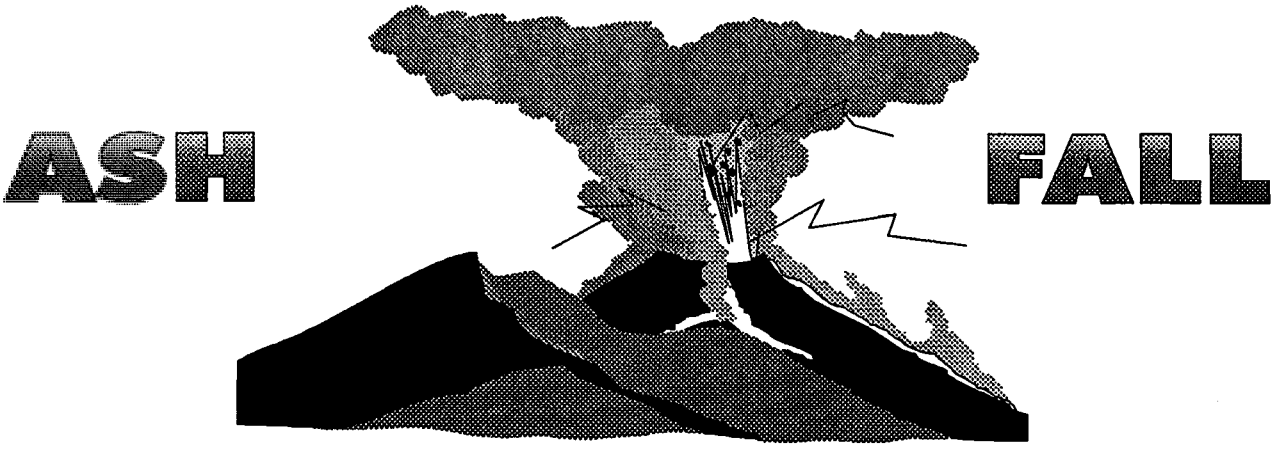

Newsletter of the Volcanology and Igneous Petrology Division
Geological Association of Canada

#37 **April, 1995**

MESSAGE FROM THE CHAIRMAN

First, my apologies on the lateness of this issue of *Ash Fall*. Both Paul and I seemed to have busy schedules this spring. Paul's schedule was compounded when he undertook editorial duties for GEOLOG. Congratulations, Paul and thanks to another Division member, Mike Easton, for his many long years of sheparding GEOLOG to the printers. It is interesting that the Division has spawned both of the last editors! See Paul's editorial in the next edition (which you should be receiving at the same time you are receiving this issue of *Ash Fall*) for his thoughts on the matter.

The next GAC/MAC Annual General meeting rapidly approaches. I am finalizing the winners of the *Leopold Gelinas* awards. This years winner of the *Career Achievement Award* is Dr. Jack Souther (Scientist Emeritus), Geological Survey of Canada. These awards will be given out at the **Division's Annual General Meeting Friday May 19, 12:30-1:30 Room Cornet A221**, during the Special Session ***Igneous Activity in Extensional Zones Associated with Subduction*** sponsored by the Division and chaired by Tark Hamilton and Georgia Pe-Piper. No elections are scheduled for this year, but many positions will be vacant next year, including Chair and Vice-chair. Please think about your willingness to serve the Division in some capacity.

The Division is also sponsoring two field trips as part of GAC/MAC. We have modified the Volcanoes of SW BC as I am unable to lead to trip. Paul is going to go solo on it, shorten it to three days and focus on the Wells Gray - Clearwater area. Sorry about the changes to those of you who wanted the broader picture. The Mt. St. Helen's trip is still a go. We already have a dozen willing soles so if you are interested, submit your name soon!

Please, please, please help!!!

I have been asked to compile Canada's IAVCEI contribution to the CNC/IUGG Quadrennial Report. This report is meant to highlight volcanological research in Canada and will be distributed at the Boulder IUGG meeting. If you would like to submit a short (less than one page) synopsis of your work, please do so. If you could send it via E-mail (chickson@gsc.emr.ca) that would be really appreciated. Or please submit something to me at our business meeting in Victoria. ***This is a golden opportunity to highlight your research internationally.***

On another front, I am co-chair of a multi-disciplinary meeting to be held in Vancouver in August 1996. The meeting focuses on Volcanoes, Earthquakes and Tsunamis and is part of Canada's contribution to the international Decade for Natural Disaster Reduction. The goal of the meeting is to bring people together from the many disciplines involved in understands and responding to these hazards and in mitigation of their impact. I have enclosed the "Call for Presenters" for your information.

Business out of the way, let me take the liberty as Chair to fill you on what I have been up to this past year. Let me start by saying I have been busy! Summer '94 was a trip to Iceland. Definitely essential for anyone interested in basaltic volcanism and the interaction of ice/water/lava. I had the good fortune of visiting Surtsey for a week with Jim Moore (USGS). He was

on the scene during the initial eruptions of Surtsey and has returned every three years to document changes and new exposures. It was an incredible experience. I would love to see a Division field trip run to Iceland, we talked about this last year. Is anyone else interested?

Following my return from Iceland I was asked to lead a mission to Argentina, Bolivia, Chile, and Peru. Funded by the InterAmerican Development Bank (IDB), we were a team of eight specialists. We looked at the capabilities of the geological surveys of the four countries and helped them develop five year work plans for the *Multinational Andean Program*. The five-year program, submitted for funding to the IDB, involves integrated geological and geophysical studies in areas along the borders of the four countries. They also asked that we complete infrastructure inventories, economic assessments and status of environmental legislation. The task was huge! Four of us, Bob Turner (GSC), Andre Panteleyev (BCGS), Rocio Lopez (interpreter) and myself spent most of October and November travelling to the four countries. Andre and I returned in January. During the 10 weeks of travelling we spent a considerable amount of time in the field looking at the project areas. The highlight of the trip for me was getting into the Maricunga Belt, on the border between Chile and Argentina, where the 10 highest volcanoes in the world are situated. The geology and scenery were breathtaking! Of particular interest to me was travelling with Andre, a noted expert in epithermal deposits. He helped give me a new appreciation for those altered areas - especially when we could find visible gold and visit the "3500 vein" at El Indio. (The 3500 vein runs 3,500 gms/tonne gold!) If the Program is funded there may be an opportunity for work by consultants and researchers in these countries in volcanic rocks and epithermal deposits. If you are interested, I would be happy to supply contact names and more background information.

I would like to say that I arrived back to my office in February to take a rest, but such was not to be. Dirk Tempelman-Kluit, Director of the Cordilleran Division of GSC, decided to step down and retire from the public service. Senior management asked that I head the office and I have agreed to do so for six months, at which time I want to get back to my volcanoes! The task even for six months is daunting. The GSC is undergoing a downsizing of about 30%. They have amalgamated our own Division with the Pacific Geoscience Division and half the former Geophysics Division based in Ottawa. Plans have been announced to move us all to one location on Vancouver Island, near Victoria and we have been given a new name "GSC Victoria." Stay tuned for more developments!

I am looking forward to seeing many of you in Victoria and if not, I hope that you will send us an update on your work, travels or research and something for the IUGG Quadrennial Report.

VOLCANO UPDATE

MERAPI, CENTRAL JAVA, INDONESIA (7.54°S, 110.44°E)

All times are local (= GMT + 7 hours)

The 9,550-foot (2,911-m) Mount Merapi, which is 310 miles (500 km) east of Jakarta, is one of the world's most active volcanoes, with its most destructive eruption this century recorded in 1930, when 1,300 people were killed. Merapi sits immediately N of the large city of Yogyakarta; at least 50,000 people live adjacent to its SW slope. The stratovolcano has an exposed, summit lava dome, the source of abundant glowing blocks that continue to tumble down its SW slope. In historical time, instability of the growing dome has led to *nuées ardentes* that have caused many fatalities, disasters described in many popular books on volcanology.

Activity increased with the appearance of low-frequency earthquakes on 20 October (figure 2). Multiphase events and rockfalls continued to be recorded at normal levels, with occasional low-frequency events and one tremor episode on 3 November. On 4 November the marked increase of activity was reported to the Chief of Regencies around Merapi. During 21-22 November, a team from the Merapi Volcano Observatory (MVO) climbed to the summit to observe dome development and install an extensometer station to measure cracks.

The first *nuée ardente* was recorded instrumentally at 1014 on 22 November at MVO, and was observed visually from the Plawangan, Ngepos, Babadan, and Jrakah observation posts. The team at the summit saw a vertical plume that originated from a location somewhere on the S part of the dome. A glowing cloud was clearly seen from the direction of Plawangan to the S. The intensity of the *nuée* increased at 1020. The Plawangan observation post was abandoned at 1508 and the personnel temporarily moved to Kaliurang. The *nuées* had diminished by 1720 that evening.

A U.S. State Department dispatch on the morning of 23 November stated that, according to sources in the area, the eruption began at 1040 on 22 November, and was preceded by an initial venting of steam about 25 minutes earlier. The initial eruption sent a plume approximately 800 m into the air and scattered rock and gravel projectiles across the ashcone. The most serious damage, however, was done on the volcano's S side where the eruption sent flows of hot volcanic mud (lahar) and superheated steam cascading down the S slope inundating two villages. A United Nations Department of Humanitarian Affairs (DHA) report the same day stated that the volcano erupted at 10:15, emitting a pyroclastic flow containing hot ash, gas, and other particles in suspension 6 km down along the Boyong river in Turgo village, Pakem subdistrict, Yogyakarta Province. The volcanology office said temperatures in the worst affected village of Turgo had reached 600 degrees Celsius. At that time, 24 people were known killed and 95 were severely injured. Evacuees totalled 6,026 from the neighboring villages in the subdistrict of Pakem.

On 30 november 1994, DHA reported that “No more pyroclastic flows observed since 23 Nov. However, lava still flowing 1.5 kms down River Boyong. Geochemical analysis indicates increased emissions of sulfur (*sic*) dioxide up to 44 tons a day, indicating possible further eruptions”. On 7 December, DHA reported a death toll of 58. “Continuing small eruptions are causing lava flows up to 1.5 km down River Boyong. One million cubic meters of pyroclastic sediment now condensIng along River Boyong, while another 12 million cubic meters is still loose around crater. Cold lahar control is urgently needed”.

DHA Disaster Administrator, Geneva, Switzerland; Global Volcanism Network; Sukhyar, Volcanological Survey of Indonesia.

Boris Behncke (Kiel) wrote:
".....German newspapers carried a few spectacular (partly color) shots of the pyroclastic flows descending the S flank of the cone. It is noteworthy that on these photos there is absolutely no vertical eruption column but large, dense plumes rising obliquely from succeeding pyroclastic flows.....the event has been characterized mostly, if not exclusively, by the generation of pyroclastic flows by the collapse of (part of the) large lava dome that has been growing episodically on the summit since early 1992.....All in all, the present disaster much resembles the June 1991 Unzen pyroclastic flows that were caused by the collapse of a growing lava dome. The reporting of "lava flows" as one of the destructive agents is certainly incorrect.....The lava flow itself should be expected to be highly viscous and therefore must be restricted to the very summit area, or to a breach on the upper S flank that may have formed during the intense activity of 22 Nov.....The current eruption has so far been quite typical, with the exception of the change of direction (the last eruption to affect a sector other than the W to SW sector occurred in 1954, towards the N and NW flanks).

The emplacement of a lava flow on the oversteepened upper flank poses the high risk of more, and larger, pyroclastic flows towards the newly-stricken direction. It has repeatedly been the case (e.g., in 1961) that after the opening of a new summit breach, a large lava dome has grown to fill that depression, and then, after several months of vigorous growth, it collapsed."

Patrick Allard (CNRS-CEA) wrote:
".....the November 22 eruption may signify an important change in the location of future magma extrusion and the distribution of related hazards at Merapi. Over the past hundred years at least, glowing block avalanches, pyroclastic flows and lahars associated with extrusion of the lava domes were entirely confined to the W and SW flanks (last major eruptive phases in 1969, 1976, 1984 and 1992). Now, in 1979 and 1983, attention had been drawn on the potential risk of new magma outbreak towards the South (from the Gendol-Woro breach), that would threaten a more densely populated area including the northern suburb of Yogjakarta city. This concern was based on the following observations: increase and then persistency of very high temperatures in the Woro and Gendol fumarolic fields (implying a close proximity to the top of the magma column, as later verified from magnetotelluric measurements), appearance of scattered but new fumaroles on the Woro downslopes in 1979, and above all extreme fumarolic alteration of this sector of the edifice (weakening its stability or/and resistance to any magma intrusion). The present events seem to verify it, south-eastward migration of the eruption site being facilitated by magma blockage in the SW Batang breach due to the presence of the huge 1992-94 lava dome."

David Stevenson, (U.K. Met. Office) adds a caution regarding fumarolic temperatures:
"The major factors that control fumarole temperature are magma source depth, gas ascent velocity, and the temperature field surrounding the fumarole conduit. The last factor depends upon the presence or absence of a hydrothermal system, and the proximity of other gas conduits. An increase in temperature can indicate magma ascent, a higher gas flux, or a general heating of the vent surroundings. As with most volcano monitoring techniques, complimentary (*sic*) data from a different method is needed to pin down the actual process."

POPOCATEPETL, CENTRAL MEXICO
(19.02°N, 98.62°W); (summit elevation 5,465 m)
All times local (= GMT - 6 hours)

The fumarolic activity that had been developing during the last two years or so culminated on early December 21, 1994, when a series of volcanic earthquakes, probably associated with phreatic explosions, marked the beginning of a new stage of eruptive activity. The seismic events, detected at 01:31, 01:32, 01:38, 01:40 and 01:48, were very impulsive, high frequency, short duration signals, and were followed by a major, lower frequency event at 01:53. The events were recorded by 4 telemetric stations operated jointly by CENAPRED (National Disaster Prevention Center) and the Institutes of Geophysics and Engineering of the National University of Mexico (UNAM).

As the day cleared an ash plume was observed for the first time in decades emerging from the volcano crater. The ash emission was moderate and produced an almost horizontal plume causing a light ashfall over the city of Puebla, about 45 km ENE of the volcano's summit. A helicopter flight at 10:30 showed that most of the ash was issued near the lower rim of the inclined crater at the NE sector. A radial fissure could be observed on the NE flank of the cone. Some steam-producing vents could also be observed along the fissure, though the cloudy conditions makes this interpretation doubtful. Old cracks in the glacier appeared to have extended a significant amount towards the W. A second flight the same day at 14:30, revealed a substantial increase in the ash production (about 3 to 4 times the amount observed in the morning). The light-gray ash appeared to be emitted in episodes, with "puffs" every few minutes. The seismic levels of activity (mostly low amplitude B-type earthquakes, concurrent with high-frequency A-type events) increased during the day, though maintaining lower levels than those observed during the previous night.

At this stage and after several consultations between the scientific group and the Civil Protection authorities, an evacuation of the most vulnerable towns and villages of the East sector of the volcano was started around 21:00 of December 21, and about 31,000 persons were moved during the night to shelters in safer areas. 19 towns were evacuated.

Popocatepetl's Holocene activity has consisted of alternating effusive and pyroclastic periods, ranging from mild steam-and-ash emissions to plinian eruptions accompanied by pyroclastic flows and surges. Boudal and Robin (1989) identify three periods of vigorous explosive activity during the Holocene: 10,000-8000 BP, 5000-3800 BP, and 1200 BP-present. The last cycle ended an effusive period from 3800-1200 BP with a vigorous explosive eruption that both enlarged the summit crater and generated St. Vincent-type pyroclastic flows. Another large explosive eruption occurred about 1000 yrs BP and produced pyroclastic flows that descended the northern flank.

Historical eruptions depicted on Aztec codices date back to 1345 AD. About 30 eruptions have been reported in historical time, although documentation is poor. Most historical eruptions were apparently restricted to mild-to-moderate Vulcanian steam and ash emission. Lava flows restricted to the summit area may also have occurred in historical time, but cannot be attributed to specific eruptions. Larger explosive eruptions, possibly Plinian in character, were recorded in 1519 and possibly 1663. The last significant activity took place from 1920-22. Then, intermittent explosive eruptions produced 6.6-km-high columns and a small lava plug was intruded into the summit crater. Minor ash clouds were also reported in 1923-24, 1933, 1942-43 and 1947.

Servando De la Cruz and the Global Volcanic Network

Field Report

Claus Siebe reported that climbers at Popocatepetl reached the summit both on the day before the eruption, and not long after the 21 December eruption. On the day before the eruption the climbers could see the crater lake and sparse fumaroles. They reportedly heard no hissing sounds and smelled less odor from sulphur-bearing gases than in previous months.

Six volcanic earthquakes took place between 0130 and 0200 on 21 December, events probably associated with phreatic summit explosions. These events were neither heard nor felt by any of about 25 mountain climbers at Tlamacaz, 4 km N of the summit. The climbers, who said they started ascending the mountain around 0400, did not notice anything unusual until at the crater rim around 0800. Minutes before reaching the rim climbers were stunned by what they thought was the sound of jet engines. At the crater rim they saw new bombs as large as 40 cm that had been thrown out of the 250 m deep crater and had burrowed deep impacts in the snow. Some climbers who had never visited Popocatepetl before reached the summit unaware of any abnormal activity. At the summit, the climbers said they could not see the crater floor even though a strong wind was blowing. They descended the mountain without incident.

Claus Siebe was at Tlamacaz at 0900 on 21 December during clear weather. He observed a continuous ash plume rising 100-500 m above the crater with pulses at 1-5 minute intervals. The plume was carried at least 60 km E. Enough silt- and sand-sized material reached Puebla (45 km ENE) to produce a thin coating on cars. The material produced so far appeared non-juvenile, and it contained pyrite, sulphur and Ca-sulfate recognizable in coatings and vein fillings.

Plume Imagery

On 26 and 27 December the Synoptic Analysis Branch reported plumes seen in the visible but not in the infrared wavelengths. A new eruption took place on 26 December at around 1300. Based on the latest significant meteorological (SIGMET) advisory from Mexico City at the time, this plume reached an altitude of about 6.7 km (22,000 ft). A report later that day indicated that the volcano had continued to erupt and created a plume that at 1745 reached 50 km in length, trending E. The next day a GOES-8 visible satellite image of the plume at 0745 suggested a gently curving, funnel-shaped mass tracking NE. The plume just touched the Gulf Coast near Tampico. Based on its lack of infrared signature and on the visible signature, the plume was thought to be of low density.

Trajectory forecasts generally showed the plume engulfing the E half of the volcano and then traveling NE. After about 24 hours, these forecasts projected the plume traveling NE and stretching over a significant part of the Gulf of Mexico. The forecasts indicated that it would later reach the Mississippi delta region. About two days after the eruption, the forecast edge of the plume would cross the SE part of the USA and reach the E coast of Florida and the Atlantic. The forecasts were based on initial volcanological assumptions that the plume reached ~20,000 ft altitude and that eruptions were sustained continuously for 24 hours.

Monitoring

Prior to the beginning of the current eruptive episode at Popocatepetl, scientists at the National University of Mexico (UNAM), in conjunction with the National Disaster Prevention Center (CENAPRED), had installed a four station, telemetered-seismic network at Popocatepetl and established a geodetic network at the volcano. Scientists at the University of Colima, in collaboration with scientists from UNAM and from Arizona State University, have been collecting data on SO2 emissions for about a year. Furthermore, scientists at UNAM have been investigating the eruptive history of Popocatepetl and evaluating volcanic hazards at the volcano for several years. Since the initial eruptive activity on 21 December, all monitoring and hazard-assessment activities at Popocatepetl have been coordinated by CENAPRED, the agency responsible for mitigating natural hazards in Mexico.

AOBA, VANUATU (SOUTHWEST PACIFIC)
(15,38°S, 167.83°E)

Aoba volcano is an oval shaped, basaltic and dominantly lavic shield volcano, by far the largest of the whole New Hebrides arc (base at -3000 m below sea level, top at 1500 m a.s.l., approximative volume : 2500 km^3). It lies in front of the d'Entrecasteaux collision zone, at the boundary between the northern and southern Aoba Basins, on a thinned crust, along a fracture running N100 E, transverse to the arc. Two summit concentric calderas (5 km in diameter for the largest) enclose the main central crater (Lake Voui, 2 km in diameter). Numerous secondary craters and cones lie along the N100 E fracture, out to the extremities of the island, where magma-seawater interactions have produced several maars in the past. The whole island is covered by a dense rainforest (almost 10 hr of hard walk to go from the shore to the summit).

Aoba volcano has been recently considered to be the most potentially dangerous volcano of the Vanuatu archipelago, due to the presence of :

1. very young deposits related to strong explosive eruptions all around the central part of the island down to the coastlines as well as thick lahar deposits;
2. the presence of Lake Voui in the crater;
3. the long time quiescence of this volcano (300-400 years);
4. strong degassing which occurred in the lake in 1991, and
5. a population of 3500 inhabitants living in a radius of 10 km from the crater.

Recent volcanic activity includes the formation of Lake Voui and Manaro Ngoro summit explosion craters and cones (some 420 years ago). It also includes N'dui N'dui lava flows, issued from the N100 E fissure, approximately 300 years ago, which reached the NW coast. Possible lahars (or only mudflows following heavy rains?) annihilated villages on the SE flanks of the island, about 120 years ago, producing several casualties. An eruption possibly occurred in 1914 with ashfalls (?) and lahars (12 casualties).

Three anomalous "boiling" areas with large bubbles (10 m in diameter) and burned vegetation were observed at Lake Voui on July 13, 1991 by a VANAIR pilot. It was the first time he observed such a phenomenon, and he recalled that the vegetation was still green in May 1991. On 24 July 1991, an aerial survey revealed only three areas of discolored water in Lake Voui. The vegetation was burned up to the crater rim, 120 m above the water. Thus, an anomalously strong SO2 degassing probably occurred between May and July. This event, unnoticed by island residents, certainly marked the end of a long time of quiescence.

Unusual seismicity was felt by Aoba inhabitants, from 1st to 7th of December 1994, with a maximum of 7 small to medium-sized events on the 5th of December. Records of this seismic crisis by ORSTOM stations located at Santo (70 km from Aoba) and Efate (260 km from Aoba) have shown that the peak activity lasted 24 h with 13 events, the largest having a magnitude of 4.6. Crustal hypocenters were located under the southern submarine base of the volcano. On 7 December, a brief reconnaissance by helicopter was done to assess the possible resumption of activity at the main crater (Lake Voui) and define the kind of eruption that could develop. Activity at Lake Voui was similar to that observed on July 1991 and September 1993, with small areas of hot, gaseous water rising in Lake Voui. Nevertheless, the rainforest appeared completely burned up to several hundred meters all around the crater.

According to a VANAIR pilot, on March 1, 1995, Lake Voui was calm with gas escapes in numerous places. The following day, the lake was steaming all over, bubbling up in the centre and its surface was rough; blowing out black sediments was also reported by this pilot. Early in the morning of March 3, people of Santo island, 70 km from the Aoba crater, observed a gas plume rising up to 2 - 3 km above Lake Voui. Simultaneously, crustal seismicity with characteristics similar to that observed in December 1994 was recorded.

From 4 to 6 March, geophysicists from ORSTOM, Port-Vila, moved to Aoba and recorded strong and continuous tremor at Ndui Ndui site, about 9 km NW from the main crater. This tremor had the following characteristics :

1. monochromatic signal with a 1.4 Hz mean frequency;
2. duration of several hours;
3. amplitude of 3-4 times the back-ground noise.

Reduced displacement calculated for this tremor is 58 cm^2, which would correspond to an eruption with a VEI of 3.5 to 4 and with a probability occurence of 70%. At the same time, local observers were trained to watch the activity and the collaboration with VANAIR pilots was reinforced. However, as usual during the tropical summer, the top of the volcano is covered by thick clouds and almost always is not visible. 5 March, a gas plume was still visible above Lake Voui.

Variations in the level of Lake Voui were noted by an Aoba inhabitant who stayed several days in the summit area : on the 4th and 6th of March, the l feet below the usual level and the entire hot lake was steaming. Soft mud was also blown all over the shores.

Recorded tremor activity remained constant on Aoba between the 9th and 13th of March but with significantly less intensity than during the 4 to 6 March period. In addition, a shallow, local micro-seismicity has been noted since the 11 th of March. During an aerial survey made on the 13 th of March, the entire lake was steaming and a strong sulfur smell had been reported all above the summit area of Aoba.

In case of increasing activity in the central crater, magma- water interactions would produce falls of ash, dense lapilli and accretionary lapilli, as well as pyroclastic flows, base surges and lahars. Lava flows may also erupt from N100 E or flank fissures. The ORSTOM seismological team in Vanuatu will be reinforced and 5 to 7 portable seismic stations will be deployed as soon as possible around Aoba Island to improve the focal locations and delineate possible areas of attenuation. Also, a new permanent seismological station will be installed on Aoba, operated by ORSTOM in Vanuatu. Daily contacts are maintained between geophysicists based in Vanuatu and geologists now based in Ecuador; these last ones are ready to move to Vanuatu.

C. Robin and M. Monzier (geologists) ORSTOM

FOGO, SW CAPE VERDE ISLANDS, ATLANTIC OCEAN

14.95°N, 24.35°W; summit elev. 2,829 m

An eruption began during the night of 2-3 April. Witnesses told reporters that the volcano was "spewing out smoke and flames." The head of the Cape Verde Red Cross stated that high flames could be seen coming from Cano crater and that "a pall of black smoke was hanging over the island." The UNDP office in Praia reported that a flank eruption occurred outside the crater from a fissure 200 metres long, from which a lava stream 10 metres wide and 2 metres thick was moving at 5 kilometres per hour. Volcanic ash was carried to an altitude of 4000 to 5000 metres. By noon police officials were reporting that everyone living in the caldera had managed to get out and had been accounted for. The lava flow was also being watched in case other evacuations were needed. The Portuguese news agency Lusa reported that 1,300 people had fled on foot; the island has ~33,000 residents on mountaineous surface of 476 square kilometers

The island of Fogo consists of a single massive volcano with an 8- km-wide caldera breached to the E. The central cone in the caldera was apparently in almost continuous activity from the time of Portuguese settlement in 1500 A.D. until around 1760. Fogo volcano had 9 eruptions with small explosions and lava flows for the last 300 years, most recently during 2 months in 1951. Lava flows from these eruptions reached the E coast. The last eruption was during June-August 1951 from vents within the caldera, S and NW of the central cone.

Global Volcanism Network and DHA-Geneva

FERNANDINA, GALAPAGOS ISLANDS, ECUADOR

0.37°S, 91.55°W; summit elev. 1,495 m.

All times are local (= GMT - 6 hours).

Fernandina volcano, which forms the westernmost island of the Galapagos archipelago, produced a red glow that was seen by both mariners and geologists on the evening of 25 January. Inspection revealed lava erupting from a fissure on the island's SW flank and thought to be coming from older, but unvegitated cones that extend in a line from the coast. The venting fissure was located about 5 km from the coast near Cape Hammond and the flow extended all the way to the sea, entering at a point about 3 km N of the Cape. Lava constructed a delta, and although reports documented a shift in the character of activity, suggesting decrease after 13 January, the eruption continued as of mid-February.

From the morning of 27 January a group of interested observers (Godfrey Merlin, David Day, Rolf Siever, Fernando Rivera, Deana Reirer, Jim Stimic, and two Isabella Park Guards) sailing on the "Ratty" made detailed observations of the eruption from land and sea.

As they approached from the S on the morning of the 27th, they observed two distinct plumes, the largest being more to the W. These plumes coalesced into a single plume, rising 3-4 km and being transported to the W at that height." The two separate plumes came from gases rising from the fissure vent and from lava entering the sea.

Concerning the eruption itself, Godfrey Merlen, reported the following on 3 February: "Although some new lava fields have been created, the eruption has settled into a pattern with fountaining lava (30-200 m [tall]) forming scoria ridges alongside its fissure. It seems that in the first moments the fissure opened up over [a distance of] about 1.5 km but later became restricted to about 400 m (29 January). However, a film taken on 2 February, seems to show an increase in the length of the fissure erupting. A river of lava about 100 m wide is flowing to the sea, about 5 km away, where new land is slowly being formed. The front entering the sea is about 800-m long."

The eruption followed a Mb 5.1 earthquake at 1811 on 14 December (0011 GMT on 15 December) approximately under the summit of Darwin volcano, on Isabela. Locations are inaccurate, however, and could be off by as much as 100 km. An additional five earthquakes over M 4.4 also took place, with calculated hypocenters farther N, including one on 11 January (Mb 5.1, Msz 4.9) with a calculated hypocenter about 20 km N of Pinta.

Although the eruption has yet to be imaged from space, and the NASA TOMS (total ozone mapping spectrometer) is currently inoperative, the eruption has been documented on film by local and visiting scientists, and by a visiting TV crew from public television in Japan. The TV crew's producer, Hiromichi Iwasaki, described a 1.5-km radius of discolored water around the entry, and rain due to condensed steam.

Tui De Roy reported that the abundance of dead fish floating on the surface attracted seabirds who dove into the heated waters and were scalded to death. She also reported that some land animals seemed unable to sense the danger from heated surfaces and in not fleeing the hot lava they were burned to death. No Galapagos tortoises currently inhabit Fernandina Island.

Fernandina also erupted in 1991, 1988, 1984, 1981 and 17 to 18 other times in a historical record going back as far as 1813. Most of the documented eruptions lasted less than a year and vented from the central summit caldera.

Rick Wunderman, Global Volcanism Network

RABAUL UPDATE

Tavurvur remained active through the end of October, although activity was decreasing. Billowing columns rose up to 800 m above the crater, but with deceasing frequency and less ash content. A new cone has been built around the active vent that was 30 m deep and had a radius of 80 m. Light ashfall continued through October in Rabaul and on the N coast area. Lava flows on the W flank of Tavurvur stopped by 27 Oct about 100 m below the rim of the cone, 2/3 of the way to the coast. The extensive pumice raft is blowing to and fro all over the bay. No information received about if people are moving back in, but RVO said there was "major destruction" in the town from the ash/mud and flash-flooding.

Global Volcanism Network

PACAYA, GUATEMALA (14.38°N, 90.60°W)

All times are local (= GMT - 6 hours)

Activity increased at 0400 on 12 October with vigorous Strombolian explosions. Approximately 5 cm of ash was deposited in El Patrocinio, ~4 km W. Ash drifted as far as Santa Lucia Cotzumalguapa, ~45 km WSW on the Pacific lowlands. Although apparently declining on 14 October, Strombolian activity was continuing, an ash plume to 300 m above the vent persisted, and tremor was still being detected by the seismometer at Pacaya. As of 14 October, five lava flows active on MacKenney cone had reached the base of the edifice, two on the N, two on the W, and one on the S flank. Flow velocities were reported to be 10 m/hour. Heavy rains and cloud cover since the start of the increased activity have prevented detailed observations. The Comite Nacional de Emergencias (CONE) evacuated 142 people from the towns of El Patrocinio, El Caracol (3 km SW), and other nearby areas, to San Vincente de Pacaya (5 km NW).

Pacaya is a complex volcano constructed on the S rim of the 14 x 16 km Pleistocene Amatitlan Caldera. In 1565, the first recorded historical eruption from Pacaya caused ashfall for three days in Guatemala City. Following explosions in July and October 1965, Strombolian activity was generally continuous until March 1989 when explosive activity destroyed ~75 m of the MacKenney cone summit and enlarged the crater. Strombolian activity began again in January 1990 and has continued intermittently since then. This latest episode of activity is similar to, but probably smaller in terms of area impacted by tephra, the activity during July-August 1991 that again destroyed part of the cone and damaged towns W of the volcano.

Eddy Sanchez, INSIVUMEH, and J. Ewert, USGS Cascade Volcano Obs.

MOUNT RINJANI, INDONESIA

The UNDP/DHA resident representative in Jakarta reported an occurrence of a cold lahar (volcanic mudflow) in Lombok, province of West Nusa Tenggara. Provincial authorities indicated that the cold lahar flushed along the Kokok Jenggak River from the crater of Mount Rinjani on 3 November 1994. Thirty people were killed in the village of Aikmel, District of East Lombok, and 1 person was reported missing. All casualties were local people who were collecting water on the river.

Mount Rinjani on Lombok island erupted in June 1994. Local volcanologists indicate that a further cold lahar may be triggered by heavy rainfall.

Disaster Information Centre

RISK ASSESSEMENT OF THE NIRAGONGO VOLCANO (ZAIRE)

Various geologists published a preliminary report describing a fountaining activity in the lava-filled crater. This does not permit determination as to whether this intracrateric eruption is the revival of the lava-lake that characterized Niragongo from 1928 (probably) and 1977 (when it disappeared rather dramatically), or whether it is the revival of "lava-pond" observed there in 1982, 5 years after the 1977 event. The difference between lava-lakes and lava-ponds (or pools) is that the former are continuously fed and drained by convective cells of comparatively light magma and comparatively dense lava, whereas the latter, although similarly fed either by rising fresh magma or by already degassed lava (as observed and described on Kilauea, Hawaii) are not engulfed through the convective process by downgoing currents of degassed, partially cooled (and consequently more dense) lava. Lava lakes may be active during many decades (and even centuries, as in the Halemaumau fire-pit of Kilauea), even when the surface rises or falls with increase or decrease of the underground magma activity. Lava ponds do rise upwards as long as fresh magma is erupted from underground.

The risks linked with the Niragongo present activity differ according to the nature of the molten lava observed in its crater: is it a lake or pool? In the former case, the risks are minor. In the latter, they depend firstly on the duration of this intracrateric eruption and the consequently rising of the pond's level and secondly on the mechanical strength of the upper parts of the crater walls; the radially oriented, hydrostatic pressure exerted against these walls will possibly split them open.

A third hypothesis is to be considered; that of a general uprise of the deep magma, causing firstly, the inflation of the whole volcanic pile of the volcano (or even, as it happened in 1977, of both Niragongo and its twin Nyamlagira), secondly, a corresponding uprise of the lava-lake and, thirdly, the splitting of a broadly opened extensional fracture system. In 1977, these fractures immediately drained the whole lake content and flooded, at very high speeds, large areas on the lower, inhabitated, slopes of the volcano, killing several hundred people.

Other eruptive risks naturally exist, such as violent eruptions that occured in prehistoric, but geologically recent times; also carbon dioxide eruptions. But whatever the possible eruptive risks, their death-toll will always be orders of magnitudes lower than that of any new displacement of the one million refugees who are presently more or less acceptably sheltered in the existing camp on the southern foot of Niragongo, especially during the present rainy season and the humid cold climate at this high altitude.

Compiled from a report by Haroun Tazieff

BARREN ISLAND, ANDAMAN ISLANDS, INDIAN OCEAN

12.29 N, 93.88 E; summit elev. 305 m

A new eruption at Barren Island was first noticed by the Indian Navy on 20 December 1994. A team composed of scientists from the Geological and Zoological surveys of India arrived at the island early on 24 January, and an aerial survey over the volcano was made on the 31st. As of 22 February, this Strombolian eruption was still "in its initial stage, gradually gaining momentum." Vegetation in the path of the advancing lava flow has been destroyed.

During January and February, a thick column consisting of pale brownish gas, dark ash particles, and white steam was rising ~200 m from the crater area at intervals of 30 seconds, accompanied by continuous rumbling and intermittent "cracking" sounds. Two new vents were active, the first within the main crater near the SW corner, and the second ~50 m from the summit down the SW flank. The eruption is believed to have started from the flank vent, around which a new 100-m-diameter subsidiary crater had formed.

Liquid lava emission was volumetrically minor; most of the eruptive products consisted of cinder and volcanic bombs. Incandescent material rising to heights of 20 m could be seen from 4 km offshore. Particles ranged in size from a few cubic centimeters to ~1 m^3, with the

average size being slightly less than 10 cm^3. Ejecta filled the pre-existing valley, located south of the western- most 1991 lava bed, from which lava flows travelled ~1.5 km from the active vents into the sea, producing profuse steaming at the ocean entry. The moving lava front was ~50 m wide and 6 m thick by 22 February. Megascopically the lava was basaltic andesite, similar to that erupted during September 1991, with a high percentage of large plagioclase phenocrysts and frequent olivine in a dark-gray glassy groundmass.

On 9 March at around 0530 GMT astronauts on the Space Shuttle noticed a small plume rising from Barren Island. A short video recording (~15 seconds) showed a "V" shaped plume that extended for ~3 km before dispersing. Visible imagery from the NOAA-14 (at 0730 GMT) and GMS (0430-0830 GMT) satellites failed to reveal a volcanic plume.

Located ~135 km NE of Port Blair (South Andaman Island), Barren Island contains a 1.6-km-wide somma open to the W with a central pyroclastic cone that has been the source of historical eruptions reported in 1787, 1789, 1795, 1803, possibly 1852, and 1991. The 1803 eruption produced lava flows that reached the coast. The 1991 eruption began in late April with hot gases and strong ash emissions and ended in late October. Basaltic andesite lava flows covered an area of about 1,600 m^2 to an average thickness of 5-6 m and reached the NW coast. Initial activity was from a vent on the upper NE flank of the central cone, but expanded to include the main crater. Gas emissions were observed from lava flows near the NW coast in April 1993.

Jim Lynch, NOAA/NESDIS

BULUSAN

Another phreatic eruption occurred at Bulusan on 21 Jan 1995 2237H (local time). Activity was difficult to see apart from lightning flashes over the summit and light ashfall over the San Benon Observatory, about 5 km SW of active crater. Based on the seismic record, the 21 Jan event was fairly strong but ash deposits measured later that day showed the overall amount to be similar to previous ash emission (1 to 2 mm, 7 km downwind). Rumbling reportedly accompanied the ash ejection.

Alert Level 2 was maintained over Bulusan and surrounding villages. This is a warning of heightened volcanic activity but is non-commital with respect to the timing of future events. This is because seismic and ground deformation parameters have not reflected the short-lived ash eruptions. As before, COSPEC could not be undertaken because of heavy cloud cover. However, one thing is for sure; the interval between this latest ash eruption and the previous has increased, and a similar but more subtle trend is perceivable for the more major events for this month. This may be taken as an indicator of decreasing activity, together with the very low seismicity and unremarkable ground deformation.

No crop damage or other damage to villages have been reported nor there have been anybody reportedly hurt as a result of these eruptions. The current alert level advises against anyone visiting within 4 km of the summit.

Bulusan Volcano spewed ashes again on 28 January at 1433 H(local time). The event was recorded by the local seismic network as an explosion type earthquake. The explosion produced a 2-km high ash cloud above the summit craters and deposited andesitic ash (3 mm max) on villages up to 15 km downwind. This event, as before, was preceeded by low and unremarkable local seismicity and little else on other monitored parameters. Most earthquakes and short-duration tremor have occurred after each explosion. Ground deformation was at background levels too.

Because no escalating activity has been detected, there has been no change in the prescribed danger zone which stands at the 4 km radius. No evacuation is therefore recommended. No damage resulting from this event has been reported.

Ernesto G. Corpuz, Volcano Monitoring Division, Phil. Inst. Volcanol. Seismol

CONFERENCES, ETC

May 29-June 2. **Melt Inclusions As Petrogenetic Indicators in Igneous Environments**; Special Session at the Spring AGU Meeting in Baltimore. ***Details from:*** Kevin T. M. Johnson, Dept. of Natural Sciences, Bishop Museum, Honolulu, HI 96817, tel. 808-848-4124, fax 808-847-8252, e-mail: kevinj@mano.soest.hawaii.edu; Alexander V. Sobolev, Vernadsky Institute of Geochemistry, Moscow, Russia, tel. 7-095-9397062, fax 7-095-9382054, e-mail: asobolev@glas.apc.org.

July 16-30, 1995. G**eological Society of America Excursion to Iceland**: Land of Fire and Ice. ***Details from***: Haraldur Sigurdsson, Graduate School of Oceanography, University of Rhode Island, Narragansett, RI 02882-1197 USA Tel. 401-792-6596; home: 401-423-0247; Fax: 401-792-6811; email address: Haraldur@gsosun1.gso.uri.edu

July 29 - August 2, 1996. **Pan Pacific Hazards '96**. ***Details from***: Conference Chair, Disaster Preparedness Resources Centre, University of British Columbia, 2206 East Mall, 4th Floor, Vancouver, B.C. V6T 1Z3. Tel: (604)822-5518 FAX: (604)822-6164 e-mail: dprc@unixg.ubc.ca

September 4-8, 1995 **Third International Dyke Conference**, Jerusalem, Israel. Dr. Gidon Baer / Dr. Ariel Heimann, Geological Survey of Israel, 30 Malkhe Israel St., Jerusalem 95501, ISRAEL. Tel: 972-2-314231, 972-2-314254; Fax: 972-2-380688; e-mail: dikeconf@vms.gsi.gov.il

5-9 October 1995. **Merapi Decade Volcano International Workshop**, Yogyakarta. ***Details from:*** Dr. Wimpy S. Tjetjep, Volcanological Survey of Indonesia, Jl. Diponegoro 57, Bandung 40122, Indonesia. phone +62 22 772606 Fax: +62 22 702761 email dali@mimo.bppt.go.id

October 8, 1995. **Workshop on thermal remote sensing of volcanoes on Io and Earth**; the Ritz-Carlton, Mauna Lani, Kona, Hawaii. ***Details from:*** David Rothery, Department of Earth Sciences, The Open University, Milton Keynes, United Kingdom. phone: (1908) 652124; e-mail: D.A.Rothery@open.ac.uk

October 12 - 15, 1995 **International Workshop on Volcanoes. Lava Dome Formation and Mitigation of Volcanic Disasters** ***Details from:*** Yuichi Nishimura, Usu Volcano Observatory, Hokkaido University, 59 Sobetsu, Hokkaido, 052-01 Japan. 81-142-75-3746 (voice), 81-142-75-3705 (fax) nishi@geophys.hokudai.ac.jp

December 9-10, 1995. **Structure, Dynamics, and Properties of Silicate Melts**; Mineralogical Society of America Short Course. ***Details from:*** D.B. Dingwell, Bayerisches Geoinstitut, Universitaet Bayreuth, 95440 Bayreuth, Germany, don.dingwell@unibayreuth.de

CANCELLATION

The Decade Volcano workshop planned for the IUGG General Assembly to be held in Boulder, Colorado, this coming July has been cancelled by its conveners, Don Swanson and Wally Johnson. This is because of duplication with the meeting "Volcanic hazard in densely populated regions" being planned for 27-30 September in Rome, Italy, which will include a session on Decade Volcanoes. Convening two meetings on Decade Volcanoes in the same summer seems unnecessary, especially since extensive new work has been done at only a few of the designated volcanoes. Please contact Professor Raffaello Trigila at the following address for further information about the Rome meeting: Dipartimento di Scienze della Terra, Universita di Roma--La Sapienza, 00185 Roma, Italy; telephone 39-6-4958377, 4957393, or 4463866; facsimile 39-6-4454729.

INTERNATIONAL ASSOCIATION OF VOLCANOLOGY AND CHEMISTRY OF THE EARTH'S INTERIOR (IAVCEI) SESSIONS

V1 Origin of Large Igneous Provinces
Conveners: M. Coffin, Institute of Geophysics, University of Texas, Austin, TX 78759-8397, USA, tel. 1-512-471-8429, fax 1-512-471-8844, e-mail: Mikec@coffin.ig.utexas.edu (IAVCEI/USA), N. Arndt (IAVCEI,France), and J. Ludden (IAVCEI/Canada).

V2 Seafloor Volcanism
Convener: J. Delaney, School of Oceanography, University of Washington, Seattle, WA 98195, USA, tel. 1-206-232-4830, fax 1-206-543-6073, e-mail: jdelaney@(IAVCEI).

V3 Processes of Magma Ascent and Explosive Volcanism
Convener: S.N. Williams, Dept. of Geology, Arizona State University, Box 871404, Tempe, AZ 85287-1404, USA, tel 1-602-965-1438, fax 1-602-965-8102, e-mail: atsnw@asuvm.inre.asu.edu, (IAVCEI/USA).

V4 Evolution of Large Volcanic Systems
Conveners: J. Pallister, U.S. Geological Survey, MS 903, Denver Federal Center, Box 25046, Denver, CO 80225, USA, tel. 1-303-236-1023, fax 1-303-236-1414 (IAVCEI[U]SA), and K. Hon (IAVCEI/USA).

V5 Dynamics of the Magma/Hydrothermal Interface
Conveners: S. Ingebritsen, U.S. Geological Survey, MS 439, 345 Middlefield Rd., Menlo Park, CA 94025, USA, 1-415-329-4422, fax 1-415-329-4463, e-mail: seingebr@rcamnl.wr.usgs.gov (IAVCEI/USA), and C. Jaupart (IAVCEI/France).

V6 Arc Volcanism and Sedimentation
Conveners: R.V. Fisher, Dept of Geological Sciences, University of California, Santa Barbara, CA 93106, USA, tel. 1-805-893-3946, e-mail: fisher@magic.geol.ucsb.edu (IAVCEI/USA), and R. Cas (IAVCEI/Australia).

And last, but far from least: **GAC VICTORIA '95.**
(Don't forget the special session "Volcanic activity in extensional zones").

DIVISION FIELD TRIPS

VOLCANOES OF THE WELLS GRAY-CLEARWATER AREA, B.C.
Leader: **Paul Metcalfe,** Geological Survey of Canada, Cordilleran Division
(604) 666-1129, FAX 666-1124
Premeeting Trip: 3 days, May 14 - 16.
The Wells Gray - Clearwater area of east - central British Columbia has been a focus for basaltic volcanism, from two million years ago to the present day. The proposed (pre-conference) field trip to this area will concentrate upon examination of the intimate relationship between the basaltic volcanism, its products and their relationship to the glacial and fluvial history and deposits of the area. The terrain to be examined includes spectacular waterfalls, canyons and larger-scale volcanic and glacial scenery. A must-see!

MOUNT SAINT HELENS: A 15 YEAR RETROSPECTIVE
Leader: **Dr. Catherine Hickson,** Geological Survey of Canada, Cordilleran Division
(604) 666-3955 FAX 666-1124
Postmeeting Trip: 3 days, May 19 - 21. Approximate cost: $300.00
1995 will mark the 15th Anniversary of the May 18th eruption of Mount St. Helens. Catherine Hickson, a witness of this event, will guide participants around the mountain recreating events of 15 years ago as well as investigating the geomorphic changes that have occurred over the intervening 15 years. New access, due to open for the 15th anniversary will allow field trip participants to drive to Coldwater Ridge and give direct access to the Pumice Plains and debris avalanche deposits. Access to the dome may also be possible. The trip will also include a visit to magnificent interpretative centre opened May 1993. This trip will be of interest to physical volcanologists, geomorphologists and hydrogeologists as well as anyone interested in volcanoes.

VIDEOS

UNDERSTANDING VOLCANIC HAZARDS

The videotape, Understanding Volcanic Hazards, is now available for purchase from the Northwest Interpretive Association for $19.95 plus postage (see rates below). The video is available in English and Spanish in either NTSC or PAL video format. The video was produced by the late Maurice Krafft for the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) and United Nations Educational Scientific and Cultural Organization (UNESCO).

Understanding Volcanic Hazards features stunning images of seven types of volcano hazards: ash fall, hot ash flows, mudflows, landslides, volcanic tsunamis, lava flows, and volcanic gases. This program is intended to help prevent future deaths from volcanic eruptions by showing compelling images of destructive volcanic activity. Hopefully, people who understand these hazards will avoid them in the future.

Orders can be placed by mail with an enclosed cheque, payable to: NWIA, or by phone with a VISA card number. Add $5.00 for postage in the United States, Canada, and Mexico. For all other destinations, add $13.05 for airmail postage or $5.55 for surface postage. Be sure to specify English or Spanish, and NTSC (US and Japanese standard) or PAL (European standard).

Northwest Interpretive Association (NWIA)
3029 Spirit Lake Highway
Castle Rock, WA 98611
USA
phone# 360-274-2125
fax# 360-274-2101

USGS VOLCANO VIDEOS

AUGUST 18, 1992 ERUPTION OF CRATER PEAK VENT ON SPURR VOLCANO

Robert G. McGimsey and Joseph M. Dorava, 1994, USGS Open-File Report 94-614.

This 25-minute, narrated video presents dramatic scenes of the second of three 1992 eruptions of Crater Peak, a satellite vent on Spurr volcano, Alaska. Favorable weather conditions permitted scientists from the Alaska Volcano Observatory to photograph the eruption from a fixed-wing aircraft flying as close as 2 km to the vent. The video includes close-up views of the roiling, 18-kilometer-high eruption column, shockwaves emanating from the column base, ash clouds from pyroclastic flows on the southeast flank, and ash fallout downwind from the vent.

10 YEARS OF VOLCANIC ACTIVITY IN ALASKA: 1983 TO 1992: A VIDEO

M.P. Doukas, R.G. McGimsey, and J.M. Dorava, 1995, USGS Open-File Report 95-61.

This 28-minute video presents eruption images from eight Alaskan volcanoes during the ten-year period. Classic volcanic phenomena are documented, including meltwater lakes formed when lava flows advanced into an ice- filled caldera (Veniaminof), nighttime views of explosive strombolian activity (Veniaminof), pyroclastic flows descending steep flanks during plinian- and peleean- style eruptions (Augustine), hawaiian-style lava fountaining through glacial ice (Westdahl), island building in the Aleutians (Bogoslof), shock waves and close-up views of a roiling, sub-plinian eruption column rising more than 18 kilometers (Mount Spurr volcano-Crater Peak vent).

Prices an ordering available from:

KAKM Video, ATTN: Penny Enders
3877 University Drive, Anchorage, AK 99508
Phone (907) 563-7070; FAX (907) 273-9192
US or Canada 1-800-684-3368
EMAIL 71541.1216@compuserve.com

Game McGimsey, Alaska Volcano Observatory