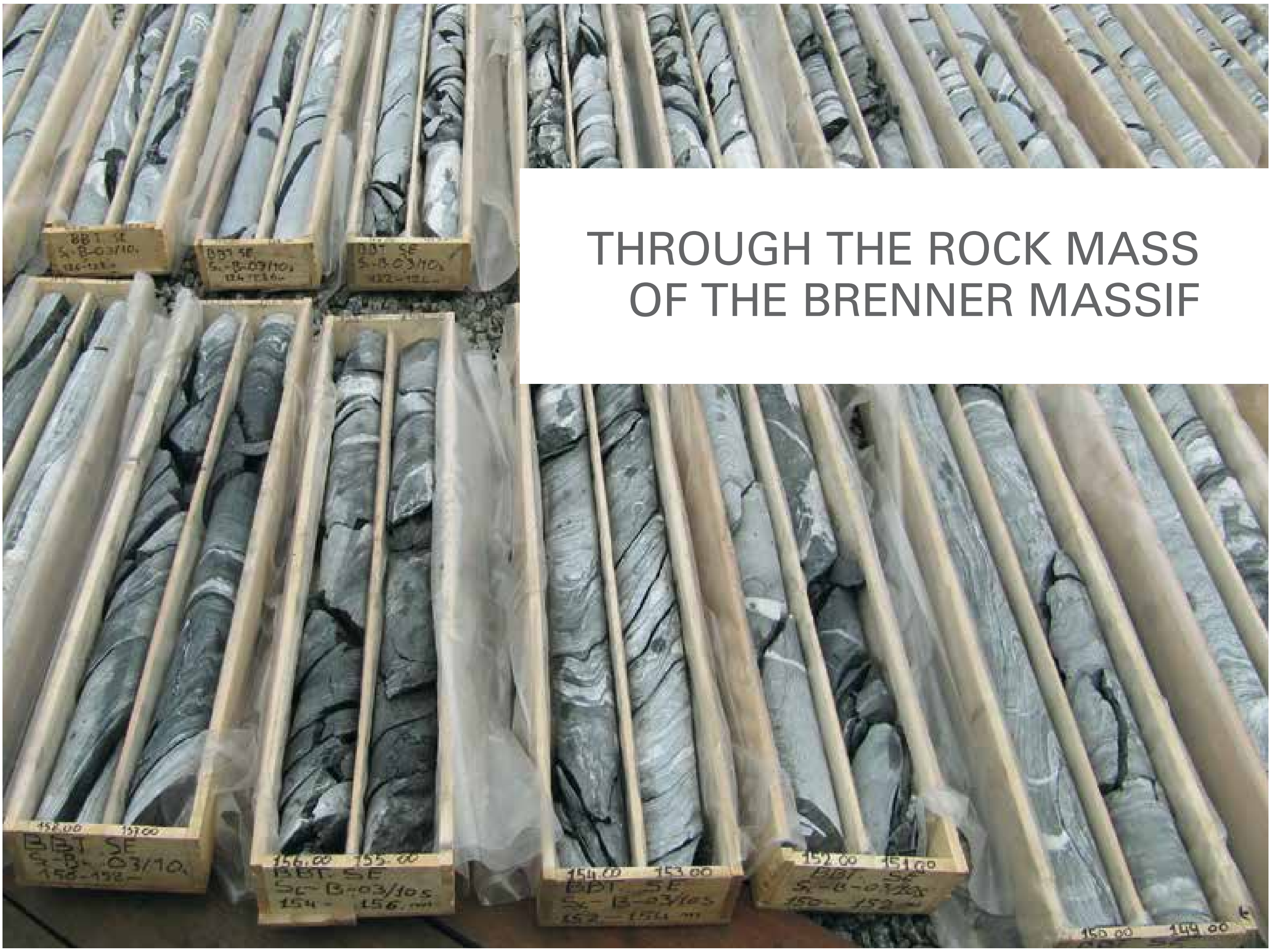
Within a few minutes, a tunnel scanner can record millions of measurement points in the tunnel. This is necessary to check the size of the excavation. If different construction phases are scanned, for example excavation and application of shotcrete, this method can be used to check the thickness of the shotcrete. With this method the contracting authority can monitor the compliance with the structural requirements.

Accuracy of the breakthrough

For the construction of the exploratory tunnel the largest expected deviation for the breakthrough in the Brenner area is 22 cm. For the construction of the two main tubes the largest expected deviation, 9 cm, is likely to occur during the breakthrough between the construction lots in Mules and the Isarco river underpass. The deviation during the construction of the main tubes will be much lower, because the measurements can be carried out via the shaft connections to the already completed exploratory tunnel.

The largest deviation in the Austrian project area was encountered during the breakthrough of the emergency tunnel, with a deviation of 18.2 cm, whereas the smallest one was encountered during the breakthrough of the exploratory tunnel, where the deviation along the tunnel length was 1.7 cm.

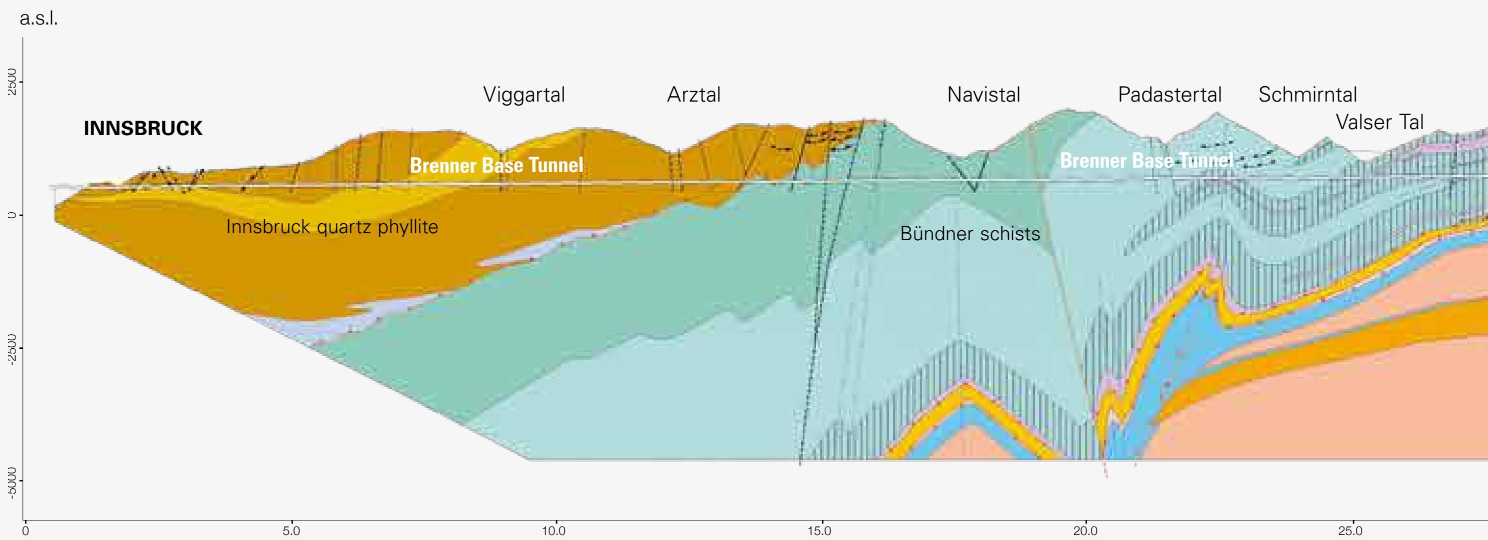
Surveyor at work with a tachymeter.



THROUGH THE ROCK MASS OF THE BRENNER MASSIF

These rock samples are the result of exploratory drilling. They provide information on the nature of the rock and form the basis for construction decisions.

Geological longitudinal section between Innsbruck and Fortezza



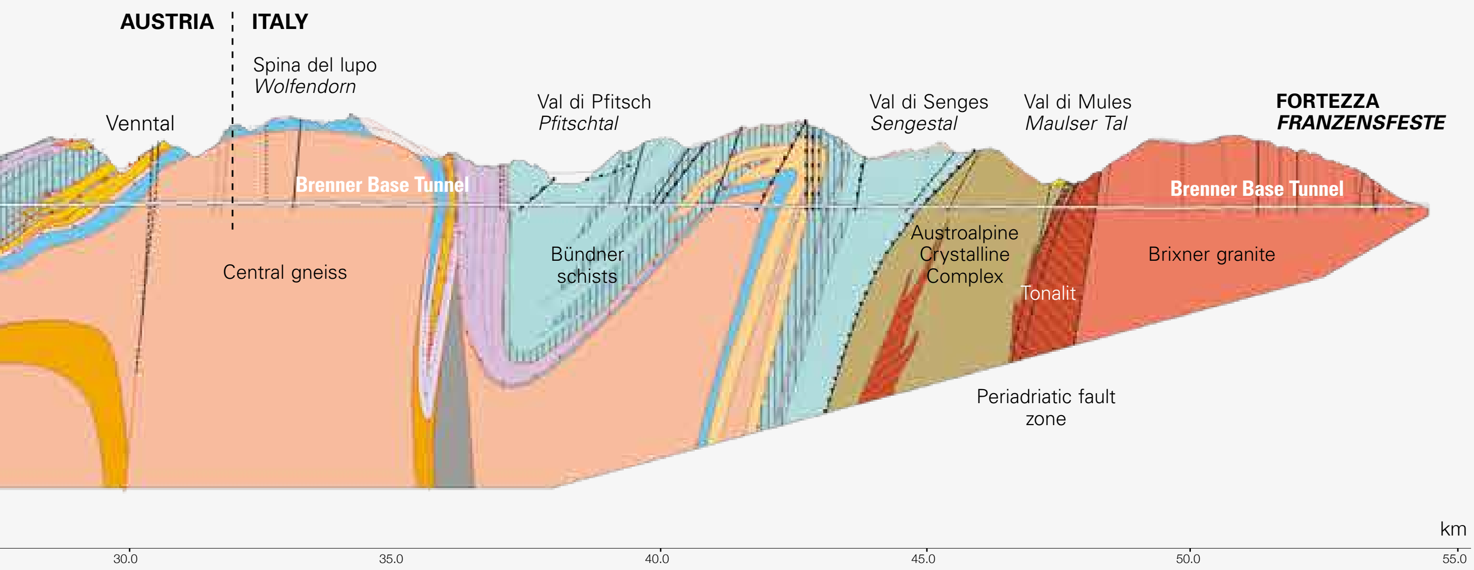
The geological conditions inside a mountain cannot be precisely predicted even using the latest technology. However, forecasts made by expert geologists, prospection drilling and the continuous exploratory tunnel minimise the construction risk.

Geological and hydrogeological conditions significantly affect the decision as to whether and where a tunnel is to be built.

To determine the appropriate route for the Brenner Base Tunnel, over 35,000 meters of boreholes were drilled at various points over the project area, some of these down to tunnel level. Rock samples were also taken and analysed in the laboratory.

Despite the use of modern technology, it is not possible to accurately predict the geological conditions inside a mountain. Therefore, an uninterrupted exploratory tunnel is being excavated as part of the Brenner Base Tunnel project to obtain more detailed information on the nature of the rock along the route. In this way, the excavation can be optimised from both a technical and an economical point of view.

On its route from Innsbruck to Fortezza, the Brenner Base Tunnel crosses roughly four different rock types: quartz phyllite, schist, gneiss and granite.



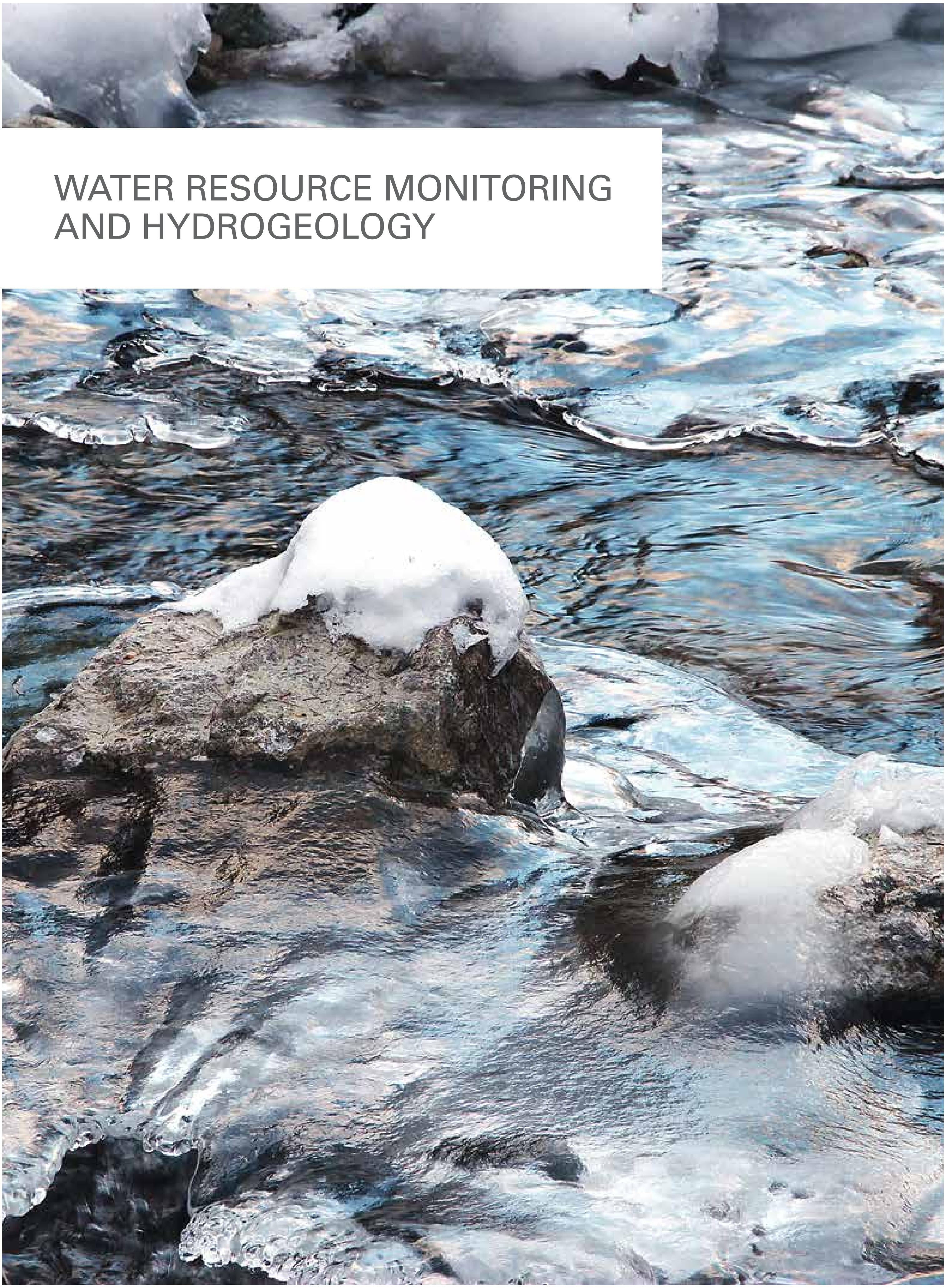
Venntal drilling campaign (2015)

Periadriatic Line

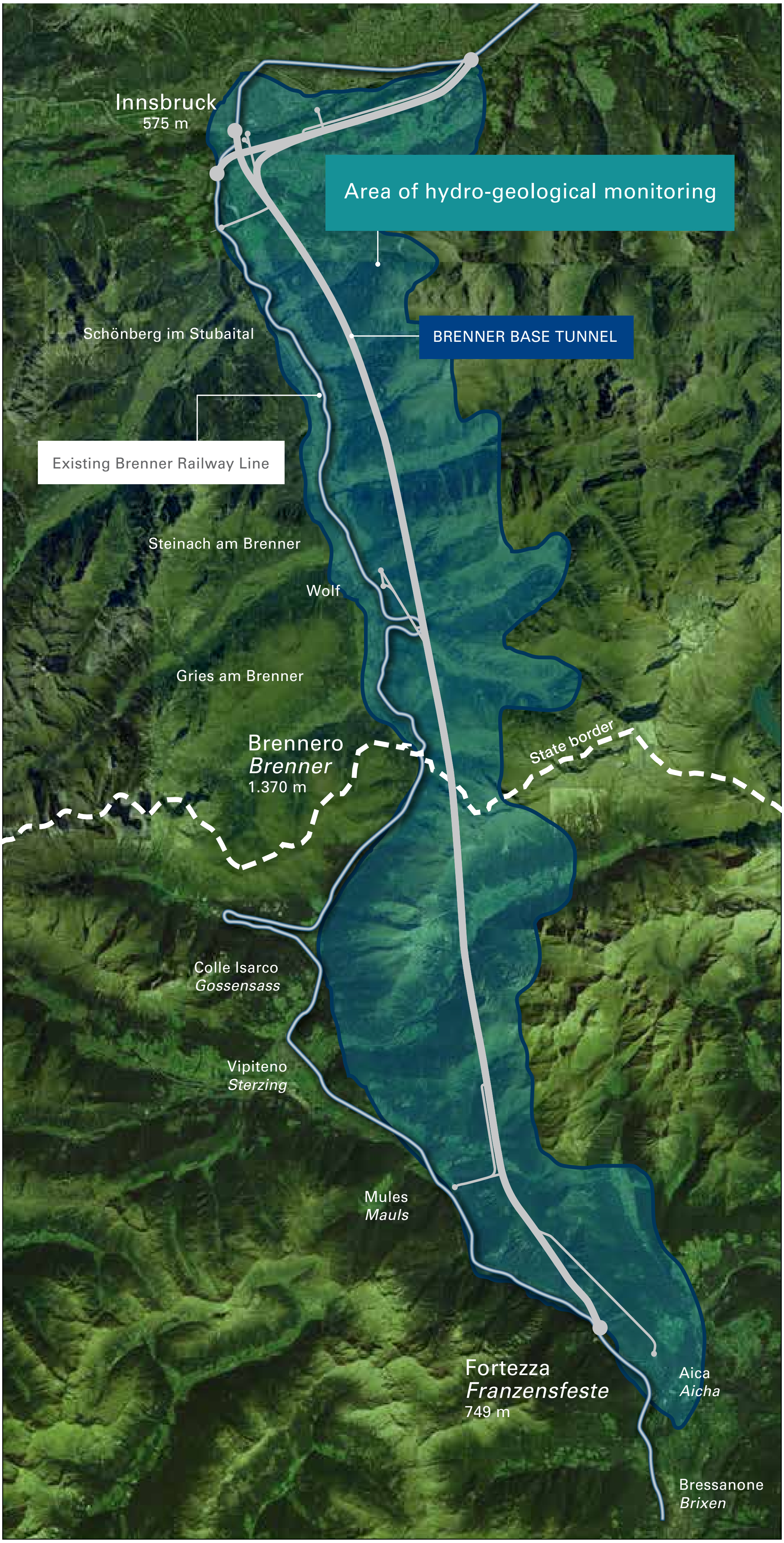
Where the Southern and Eastern Alps divide

A particular challenge for the construction of the Brenner Base Tunnel is t he Periadriatic fault zone. At a total length of 700 kilometres, it is the most significant tectonic fault line in the Alps. It crosses the tunnel axis at Mules with a width of about 700 metres. The Periadriatic fault zone separates the Southern Alps from the Eastern Alps.

WATER RESOURCE MONITORING AND HYDROGEOLOGY



The protection of water, whether above or below ground, is the highest priority in all construction works for the Brenner Base Tunnel.



The graph shows the area along the Brenner Base Tunnel that is permanently subject to precise hydrogeological monitoring.

The Alps are the wellspring of Europe. To ensure that this will be preserved, the construction of the Brenner Base Tunnel is accompanied by a very extensive water monitoring programme.

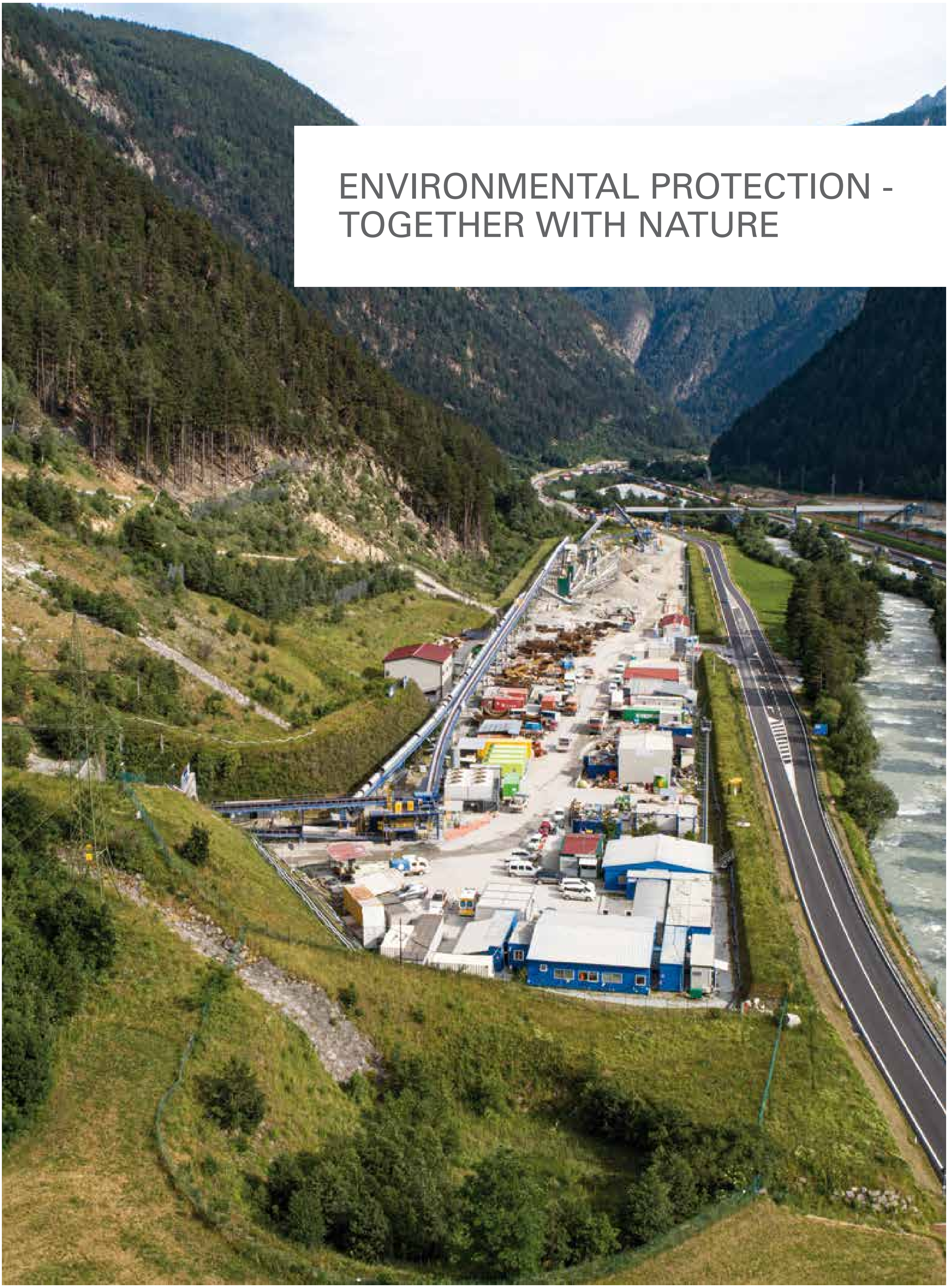
Between 2001 and 2005, before the construction works had even begun, numerous measuring points were established right across the main Alpine ridge and the monitoring of water sources began, so as to understand and observe the complex structure of the water balance along the project area and immediately determine if any adverse effects are being caused by the construction of the tunnel.

There are now more than 1,300 measurement locations between Innsbruck and Fortezza, where the quality of surface and underground waters is measured. The properties of the water, such as the flow in springs and streams, groundwater levels, temperature and conductivity are ascertained before, during and after the construction of the tunnel. The amount of rainfall is also closely monitored. So it is possible to understand whether any changes in the water level are due to tunnel construction or variations in rainfall.

A team of experts also regularly takes water samples to analyse their chemical composition in the lab. The Brenner Base Tunnel is being built at a great depth and for the most part through dense rock. This implies only a very slight risk of any water sources drying up. However, should the water balance along the project area change, there are already measures in place that can be implemented immediately so that there is no adverse effect on water supply.

Experts regularly take water samples for analysis in accredited laboratories.

ENVIRONMENTAL PROTECTION - TOGETHER WITH NATURE



At the Mules construction site, the measures taken to protect the environment and cut down on noise emissions can now be clearly seen.

The data are used for monitoring purposes and as a basis for hydrogeological models. To this end, the rock mass was classified in hydrogeological zones based on the permeability of the rock, thus defining flow systems at varying depths.

Austria and Italy are implementing numerous environmental projects during the construction of the Brenner Base Tunnel. The high-capacity rail line itself is contributing to the protection of the Alps. Even the construction process is as environmentally friendly as possible.

The construction of the Brenner Base Tunnel is accompanied by comprehensive environmental measures. The public and the flora and fauna are affected as little as possible by the construction work. The construction of the Brenner Base Tunnel is subject to strict environmental regulations.

Protecting the public

Dust and noise at the construction sites are kept as low as possible. Noise protection baffles and walls have been erected to protect against noise pollution. The turbines used to ventilate the tunnel are housed in their own caverns built in the rock. Where construction sites are located close to populated areas, construction hours are limited to take into account the needs of the local residents.

Air pollution caused by construction site traffic is also minimised. This is why several additional motorway slip roads have been provided in the project area: they allow the construction site to be supplied exclusively over the primary road network, thus effectively eliminating additional traffic through local residential areas.

A dedicated access tunnel, the Saxener tunnel, was built for the construction site in Wolf near Steinach am Brenner. All site traffic exits the A13 Brenner motorway at the Plon road maintenance depot and travels through the Saxener tunnel directly to the construction site in Wolf. The town of Steinach is therefore not burdened with construction site traffic.

A dedicated railway siding was built for the Wolf construction site in 2016. Construction materials and machinery can be directly delivered and removed by train.

All site roads and temporary storage areas on the construction sites are watered down to reduce dust. Vehicles and construction machines are cleaned regularly. Material transport within the construction sites takes place largely via conveyor belts. All vehicles and construction machinery must comply with the latest technical standards.

The Wolf construction site has a direct access to the A13 Brenner motorway and, via its own rail link, to the Brenner Base Tunnel.

All water flowing from the tunnel during the construction phase is purified in the water treatment plants.

Tunnel drainage waters

The water from the tunnel is purified according to legal regulations, cooled and only then discharged into other bodies of water. This process is carried out in water treatment plants, part of a water protection system, located on the various construction sites. Furthermore, hydro-ecologically relevant accompanying parameters (e.g. pH value, ammoniacal nitrogen, turbidity, etc.) are continuously monitored by means of continuous measurements and by taking daily mixed samples which are analysed by a state-accredited testing and inspection body to ensure compliance with statutory limits. The measurements are continually forwarded to the pertinent authorities. All the data gathered can be seen in real time thanks to online monitoring.

Protection of flora and fauna

The construction of the Brenner Base Tunnel also impacts the habitats of animals and plants, particularly around spoil disposal sites. Most areas are only temporarily in use and are then restored to their original state.

Bats have become increasingly rare and need special preservation measures – including the brown long-eared bat (Plecotus auritus), one of 24 species of bat in Tyrol. Before works began in the Padaster valley, BBT SE carried out widespread monitoring of the environmental situation. For the preservation of this species of bat, nesting boxes have been installed around the spoil disposal site.

Environmental compensation measures

The following environmental measures, which have added value both for the public as well as for nature, are being implemented during the construction of the Brenner base Tunnel.

Revitalisation of the Tantegert marshy forest area

Over the first six months of 2016, the Tantegert marshy wooded area near the Lanser Kopf summit, at the Tantegert tram stop, was restored in cooperation with the city of Innsbruck and private property owners. The water level of the artificially drained moorland was raised again and a space with two tarns was created. The grey elder forest was improved and foreign species were removed. The city of Innsbruck also built a barrier-free path around the moorland and installed display boards and rest areas, creating a barrier-free and high-quality local recreation area which can also be reached using public transport.

Orchid meadow in the Padaster valley

Small biotopes are a very important part of a linked biotope whole. They include orchid meadows, which can often be found in unfertilized, damp calcareous or alkaline grasslands. In the Padaster valley, BBT SE successfully transplanted a roughly 250 square metre orchid meadow, thus assuring its continued survival.

Hydro-ecological measures

These measures ensure compliance with the provisions of the National Water Protection Plan and, at the same time, ensure that some of the most valuable habitats in the Alps are revitalised and saved for posterity.

Restoration of the banks of the Schalderer brook

The banks of the Schalderer brook near Varna were restored, creating a new recreation area which includes a footbridge, flat green areas, playgrounds for children, a stony pool for Kneipp water therapy and a 140-m path.

Widening and improvement of the Isarco riverbed

Near the Sterzinger Moos, 200 m of the Isarco riverbed were broadened by about 0.5 hectares (1.2 acres). This was done to create a non-consolidated island and restore the banks with natural tree vegetation. Further improvement of the Isarco river is planned between the Genauen disposal site and the Fortezza reservoir, with stone groynes to be built using massive boulders and groups of rocks to break up the river flow. About 6,500 m^3 of rocks will be used.

Transformation of waterways to make it easier for fish to pass

- Dismantling of weirs in the Sill river in the municipality of Innsbruck
- Transformation of the Navis brook
- Creation of a fish ladder in the Gschnitz brook
- Widening of the mouth of the Padaster brook

Widening of rivers and creation of meadows

- Widening of the Vizze brook to the Isarco river
- Widening of the Sill at the Wolf portal

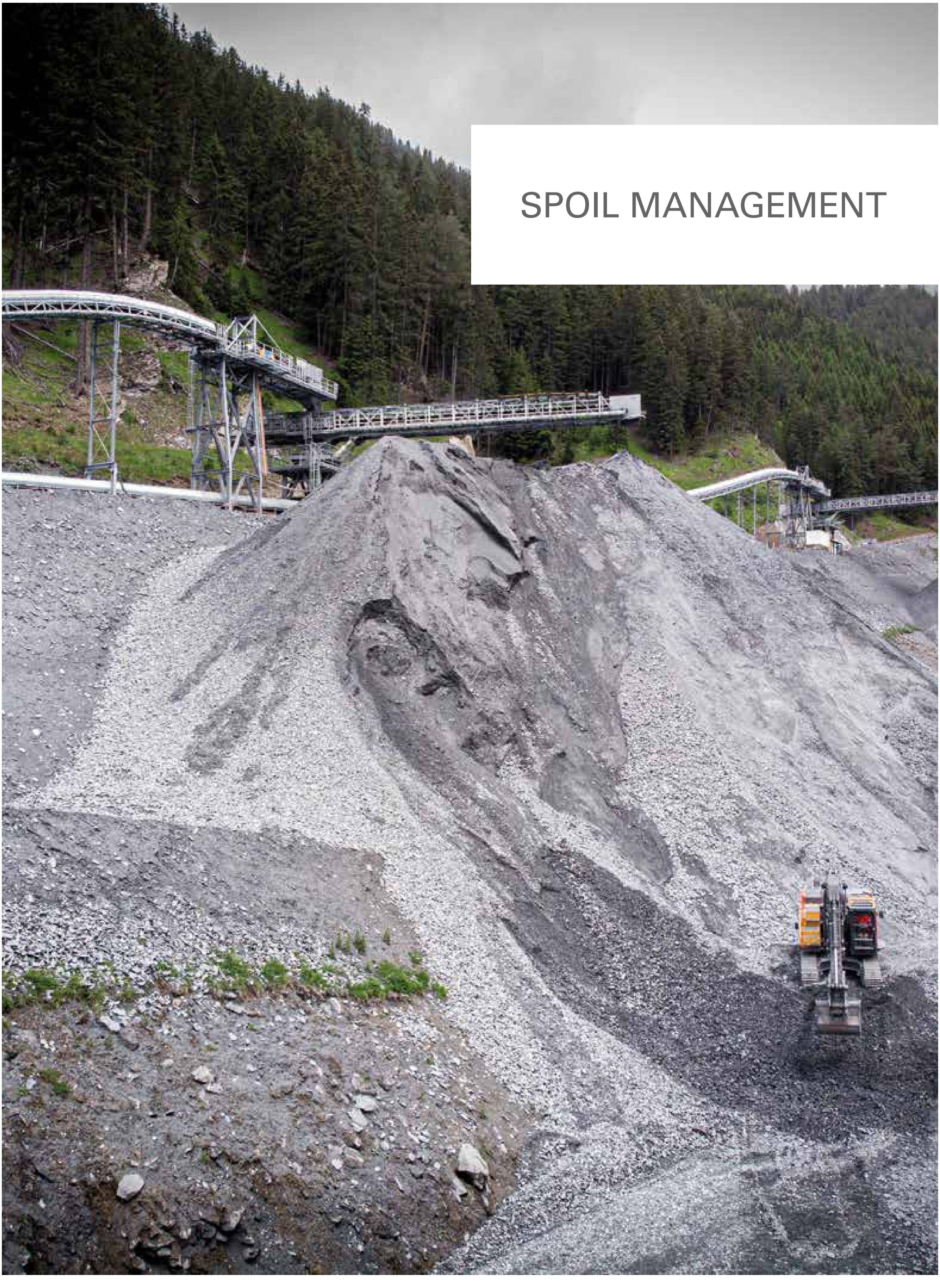
Further measures

- Creation of a geological nature trail in Campo di Trens
- Construction of ponds for agricultural irrigation
- Waterproofing of the Schrüttensee outlet
- Construction of noise barriers along the existing railway line
- Laying of underground power lines in Campo di Trens and Varna
- Construction of underground waste collection sites

Revitalisation of the Tantegert marsh area near Innsbruck

The Tivoli weir is located within the territory of the city of Innsbruck and is part of a power plant on the Sill.

SPOIL MANAGEMENT



A large part of the excavated material will be processed in the immediate vicinity of the access tunnel and made into concrete aggregates.

The careful use of resources and of the environment goes without saying, as part of the huge Brenner Base Tunnel project.

The construction of the Brenner base Tunnel involves the excavation of about 21.5 million cubic meters of spoil. Depending on the quality, this will either be landfilled or recycled.

From tunnel spoil to tunnel raw material

The processing and recycling of the material helps to preserve resources. The processed material can be used for the production of concrete for inner linings and base slabs as well as shotcrete. Since the tunnel spoil is very diverse due to varying geological conditions, the amounts of recyclable tunnel spoil also vary as construction proceeds. When more material is processed than is required for re-use, it is used as aggregate to produce concrete in other sectors.

Universities and the industrial sector are developing innovative techniques and new infrastructural plants in order to be able to use the huge amount of material as aggregate anyway. Research is done and tests are carried out in laboratories and on the construction sites until suitability is proven. The processing into concrete aggregates is done in situ on the construction sites in dedicated gravel plants and concrete production factories. A control system guarantees that the produced concrete complies with the required high quality standards.

Most of the tunnel spoil is transported on conveyor belts.

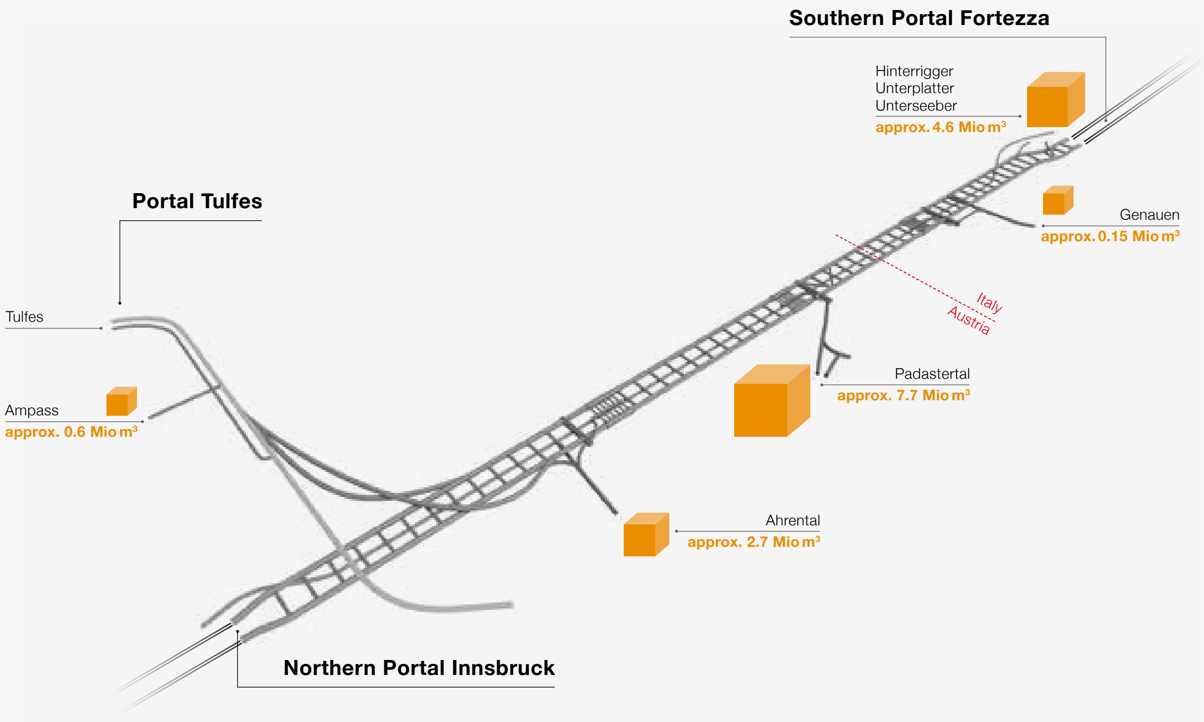
Disposal site Hinterrigger near Aica (July 2021)

Disposal sites along the line

Five disposal sites are available for the disposal of non-recyclable material in Tyrol and Alto Adige. These are Ampass, Ahrental, Padastertal, Genauen and Hinterrigger. In order to avoid long distance haulage of the spoil, each disposal site is located next to the access tunnels. The tunnel spoil is transported by conveyor belts from the excavation zone to the nearest disposal site.

Great care is taken to ensure that the disposal site also serves other purposes, too, such as noise shielding and forest and pasture separation. Therefore, the disposal sites are configured to fit in the landscape without destroying the natural scenery and without disfiguring its appearance. Once the filling operations are completed, all areas will be restored to their original use as forest or agricultural land.

Disposal sites and capacities



From a V-shaped valley to a U-shaped valley

In the Padaster valley, a side valley of the Wipptal valley, BBT SE is creating the largest tunnel spoil disposal site of the project area. About 7.7 million cubic metres of material will find their final resting place there. This is more than half of the entire amount on the Austrian project side.

Several measures had to be taken in order to set up the Padaster valley disposal site. First of all, the re-routing tunnel for the Padaster brook was built. It is 1,500 metres long. The deviation of the Padaster brook was a prerequisite for the approval of the disposal site. During the construction and disposal phase, the Padaster brook is being re-directed through the re-routing tunnel.

In order to reach the disposal site without having to travel through residential areas, a 700-metre tunnel, the so-called Padaster tunnel, was built. In order for the spoil to be carried directly to the disposal site during the construction phase, a 950-m long spoil tunnel was also excavated. Through this tunnel, conveyor belts transport the tunnel spoil straight to the disposal site.

Above the re-routing tunnel, a vast debris barrier was built. About 100 metres towards the valley entrance, an intake structure was built and the Padaster brook flows through this into the re-routing tunnel. Both structures protect the disposal site from flooding and flood debris accumulation during the construction phase. The district of Siegreith (Steinach am Brenner) was struck by severe weather in July 2012, but thanks to the debris barrier that had just been completed, the district was spared from mudslides.

A huge debris retention basin was built at the place where the Padaster brook resurfaces after having flowed through the re-routing tunnel. It provides effective protection from flood debris accumulation and flooding. After the completion of the disposal activities, the new valley floor will be completely re-planted. A new natural brook bed, pasture areas, environmental compensation areas and a forest road are being built.

Padaster Valley 2014: The construction works (spoil removal tunnel, holding basins etc.) are completed, the disposal of the tunnel spoil is currently ongoing.

After the completion of the disposal of the tunnel spoil, the Padaster valley will be completely re-planted (re-forestation, new brook bed, environmental compensation areas etc.).

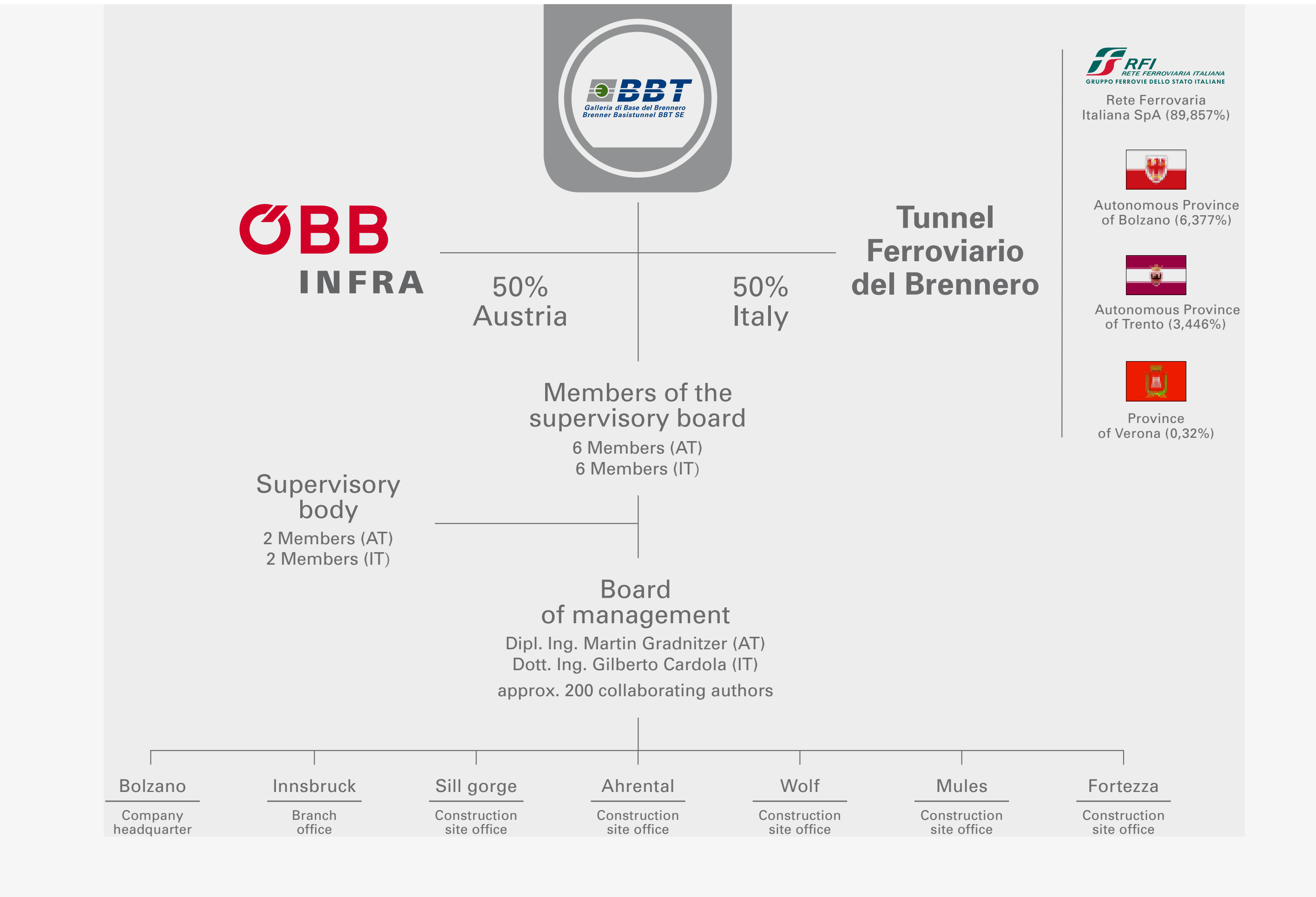
Aerial photograph of the Padaster valley (May 2021)

BBT SE - A PROJECT COMPANY UNDER EUROPEAN LAW

In 1999, the Ministers of Transport of Austria and Italy established the European Economic Interest Grouping BBT EEIG. The company was set up to plan the Brenner Base Tunnel. It was the basis for the company Galleria di Base del Brennero – Brenner Basistunnel BBT SE, established on December 16th 2004, which is now responsible for the construction of the Brenner Base Tunnel. The acronym SE stands for Societas Europea, a transnational type of company provided for by European law.

Preliminary works for tunnel construction began in 2006. Actual construction began in 2007.

Shareholders



Austria and Italy are equal shareholders in BBT SE. The sole Austrian shareholder is Österreichische Bundesbahnen Infrastruktur AG at 50 %.

The holding company TFB (Tunnel Ferroviario del Brennero Holding AG) holds 50% of the company's shares for Italy. TFB's main shareholder is RFI (Rete Ferroviaria Italiana) at 89.85 %, further shareholders are the Autonomous Province of Bolzano at 6,377 %, the Autonomous Province of Trento at 3,446 % and the Province of Verona at 0.32 %.

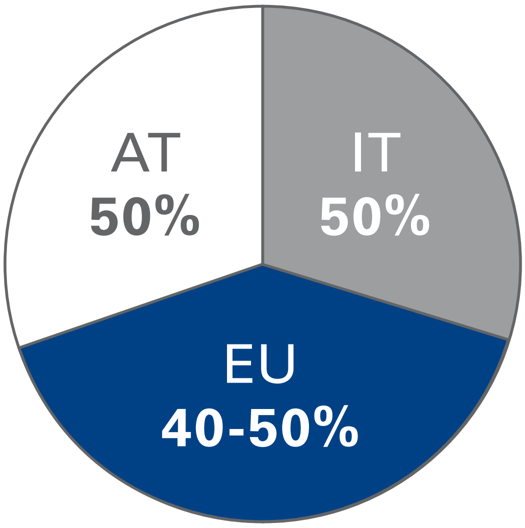
Company Headquarters

After the State Treaty between Austria and Italy concerning the construction of the Brenner Base Tunnel was signed on April 30th, 2004, the main offices of BBT SE were located in Innsbruck. With the start of the construction phase in 2011, the main offices were transferred to Bolzano. Once the Brenner Base Tunnel starts operations, the main offices will return to Innsbruck.

In addition to the offices in Bolzano and Innsbruck, there are offices located in the project area between Tulfes and Fortezza.

Financing

Between 40% and 50% of the cost of the Brenner Base Tunnel is co-financed by the European Union. The EU constantly monitors construction progress and the usage of the financing granted and based on this, the Union decides whether to continue granting funds. The remaining 50% - 60% of the costs are shared equally between Austria and Italy.



www.bbt-se.com

Constantly updated information on the Brenner Base Tunnel project
Registration for tours, tender procedures for construction work and services.

Infopoints

Free admission

BBT Tunnelwelten Steinach am Brenner
Alfons-Graber-Weg 1
A-6150 Steinach
www.tunnelwelten.com/en

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