SPECIAL REPORT

Hot science from a volcanic crisis

The eruption of Mount St Helens in 1980 left an indelible mark on the field of volcanology. **Janet Fang** reports.

Thirty years ago this week, Mount St Helens in Washington state was swollen to bursting point. The northern flank of the mountain was bulging outward at a rate of more than one metre per day as magma built up inside. By 18 May 1980, the volcano could withstand the pressure no longer. The side of St Helens collapsed in an immense landslide, unleashing the largest explosive eruption in US recorded history.

An avalanche of rock raced 22 kilometres downhill while a plume of debris shot 25 kilometres skyward, punching into the stratosphere. The eruption killed 57 people near the volcano and blanketed 10 states with a layer of ash.

Amid all the destruction, however, the blast stimulated unheralded interest in eruptions and sparked many careers in volcanology. Not since the annihilation of Pompeii by Mount Vesuvius in Italy had a volcanic event garnered so much attention from scientists and public officials. After St Helens blew, the US government boosted funding for research in this area by more than a factor of 10, opened up new volcano observatories, and within a few years developed an international programme to respond to volcanic crises around the world (see 'A blast from the past').

"St Helens blew up in a very photogenic way near a major American city and caused dozens of fatalities, millions of dollars of destruction, and incredibly violent stories and pictures," says geologist Jonathan Fink from Arizona State University in Tempe. "It was impossible to ignore." With increased funding and new research opportunities, "a whole generation of volcanologists came out of that period", he says. So did a new understanding of explosive volcanism and how to forecast it — tools that have helped save thousands of lives over the intervening decades.

One of those who joined the field then was John Pallister, now chief of the Volcano Disaster Assistance Program, which is part of the US Geological Survey (USGS). At the time of the explosion, he was a graduate student at the University of California, Santa Barbara, working on a project in Oman looking at the ocean

crust and mantle. "Everybody in the geological world turned their heads and listened to the news every day and thought, 'I sure would like to understand what happened!'"

Mount St Helens provided "unprecedented access to an erupting volcano", says Cynthia Gardner, scientist-in-charge at the Cascades Volcano Observatory in Vancouver, Washington. In 1980, Gardner had just started with the USGS in Denver, Colorado, in an office that also housed the volcano hazards group. "You could see what the inside of a volcano looked like — it was revolutionary," says Gardner.

One of the biggest insights for volcanologists was the lateral blast that occurred when the landslide unroofed the volcano's highly pressurized magma dome. Before that eruption, scientists had never witnessed the violence of a sideways eruption, which blew down enough trees to build 300,000 two-bedroom homes. Mount St Helens showed in dramatic fashion how volcanoes can grow unstable and fall apart.

As volcanologists picked through the debris, they identified distinctive rounded knolls, or hummocks, left behind by the avalanche that started the eruption. Researchers realized that similar hummocky deposits elsewhere must have formed in the same way, when the flank of a volcano collapsed. Since 1980, volcanologists have found at least 200 similar deposits worldwide, such as those at Mount Galunggung in Indonesia and at Unzen and Bandai in Japan. "It was the 'aha' heard around the world," Gardner says.

Furthermore, the lateral blast left a thin but characteristic type of deposit that geologists have also spotted elsewhere. Such deposits serve as a warning sign that a volcano has previously directed its energy sideways: at Lokon in Indonesia, for example, a series of thin surge deposits clued scientists in to the hazard

Since the avalanche that uncorked Mount St Helens, eruptions have rebuilt part of the volcano.

USGS/J. PALLISTER

for nearby villages.

The St Helens eruption advanced knowledge about volcanoes in many disciplines, but petrology and seismology benefited most. It allowed petrologists to decipher 'volcano plumbing', by using the erupted rock to determine the depth and temperature of the magma reservoir and how quickly magma rose to the surface. And from the 10,000 or more earthquakes that shook St Helens before the eruption, seismologists identified specific seismic patterns that can help to predict eruptions.

Explosion in funding

In 1979, funding for the USGS Volcano Hazards Program was less than US\$1 million, nearly all of which went towards studies of Hawaiian volcanoes. In the federal budget for 1981, support for the programme jumped to \$12.6 million. The USGS established the Cascades Volcano Observatory to monitor

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St Helens and nearby mountains. Later, the agency and local institutions set up observatories in Alaska and at Long Valley in California, as well as one to monitor activity in the Yellowstone National Park region. Funding remained fairly steady until the Mount Redoubt eruption in Alaska in 1989, which brought total appropriations up to about \$16 million.

Currently, the programme receives around \$24 million. But, adjusted for inflation, overall funding has remained flat since 1991. Fink, who chaired a National Research Council review of the programme in 2000, observes that support for volcano research increases steeply right after a calamity, then declines to a steady, lower level until the next event. "The amount of the temporary increase tends to scale with the number of deaths or the total dollars of destruction or the media coverage," he adds.

Five years after the St Helens event, mudflows from a small eruption of Nevado del Ruiz in Colombia killed 23,000 people. The fatalities and economic losses from the two eruptions prompted the USGS and the US Agency for International Development to create the Volcano Disaster Assistance Program in 1986 to

help foreign countries forecast eruptions. Work by that programme and others during the 1991 eruption of Mount Pinatubo in the Philippines led to an early warning that allowed crisis-response teams to evacuate tens of thousands of people.

The 1980 eruption was not the first time Mount St Helens had lost its top. About 2,500 years ago, the volcano collapsed in another flank failure, and then rebuilt itself over the following 150 years. A similar pattern may be occurring today. In September 2004, magma that had lingered underground since the 1980s began erupting and forming a new dome inside the mountain's crater. The series of dome-building eruptions continued until January 2008, reconstructing about 7% of what was lost in 1980. It is likely that more small eruptions will continue to rebuild the dome over the coming decades, according to Gardner, who adds that there will probably not be another flank collapse or lateral blast until the summit has re-formed.

A 2005 USGS report ranked the 169 US volcanoes by their threat levels and monitoring capabilities. St Helens, which was erupting at the time, is second, after Kilauea in Hawaii. One of the other mountains in the top five is Mount Hood in Oregon, which has had more than 50 small earthquakes in the past year.

Jay Wilson, a hazard-mitigation coordinator for Clackamas County where Mount Hood sleeps, was a high-school student in Birmingham, Alabama, in 1980, who caught the volcano bug from the St Helens event. Three weeks ago, Wilson joined USGS geologists to brief members of Congress on volcano risks. They were also garnering support for a recently introduced bill, which asks for \$15 million annually for a National Volcano Early Warning and Monitoring System. Such a project would expand existing

"A whole generation of volcanologists came out of that period."

efforts that monitor only a few volcanoes to keep tabs on all active US volcanoes that pose a risk to people.

That kind of work will require new blood in the volcanology field. As researchers mark the thirtieth anniversary of the St Helens eruption, many who studied the volcano are nearing the end of their careers. Frederick Swanson, a geologist with the US Forest Service's Pacific Northwest Research Station in Corvallis, Oregon, rushed to Washington in 1980 and toured St Helens by helicopter to study the landslide's effects. Now he's contemplating retirement. "We have a rich legacy of information from 30 years of volcano research," he says. "We're keen to continue studies, as well as ignite new ones." ■

A BLAST FROM THE PAST

The 1980 crisis at Mount St Helens sparked widespread interest in explosive volcanoes and prompted the United States to prepare for eruptions at home and abroad.

1980

On 18 May, Mount St Helens erupts and kills 57 people. The US Geological Survey establishes the Cascades Volcano Observatory in Vancouver, Washington, to monitor volcanoes in the region.

1985

The eruption of Nevado del Ruiz in Colombia kills 23,000 people.

1986

The United States sets up the Volcano Disaster Assistance Program (VDAP) to help other nations with volcanic crises.

1988

The Alaska Volcano Observatory is established.

1989-90

Mount Redoubt in Alaska erupts and a commercial plane nearly crashes after flying through an ash cloud from the volcano.

1991

Mount Pinatubo erupts in the Philippines (pictured). VDAP researchers monitor the volcano before the eruption and provide information that saves thousands of lives.

1995

Using knowledge from St Helens, VDAP scientists help respond to a volcanic crisis on the Caribbean island of Montserrat, when the Soufrière Hills volcano erupts.

2001

The Yellowstone Volcano Observatory is established.

2004-08

Relatively small eruptions of Mount St Helens rebuild part of its central dome.

2005

The Volcano Hazards Program assesses all 169 volcanoes in the United States and identifies 57 priority volcanoes that are undermonitored relative to the threats they pose.

2009

Senator Lisa Murkowski (Republican, Alaska) introduces a bill to establish a National Volcano Early Warning and Monitoring System.