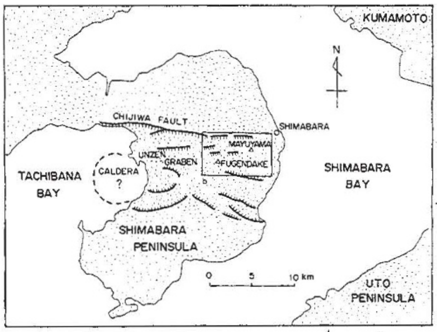
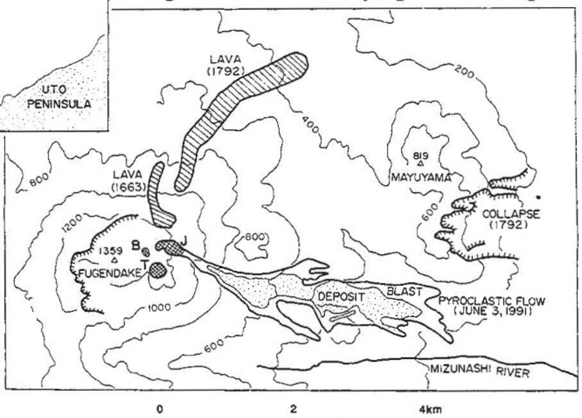
July 1990. Finally, steam containing ash blew up from Tsukumojima and Jigokuato craters on 17 November 1990, and from Byobuiwa crater on 12 February 1991. Volcanic ash that had accumulated on the slopes produced small mudflows after heavy rain in May.

The eruptive activity entered a new stage in the middle of May. The seismic networks of the Japan Meteorological Agency and Shimabara Earthquake and Volcano Observatory detected many shallow volcanic earthquakes immediately below the active craters. Simultaneously, a continuous electronic distance meter measurement by the Geological Survey of Japan and a tilt measurement by the Earthquake Research Institute revealed significant swelling of Mt Fugendake. On this evidence, the Coordinating Committee for the Prediction of Volcanic Eruption issued a warning of magma outflows. A 40-metre-wide lava dome appeared in Jigokuato crater on 20 May, which soon broke up and then reformed.





Above, the tectonic setting of Unzen Volcano and, right, the eruptive activities of Mt Fugendake and Mt Mayuyama. (J, B and T are Jigokuato, Byobuiwa and Tsukumojima craters, respectively.)

The major eruption of 3 June was preceded by several smaller ones, starting on 24 May, that produced pyroclastic flows in the east valley up to 2 km from the crater. The lethal pyroclastic flow of 3 June resulted from an explosion that produced a 300-metre long groove connected to the crater on the east slope. Subsequently, lava domes grew along the groove as well as on the crater. Further explosive eruptions on 8 and 11 June shot cinders up to 15-centimetres across over Shimabara city and spread volcanic ash over distances exceeding 100 kilometres. Both eruptions were accompanied by a change in tilt angle corresponding to a rapid contraction of Mt Fugendake, followed by a slower recovery.

After these events, eruptive activity became less explosive and the domes showed evidence of lava flow in them. An estimated 0.01 cubic kilometres of material was ejected by the end of June, half the amount erupted in 1792. The magma was of a dacite composition with about 66 weight per cent of SiO_2, according to the analysis by Kyushu University.

It is encouraging that the migration of magma to the surface was correctly predicted by the volcanologists. But it was not expected that explosive eruptions would follow the formation of lava domes. This abnormal sequence may have occurred[3] because the first magma ascended into a cool environment and rose as solid lava domes. These would have prevented dissolved gas from leaking from the underlying hotter magma. Instead, it escaped by driving the subsequent explosions. If this is the case, the explosion can be described, using the term coined in Fink's recent News and Views[4], by a pressure-cooker model. The pyroclastic flows, Fink suggested[5] shortly after the eruptions, arose from the collapse down the mountain flanks of the continuously growing lava domes. The collapse created a hot avalanche of exploding gas-rich lava, known as a Merapi-type flow (after the Indonesian volcano of that name). Implicit in this analysis is the prediction that the avalanches will be small-scale. Other volcanologists, however, doubt that the cooled lava domes could have the necessary explosiveness and argue instead that the outflows were Pelean or Soufriere-type, emanating directly from the volcano's vent. What actually happened will be revealed in the future, when the abundant data have been examined. □

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DAEDALUS

Fake fur

WHEN you eat an apple, a slice of the seed-case membrane often sticks maddeningly between your teeth. How can such a frail film be driven like a nail into so narrow a gap? The penetrating seed membrane is of course supported against buckling by the surrounding apple material. Even so, says Daedalus, saliva makes the crucial contribution.

Biochemists may regard saliva as simply a solution of pre-digestive enzymes. But to an engineer, it is a cunningly formulated cutting-lubricant, designed to minimize the load on our teeth and jaws. With its subtle nonlinear visco-elasticity and low surface energy, it penetrates into food, coating the interfaces, weakening the adhesion between them, and almost abolishing the frictional drag of shearing and sliding. As an annoying side-effect, it also lubricates the insertion of food scraps between the teeth.

DREADCO engineers are now trying to imitate this effect. They are lubricating thin fibres of nylon, glass or silica with various visco-elastic fluids or waxes, and firing them at polymeric and even metallic surfaces to drive them in. They hope to perfect a lubricant wax whose rheology imitates that of saliva, and whose surface energy is matched to that of the material to be penetrated, thus minimizing the energy of insertion. A sheet of this wax will be loaded with millions of parallel fibres, packed densely together like the bristles in a brush. The sheet will be laid against a surface and flattened onto it with a sudden powerful blow. Each fibre, lubricated and protected from buckling by the surrounding wax matrix, will be driven into the surface and firmly held. When the wax is melted away, it will leave a furry surface.

So many animals have fur, says Daedalus, that it must be more than a mere camouflage and thermal insulator. His new process should bring its many benefits to technical products as well. Furry cars, for example, would absorb small collisions without damage, and would be less damaging in their turn. They would shed water as a thatched roof does, keeping the underlying metal dry; they would be quieter, and their air-resistance might be lower. They would never need painting or polishing, though they might need grooming. Furry houses would hold the heat better, and furry furniture would be softer and kinder to the touch. Even aircraft might benefit. Daedalus reckons that the soft and flexible avian wing is far more efficient that one of rigid metal alloy. Once the process has been properly worked out, he hopes to cover the wings of our current metal monsters with a delightful fledging of artificial feathers.

David Jones