



# AVALANCHE!

If you manage to survive the snow crashing into you at 180 miles per hour, chances are you will suffocate encased in a cement-hard icy tomb. Marc Spiegler meets the experts battling to understand these natural catastrophes, the snowboarders who have lived to tell the tale and the avalanche-training instructor who wants to bury his students alive.

In the trophy spot above Alex Caloz's mantlepiece hangs a snapped white snowboard, its jagged layers of wood and fibreglass splintered like a shattered bone. It's a memorial of sorts, to the epic storm Lothar, and to Caloz's near-death under an avalanche.

Just after Christmas 1999, Lothar rolled across Europe uprooting forests. Caloz was in Chandolin, a Swiss village where the 31-year-old spent much of his childhood. At 2,000m, blizzards are a boy's best friend. You rise before dawn, hike a favoured ridge and cut "first tracks" across the white expanse below. The slope's steepness produces a shearing wind that whistles over your goggles, around your ears, down your collar. At your feet, there is no sound—just a snowboard floating through powder. No amphetamine can rival that combination of adrenaline and aesthetic joy.

But just like any other high, this alpine rush creates an appetite, and that appetite fogs your judgement. Cabin fever only compounds matters. Three days of Lothar's high winds and blinding snow had shut down all outdoor sports in Chandolin. Foot upon foot of powder fell and by the time the blizzard lifted the entire mountain range was trip-wired, its slopes and couloirs set to collapse upon the slightest provocation.

The sunlight was piercing and the sky crystalline blue as Caloz joined a large group of snowboarders that morning. At first they only rode marked trails. Then, the posse started furtive little forays into the powder just off-piste. For some, that sufficed. But a group of five, including Caloz, broke off to hit higher-altitude runs with more profuse powder. They agreed to ride through forests—theoretically safer terrain, immune to the huge "slab avalanches" that break loose on open slopes. But forests have their own dangers. On the first descent, one of Caloz's companions dropped into a "tree hole", a massive air pocket, sometimes man-high, that forms beneath evergreen branches during blizzards. Badly winded from the crash, he quit after that run. On the next ride, a rock gouged another companion's board to the core. His day's riding, too, was finished.

Now they were three—Caloz, his close friend Ivan Zwahlen and Mirko Weber, a less

experienced rider. The trio decided to ride le Rotze, an exposed slope that Caloz knew well. Looking down from a plateau above the 300m descent and seeing a steep overhang, they hatched a "safe" plan: riding solo to minimise the pressure upon the slope, each man would execute two softly arcing turns, avoiding the drop-off, and then take cover in the forest below.

Zwahlen went first. Launching straight down on to the slope, he gained speed rapidly. He took his first turn—to the left, well above the cliff—and the entire snow cover fractured behind him, like a windowpane struck by a thrown brick. Caloz and Weber screamed to warn Zwahlen. Drowning their yells, a second rumbling erupted 10ft behind them. Too late, they realised the "plateau" they stood upon was just a hardened mound of wind-driven snow, hanging over a steep incline; it had cracked loose, and now swept them downward. "I was rowing furiously with my arms," recalls Caloz. "I was trying to let as much of the avalanche pass me as possible. Snow was streaming over my head, shoulders and back. I hit a tree, barely caught it, and tried to stay there."

Later, he realised that the impact had snapped his snowboard in two. Far worse, he was being buried alive as the descending snow built up around him. So Caloz let go of the tree and hurtled further down the slope. Nearing the precipice, he landed against another tree. This time, he held fast, more afraid of falling than of suffocating. Finally, the avalanche ended. Caloz was buried to his shoulders in hard-packed snow. His left knee felt pole-axed. He screamed, and Weber rode down on a badly cracked board to help him. Farthest back of the three when the slope dematerialised, Weber had been dragged through dirt, logs and boulders as the avalanche razed the entire winter's snowcover. Blood flowed from his back and legs. As Weber dug out Caloz's twisted leg, they listened for Zwahlen. Nothing.

Carried over the 13m cliff, the lead rider had been submerged by snow. But one glove, ripped from his hand, had carried to the surface. An emission from his avalanche transponder confirmed that he lay somewhere below. Weber dug down with his bare hands, discovered Zwahlen's backpack, extracted a snow shovel and finished digging him out.

Buried 2m under, Zwahlen was in shock, with badly torn knee ligaments, but still alive.

Looking back, Caloz recognises the folly of the trio's Rotze descent. Raised in the mountains and trained as an elite Alpine soldier, he knew full well how dangerous Lothar had made the area. But the combination of perfect snow, full sun and pent-up energy catalysed a spiralling sort of madness. "My whole body was demanding that I continually try to ride something bigger, steeper, more beautiful," Caloz explains. "We kept trying to chew off just a little more, do something a little riskier. Here, people talk about the mountain as if it's a real being. Usually that's just posing, not something we take seriously. But I have to say this: that day the mountain was talking to us. And we just would not listen."

To many Swiss, the Alps are less a landmass than a life-force. Even in the summer, the mountains remain treacherous terrain. The higher you go, the more squarely you confront the elements, without forests or ridges to buffer you from storms. Wind gusts, lightning strikes and flash rains can sweep hikers into nearby abysses. In the winter, things get even trickier. Glacier crevasses lurk beneath inviting powder fields. Freak blizzards strand alpinists on exposed ridges. Dense fogs and cold fronts envelop hapless parties.

But avalanches rank the most deadly—in 30 per cent of avalanche accidents somebody dies, twice the mortality rate of any other Alpine-disaster scenario. The luckier fatalities die immediately, from crushing impact against rocks or glacial ice. Unlucky ones survive the initial event. The roaring subsides. The snow stops tumbling around them. They come to a dead stop and find themselves in total darkness, encased by concrete-hard snow—unable even to twitch a finger. Then comes a ghastly race between hypothermia and asphyxiation. Either way, it's an agonising death—one that, statistically speaking, was almost certainly unleashed by the victim or someone in the victim's party. In the Rocky Mountains, most US ski resorts take stern measures to avert avalanche fatalities. Riding off-limits areas can trigger a wide array of ski-patrol punishments, including immediate

Following an avalanche at Evolène, Switzerland, in 1999, rescue-team workers look for survivors—and bodies





confiscation of your annual ski pass. Sometimes, even, police arrest freeriders.

The Swiss simply cannot fathom such an attitude. Romano Parajola, the ski-patrol director for the entire five-mountain Davos ski area, explains, "As a rule, we don't want to forbid anything. People should understand the risks and decide freely whether to ride in a certain area." That being said, in Switzerland anyone leaving marked trails loses the right to sue the resort over injuries and becomes responsible for any rescue costs following an accident. (Not surprisingly, a quarter of the Swiss population are members of Rega, an emergency-rescue organisation that sent its helicopters to the aid of more than 1,100 winter-sports victims last year.) "We're only concerned with avalanches near the lifts, pistes and buildings," Parajola says. "When you freeride outside the marked trails, avoiding avalanches becomes your problem. We can't be expected to secure the whole mountain."



To outsiders that might seem unsympathetic, but the Swiss place a huge emphasis on people taking responsibility for their own actions; insurance payments to pedestrians struck by cars, for example, decrease in proportion to how far they were from the nearest zebra crossing. Thus, as the inevitable reports of avalanche deaths and fatalities pour in each winter, the Swiss tend not to respond with horror but rather with a battery of questions: where exactly was it? What kind of avalanche hit? What was the official avalanche-warning level? Was the group properly equipped? Were they with a guide? Each case is categorised and then stored in the ever-amassing avalanche lore that gets rolled out over dinner tables, in school playgrounds and around chalet fireplaces.

For centuries, the Swiss have viewed avalanches much as deep-sea fishermen see huge squalls: a fatal fact of life – often avoided through wisdom, sometimes only by luck. In a Swiss anecdote, legendary avalanche expert Werner Munter dug a pit in the snow, analysed the snowpack and found it stable. Minutes later, an avalanche tore down the mountain-side leaving only his snow pit standing.

Although British adventurers popularised mountaineering and skiing in the Alps during the mid-1800s, avalanches have been an integral part of Swiss culture for centuries. Before it was a finance centre, the resource-poor

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country subsisted from its farming. Much of that took place in mountain pastures, so many villages, naturally, were established in the valleys and on the slopes of the Alps, often in ill-advised locations. Recalling winter tragedies, folklorists described avalanches as monsters surging forth from snowy lairs to attack the villages below. Religious folk, meanwhile, ritualistically rang church bells to avert them.

**Nowadays, dynamite has** replaced divine intervention. Rise from your ski-station bed early enough after a big blizzard and stick your head out the window – the hills are alive with the sounds of munitions.

The concept here is simple: when you know an avalanche seems likely, you set it loose with dynamite, rather than letting some unlucky skier do the job. In Davos, the blast-master is Konrad Flutsch. Senior member of the ski patrol, he's a tall 59-year-old, with weathered skin, his lanky brown hair secured by a narrow cloth headband. He works with Parajola, from a wood-heavy aerie inside the main mountain-top building atop the Parsenn peak. Floor-to-ceiling cubbyholes bristle with Alpine rescue equipment and photos of past avalanches decorate the walls. In one, the entire side of a huge mountain has come

down in slabs. The zigzagging half-mile slice in the remaining snow cover above the devastation looks as clean as any surgeon's incision.

Fetching the explosives, Flutsch goes into a small room, opens a locked door and enters a large closet with 6in-thick concrete walls. A metal safe, almost large enough to stand upright within, holds the dynamite. (To avoid accidents, the fuses are kept 50m away, in another equally imposing safe.) Gelatinous and wrapped in thick orange plastic, the dynamite looks like an oversized sausage. Weighing just over 5lb, the single charge can purge a few hundred tons of powder from a slope. In a typical year, Davos goes through two tons of such dynamite, distributed across roughly 160 different danger spots.

Delivering the dynamite represents an adventure sport of sorts. The simplest method involves walking or skiing to a point just above the avalanche's "release zone", the area in which any pressure can trigger disaster. Demonstrating, Flutsch hikes a few minutes from his office to a steep slope overlooking an undulating off-piste valley. As we trudge down the hill through deep powder, Flutsch casually recounts the time an avalanche snared him. Setting off solo on a sunny day to reach his mountain hut, he misjudged a slope, which

collapsed under him. Trapped with only one skiboot sticking out, he was buried for 90 minutes before a rescue team summoned by a passing skier arrived. As the blastmaster recalls the event, there's no fear or wonder in his voice, no intimation of either immortality or benediction. Instead, he treats it as an object lesson, itemising his various mistakes that day.

Attaching a long cord to the dynamite, he nonchalantly lights the 90-second fuse, then fiddles with the netting around the dynamite for 10 eternal seconds. Finally, he throws the charge down the mountain with a pendulum swing of the rope. It lands, skids briefly and comes to a rest 20m downhill. (Ideally, the dynamite should always lie on the surface. If the charge sinks, the snowpack absorbs too much of its explosive power.) After about 70 seconds, Flutsch puts his fingers in his ears. I imitate him. And then, the charge explodes, the sound echoing off every crevice and gully. A giant grey crater erupts, followed by a small flow of powder.

Often, it's not that easy. When the patrol must clear many slopes quickly, or to reach otherwise inaccessible areas, helicopters are deployed. Hovering just a few feet above the snow, the pilots keep the craft steady as the fuse is lit and the dynamite thrown. If the

surface is icy, the patrol encircles the tubular dynamite pack with a fibreglass ring shaped like a massive Chinese throwing star. Dropped with force from the helicopter, the package's teeth instantly pierce the hard crust, anchoring the charge in place. When bad weather precludes helicopter flights, out come the shoulder-mounted mortars. Detonating upon impact, the dynamite charges are fired into faraway slopes by mobile two-man teams. Finally, near the ski-patrol headquarters stands a mortar emplacement, used when the conditions turn truly foul. Setting the rocket's angle of elevation and compass direction from a reference book, Flutsch will fire the rocket blindly into very thick fog, confident that it will purge slopes up to 1,200m away.

Perhaps the most complicated hazard to remove, cornices (also called windlips) require multiple charges to dislodge their massive weight. Formed when snow blows across a mountain ridge, the cornice looks like a surfer's dream wave. Tons of hardened snow hang suspended at the top of a slope, frozen in midair like a palazzo balcony. Because their tops are flat and seem so solid, cornices often betray even experienced alpinists by crashing down unexpectedly. To explode a windlip, the ski patrol digs a series of holes into the cor-

nice, far back from its edge, and packs them with dynamite. Another charge is suspended on a rope, squarely under the arc of the lip. One fuse connects them all. Made of white gunpowder, the wick burns at 6,000m per second, 15 times the muzzle velocity of an Uzi sub-machine-gun. After it's lit, a half-dozen explosions detonate in unison, cracking the cornice like a candy stick.

**Before the blasts,** of course, come the decisions about which slopes to purge. Parajola relies heavily on the database of past avalanches provided by the Swiss Avalanche Institute, based in the village of Davos. Acting in self-defence, the Swiss have long led the world when it comes to avalanche research. Founded in 1942, the institute today plays a central role in all things snow-related, from pure science to Alpine building codes to daily avalanche warnings. The activities undertaken by its 120 scientists and students encompass a dizzying scope: geography, meteorology, physics, computer modelling, hydrodynamics and civil engineering. Not to mention the handful of mountain guides on staff, who serve as "reality testers" when results come out of the labs, comparing new scientific findings with their own real-world experiences.



Clockwise from top left: Swiss Army rescue workers search the debris of an avalanche at Evolène, February, 1999; an avalanche approaches a team of climbers; rescuers use long poles to probe the snow for skiers buried alive in Parsenn near Davos, Switzerland; an avalanche rescue training exercise; and avalanche warning signs

keep analysing what's actually happening around them. But where Aval-ID can really help is with preparing for extreme catastrophes, telling you which roads or settlements might get overrun."

Of course, there's only so much avalanche work you can do on a hard drive, so whenever big snows hit, teams from the institute decamp to the French-speaking southwest of the country. There, the institute has its own private avalanche testing area. On a slight incline stands a concrete bunker covered in sensors. The scientists climb inside, turn on all the instruments and then signal their readiness. Atop the massive facing slope, a single dynamite charge fractures the snowpack. An avalanche comes roaring down, the towering cloud of loose snow rising to engulf the 21m, instrument-covered tower erected squarely in its path, then flying across the small valley to bury the bunker full of scientists.

Laymen might describe this simply as "a huge bloody avalanche"; snow scientists have a more nuanced view. To them, the event involves two different types of avalanche: the "slab avalanche", heavy layers of snow fracturing and tumbling near ground level; and the "powder avalanche", clouds of unbound snow kicked up by this commotion and swept downwards. Though far less destructive than the heavy slabs, the powder clouds are hardly harmless. Sometimes reaching heights well over 200m, they suck in any loose powder from adjoining areas. And while slab avalanches usually stop once the terrain flattens out, powder avalanches often continue moving, sometimes for another half-mile. In the winter of 1999, after a series of heavy storms packed the Swiss mountains with snow, several powder avalanches carried downhill into villages that experts assumed to be protected by the surrounding terrain. Moving at speeds of almost 180 miles an hour, the powder ▶



clouds pushed an air mass in front of them that shattered windows and fine snow buried people alive – from a medical standpoint, their deaths were akin to drowning.

Not surprisingly, powder avalanches immediately became a focus of more intense study. But the interaction between slab and powder flows are pretty complex, explains the institute's Barbara Turnbull, currently working to build a computer simulation combining both types. "There are 16 differential equations involved here," she explains. "You have to calculate not only what's going on underneath, but also the effect of the entrained air being sucked in from the sides of the slab and bringing snow with it. Plus, you have to model how the slab and the powder's movements couple and then decouple."

Like many at the institute's staff, Turnbull that day wears Gore-Tex mountaineering trousers, having ridden the slopes before work. In the car-park, dozens of snowboards and skis lie against the wall. Only a handful of the institute's staff are not sports fanatics, and many live in avalanche-hazard "blue zones", submitting themselves to house arrest or even evacuation when big snows hit. And while no staff member has ever died in an avalanche, many have lost friends or neighbours to Alpine tragedies.

**One beautiful day** early last March, Swiss distance runner Franziska Rochat-Moser, winner of the 1997 New York Marathon, ascended La Para, a 2,500m peak near Gstaad. She was on skis, as were the two experienced



The Swiss Avalanche Institute's scientists climb into this sensor-covered bunker and then trigger an avalanche. As snow and ice crash down upon them by the ton, they calmly collect data to learn more about avalanches

mountaineers accompanying her. But as the trio started down the very route where they had just ascended, the cornice disintegrated beneath them. The lead skier jumped to safety. The second was safe, a lucky foot away from the fault-line. Rochat-Moser had no chance. She fell more than 200m on to an adjoining slope, was dragged 600m downhill by the avalanche set off by the falling cornice and wound up buried under a pile of wet snow. Rescued 30 minutes later and helicoptered to safety, she died the next morning.

Ady Ryf, the Interlaken co-owner of an avalanche-training school, says that in the following days he took numerous calls from former students, disturbed that the star athlete

died while accompanied by two experienced off-piste skiers. Yet within a few minutes, he says, even the basic-course graduates would ask, "Um, wasn't she out there a bit too late?" Indeed, the general consensus among mountain-savvy folks is that Rochat-Moser's death involved a combination of bad luck and bad planning. The party of three had descended just after 2pm, on a relatively warm day. By then, the cornice's top layers had melted, releasing water that made it too heavy to sustain the weight of the three skiers without collapsing. In fact, many experts say, it could well have fallen without them.

Such accidents frustrate Ryf, for they are precisely what his training courses fight to stop. "The press always writes, 'The mountain took their lives'," he explains. "Yes, sure, you can never fully understand avalanches, so off-piste you have to live with some risk. But usually these people ran a series of red lights, and then they paid the price." Catering to the general public, his initial course teaches a fairly simple technique for calculating the risk posed by any slope, plus basic avalanche rescue. When it started six years ago, the clients were mostly snowboarders who had survived their first brush with an avalanche. Then came the sponsored riders, sent en masse by sports companies who feared a PR disaster if a whole team disappeared during a photo-shoot. Today, it's mostly people just starting to ride off-piste, who want to understand exactly what they're getting themselves into.

Last January – for precisely that reason – I took Ryf's course. After two-and-a-half days of theory and field training, the group faced its "final exam", staged on a steep avalanche-prone slope. Allotted seven minutes to find an unknown number of buried "bodies" (actually, backpacks containing transponders) spread across a quarter-mile squared of terrain, the serious students performed remarkably well. Those who had treated the weekend as a fun-and-sun excursion floundered.

But Ryf had one last way to drive home the gravity of the course matter. He commanded our group to dig shallow graves in the avalanche zone. Taking turns, students lay down with one hand over their mouths as we covered up their bodies. Their second hand was kept free, sticking out to signal distress if necessary.

Even under 15cm of loose snow, the weight exerted upon your rib cage suffocates you. More frightening: while you can hear every word pronounced above the surface, your strongest scream sounds like it's coming from inside a shipping container. "Even the ones who were laughing during the rest of the weekend come out with wide eyes and go all quiet," Ryf says. "People come to us wanting to learn how to use the cool tools – the transponder, shovel and probe. But we want them to take the mountain seriously and avoid starting avalanches. When I hear about a kid or a teenager dying that way, I'm shattered. But when experienced adults die, I'm angry at them for what they did to their families. It's not the mountain that killed them." ■

To find out more: Davos ski domains, [www.davos.ch](http://www.davos.ch); Swiss Avalanche Institute Davos, [www.sif.ch](http://www.sif.ch); Mountain Surf Club, [mountainsurfclub.ch](http://mountainsurfclub.ch); general information, [www.avalanche.org](http://www.avalanche.org)



## Avalanche of jargon

*This glossary won't help you much in an avalanche but at least you'll sound mountain-savvy on après-ski terraces*

**Avalanche transponder** Set to emit at 457kHz and worn close to the body, this device can also be switched to "search mode" on that same frequency. Essential.

**Cornice (aka windlip)** These concave structures (pictured, above) form when winds sweep snow across a ridge line. Extremely dangerous because they seem so solid yet often collapse atop a steep slope.

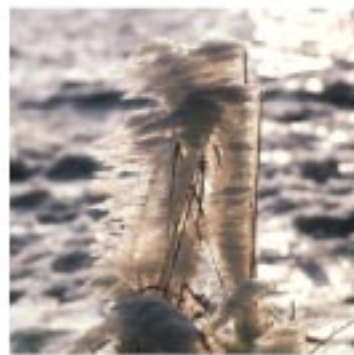
**Flow avalanche** A mud slide made of wet snow. Common in the spring, they are slow moving, but extremely heavy and quite damaging to anything they hit.

**Hoarfrost** A surface layer (pictured, below) resulting when cold nights follow warm days. Sparklingly beautiful, hoarfrost's long crystals unfortunately fold down into a perfect sliding surface when new snow falls, setting up the slope for slab avalanches.

**Powder avalanche** Sometimes reaching heights of 200m, these fast-moving clouds of powder can blow apart small houses and suffocate people.

**Release zone** The unstable part of the slope where an avalanche starts. To be avoided at all costs during avalanche-warning periods.

**Slab avalanche** Occurs when the layers of a hardened snowpack crack. By far the most dangerous type of avalanche because fractures tend to create a slope-wide domino effect involving several-ton blocks of hardened snow and ice.



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