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Advanced Workshop on Evaluating, Monitoring and Communicating Volcanic and Seismic Hazards in East Africa

17 - 28 August 2009

Effective Communications: Imperative in Reducing Volcano Risk

Bob Tilling
US Geological Survey
Menlo Park
USA

Strada Costiera 11, 34151 Trieste, Italy - Tel.+39 040 2240 111; Fax +39 040 224 163 - sci_info@ictp.it

Evaluating, Monitoring, and Communicating Volcanic and Seismic Hazards in East Africa:
ICTP Workshop, Trieste, Italy, 17-28 August 2009

EFFECTIVE COMMUNICATIONS: IMPERATIVE IN REDUCING VOLCANO RISK

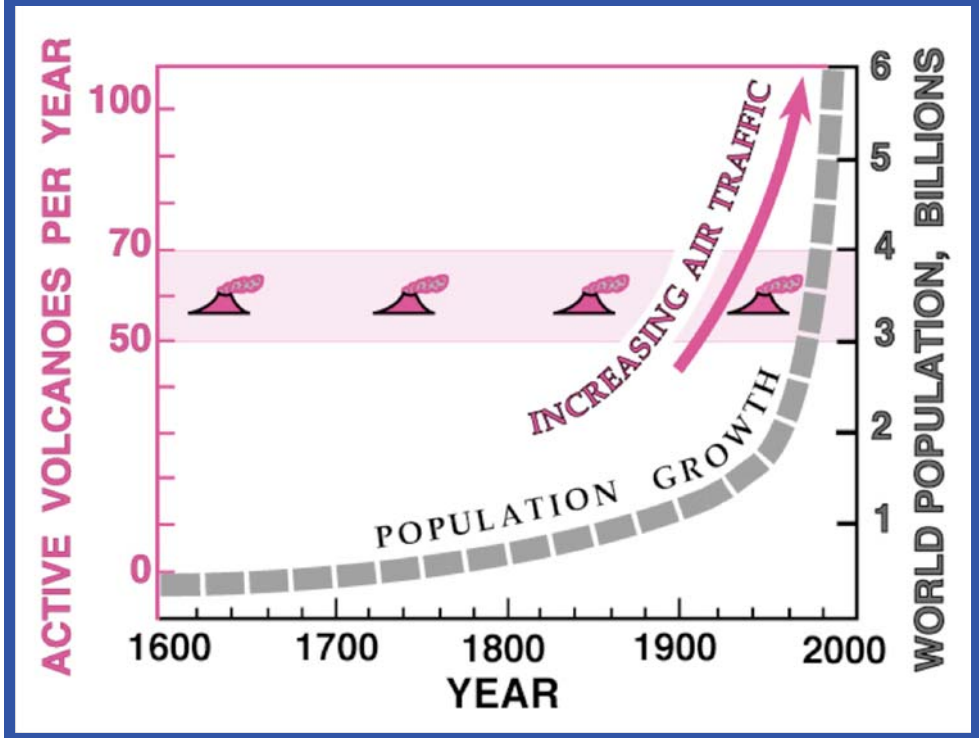
Robert I. Tilling

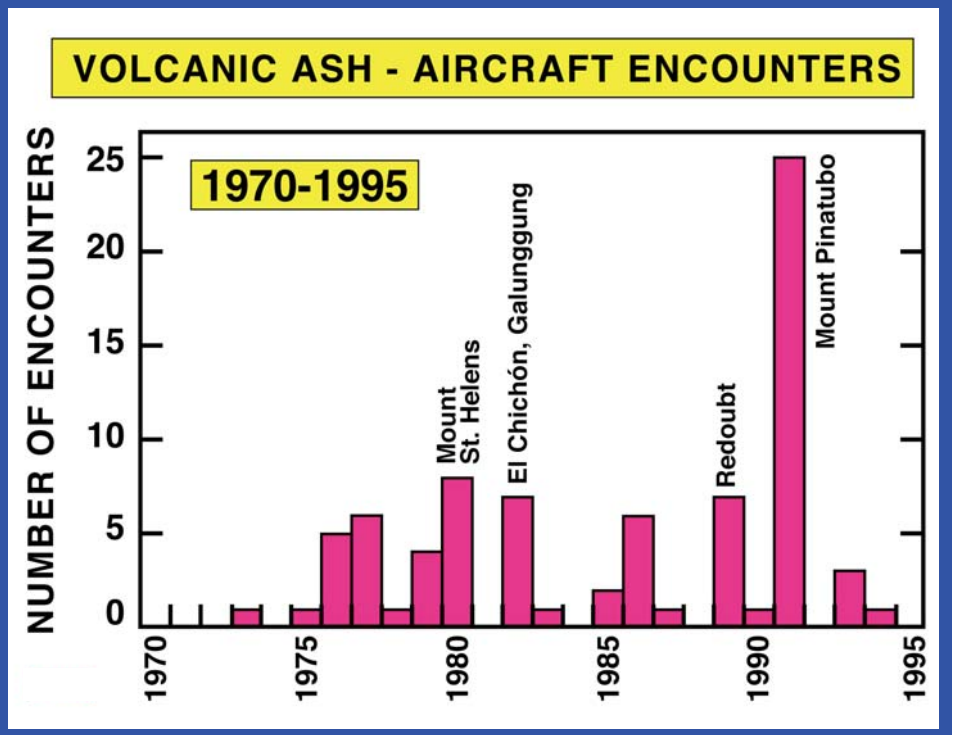
Volcanologist Emeritus, Volcano Hazards Team,
U.S. Geological Survey, Menlo Park, California 94025, U.S.A.

Tungurahua, Ecuador, 2006

USGS

RISK FROM VOLCANO HAZARDS IS EVER INCREASING WORLDWIDE BECAUSE OF DEMOGRAPHIC FACTORS





- Exponential growth in world population
- Increase in air traffic (passenger & cargo)
- Expansion of socio-economic development into more hazardous regions

USGS

TO REDUCE VOLCANO RISK

STILL SPARSELY POPULATED REGIONS:

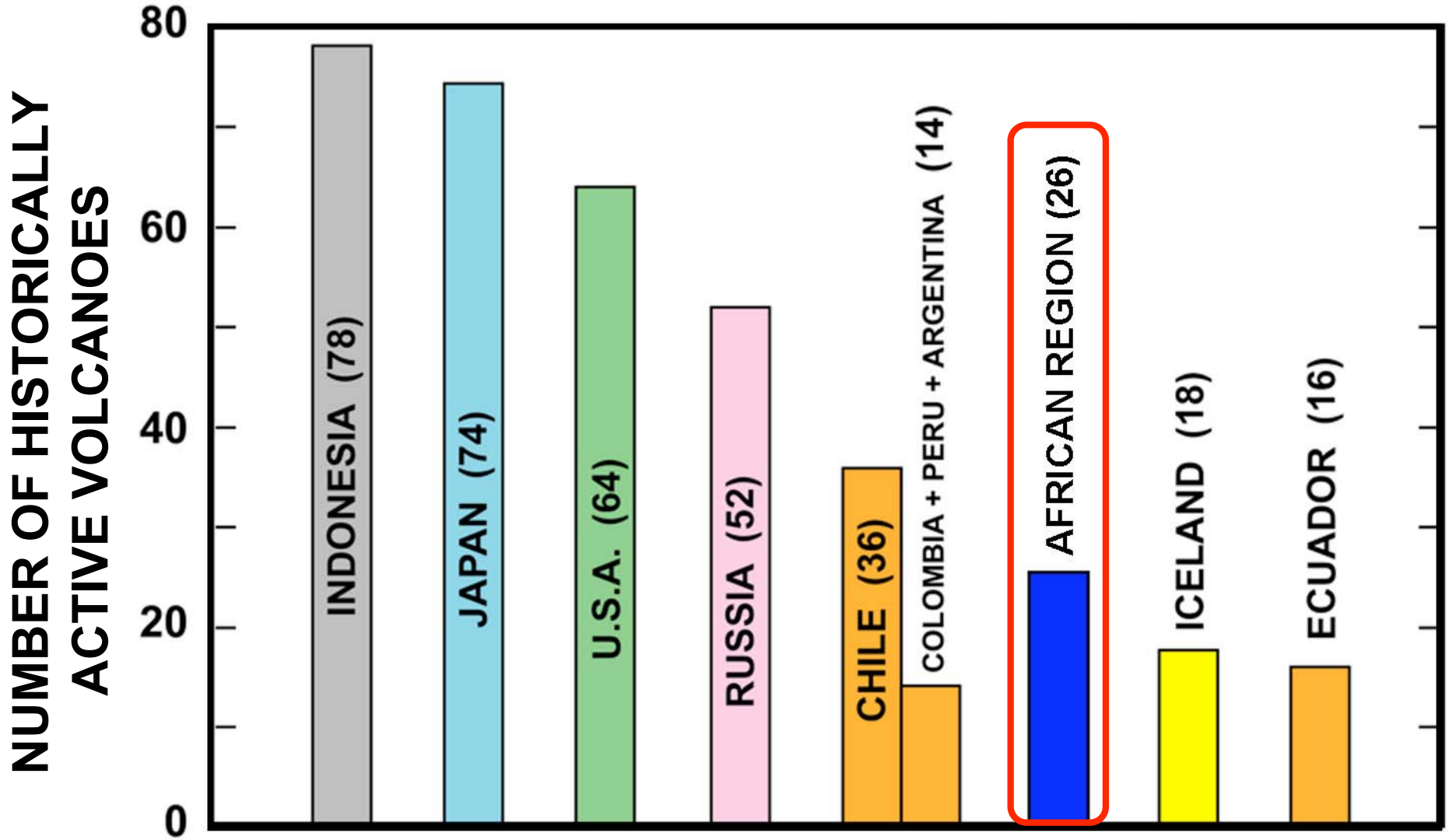
- HAZARDS ASSESSMENTS & ZONATION MAPS IN LAND-USE PLANNING
- NO HIGH-DENSITY DEVELOPMENT IN HIGH-RISK ZONES

ALREADY DENSELY POPULATED REGIONS:

- INITIATE/UPGRADE VOLCANO MONITORING
- IMPROVE PREDICTION CAPABILITY
- ESTABLISH & MAINTAIN EFFECTIVE COMMUNICATIONS AMONG SCIENTISTS, OFFICIALS, AND POPULACE

USGS

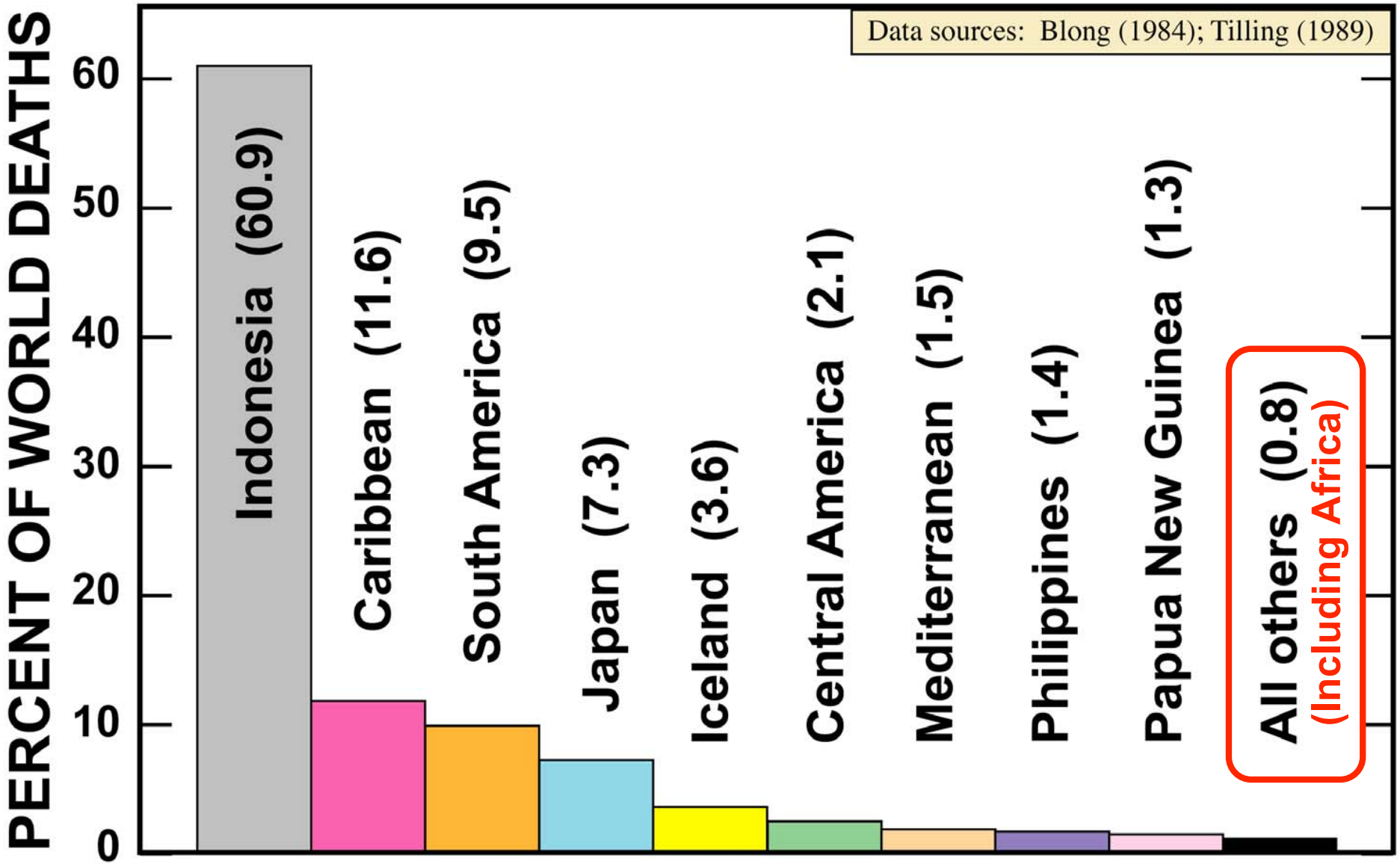
AFRICAN COUNTRIES HOST 26 OF THE WORLD'S ~ 550 HISTORICALLY ACTIVE VOLCANOES



Data source: Simkin and Siebert (1994)

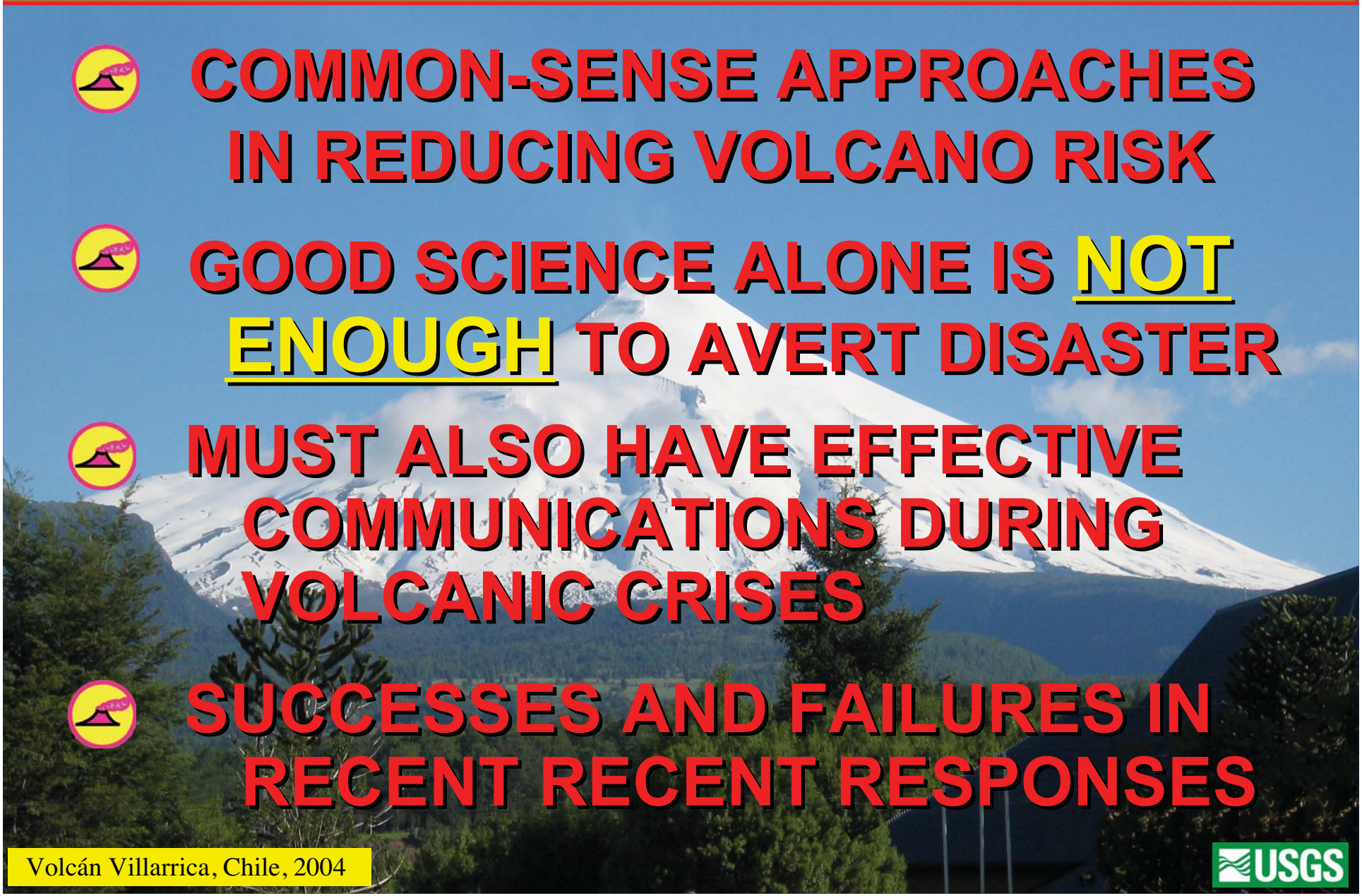
USGS

ERUPTION-RELATED DEATHS (~ 300,000) SINCE 1600 A.D. IN VOLCANIC REGIONS



FOCUS OF MY TALK

- COMMON-SENSE APPROACHES IN REDUCING VOLCANO RISK
- GOOD SCIENCE ALONE IS NOT ENOUGH TO AVERT DISASTER
- MUST ALSO HAVE EFFECTIVE COMMUNICATIONS DURING VOLCANIC CRISES
- SUCCESSES AND FAILURES IN RECENT RECENT RESPONSES



Volcán Villarrica, Chile, 2004

USGS

SOME COMMON-SENSE APPROACHES IN REDUCING VOLCANO RISK

- Make geologic maps for **ALL** young volcanoes, ideally at 1:25,000 scale or more detailed
- Study and date volcanic deposits to reconstruct eruptive style, history, and frequency
- Prepare hazards assessments and maps
- Begin or expand volcano monitoring, ideally in real or near-real time to extent possible…**BUT**
- Simple, "low-tech" monitoring can be useful…and is certainly much better than doing nothing while hoping/waiting to do "high-tech" monitoring

Tungurahua, Ecuador, 2006

USGS

SOME COMMON-SENSE APPROACHES IN REDUCING VOLCANO RISK

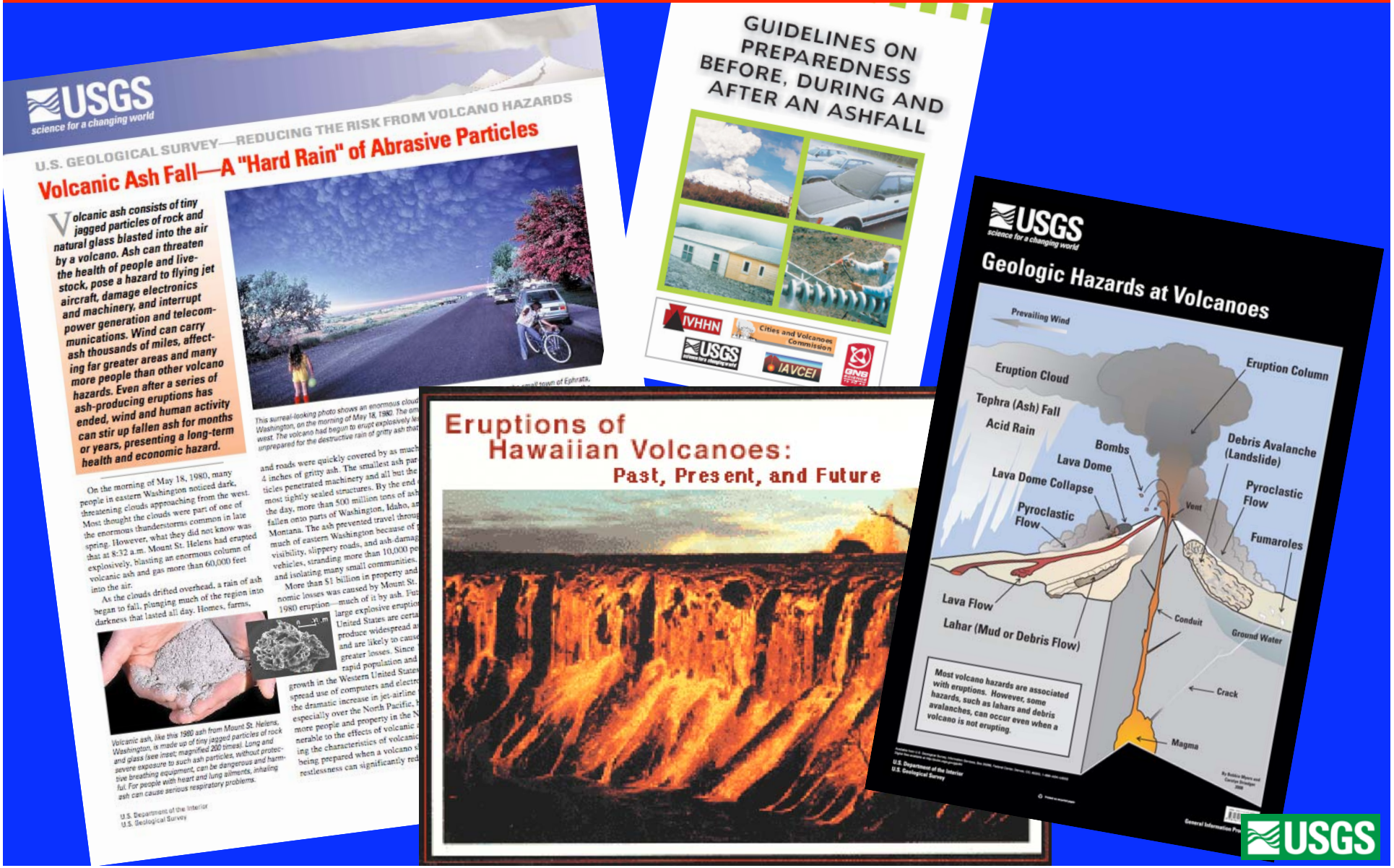
- **MOST IMPORTANT OF ALL**…MUST EDUCATE AND INVOLVE THE CIVIL AUTHORITIES, THE COMMUNITIES AFFECTED, AND THE NEWS MEDIA

- **ESTABLISH EFFECTIVE COMMUNICATIONS** AMONG ALL PARTIES…IDEALLY, BEFORE A VOLCANIC CRISIS STRIKES

Merapi Volcano, Java, Indonesia

USGS

EXAMPLES OF NON-TECHNICAL MEANS TO ENHANCE AWARENESS OF VOLCANO HAZARDS: FACT SHEETS, POSTERS, BROCHURES, BOOKLETS, VIDEOS, ETC.



DEVELOPING EFFECTIVE COMMUNICATIONS IS NOT AUTOMATIC, EASY, OR QUICK

- **HAZARDS INFORMATION MUST BE AS CERTAIN AND PRECISE AS SCIENTIFIC DATA ALLOW**

  THE REALITY: *MOST HAZARDS INFORMATION LACK THE CERTAINTY AND PRECISION WISHED FOR OR DEMANDED BY OFFICIALS AND THE PUBLIC*

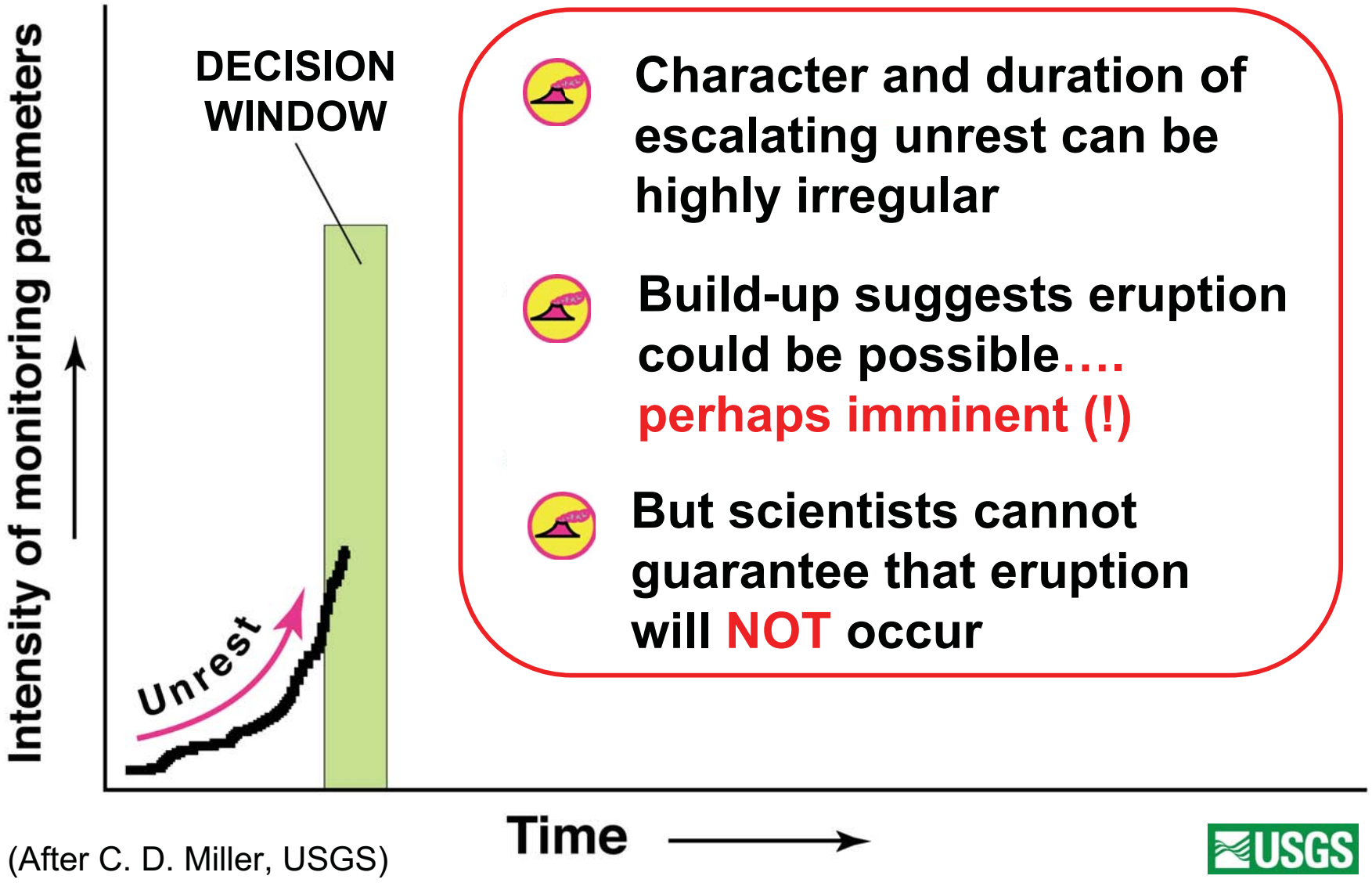
- **INFORMATION MUST BE COMMUNICATED IN A MANNER UNDERSTANDABLE TO OFFICIALS, NEWS MEDIA, AND THE PEOPLE AT RISK**

- **SCIENTISTS SHOULD NOT ADD TO CONFUSION… MUST SPEAK WITH A SINGLE VOICE PUBLICALLY**

- **SCIENTISTS MUST ENHANCE THE PUBLIC AWARENESS OF VOLCANO HAZARDS…IDEALLY WELL BEFORE A CRISIS STRIKES**

USGS

GREEN BOX IS THE "DECISION WINDOW" DURING WHICH PUBLIC OFFICIALS FACE CRITICAL DECISIONS ABOUT ENSURING PUBLIC SAFETY

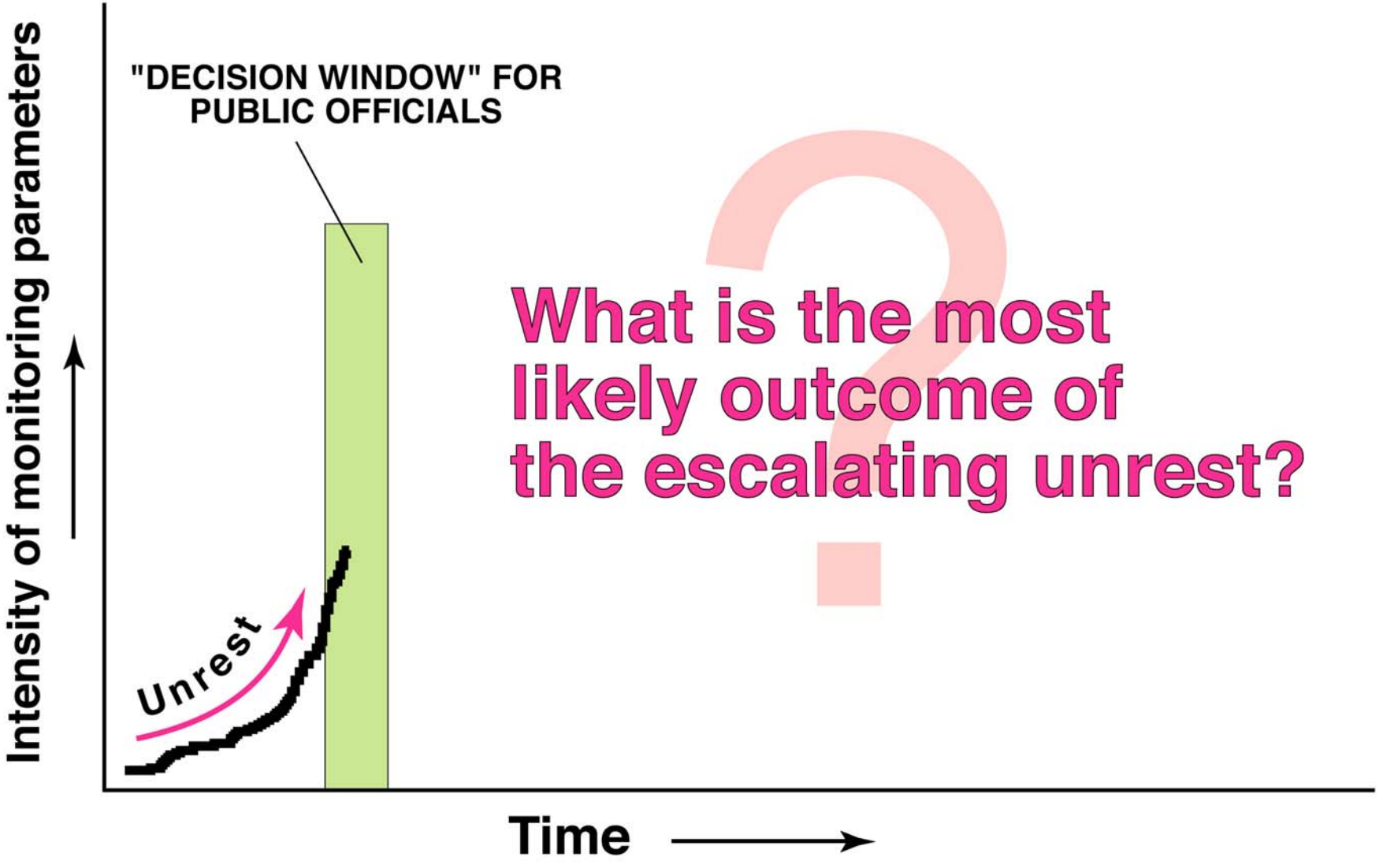


- Character and duration of escalating unrest can be highly irregular
- Build-up suggests eruption could be possible…. perhaps imminent (!)
- But scientists cannot guarantee that eruption will NOT occur

(After C. D. Miller, USGS)

USGS

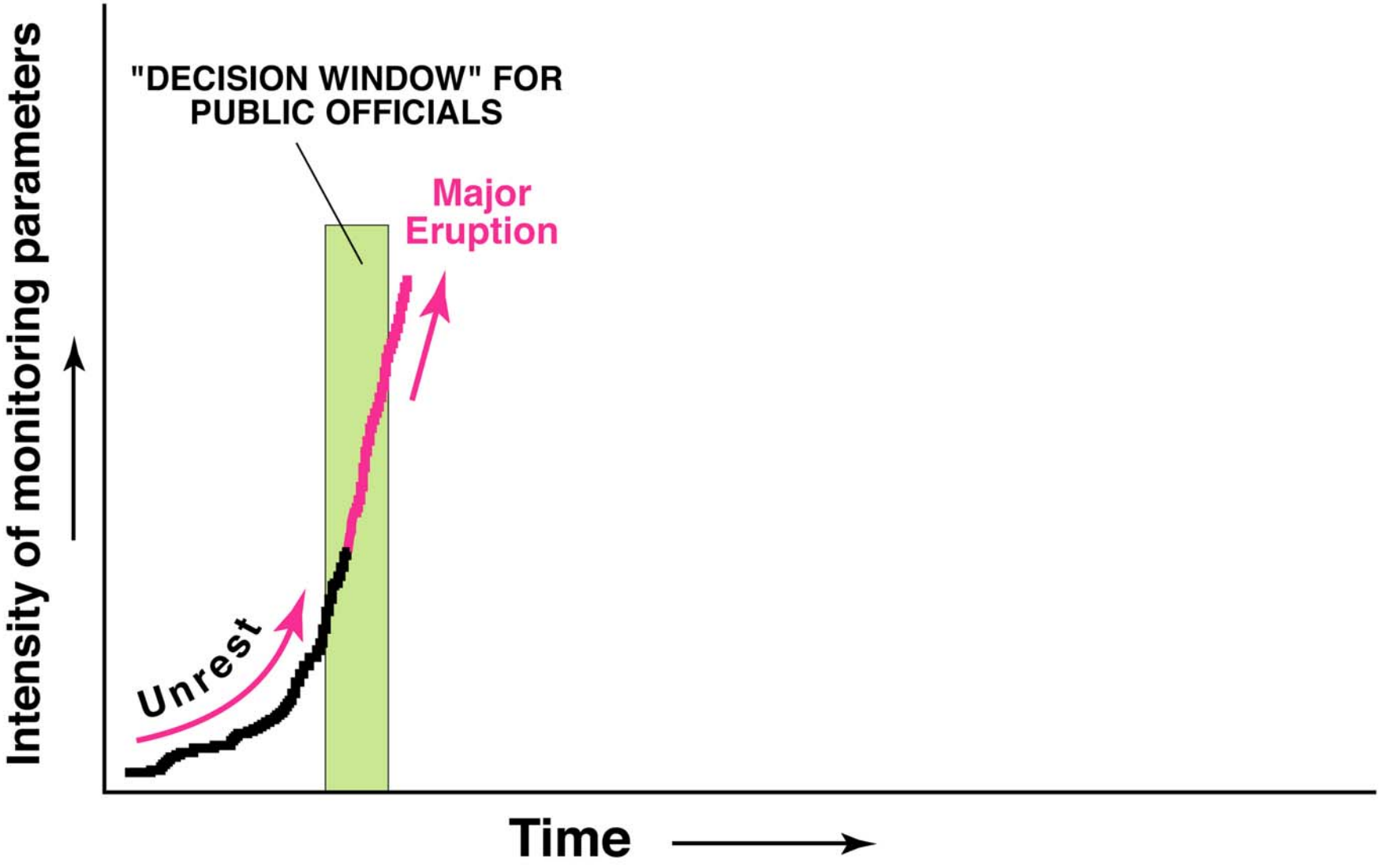
THE PARAMOUNT QUESTION FOR SCIENTISTS AND PUBLIC OFFICIALS IN FACING CRITICAL DECISIONS



(After C. D. Miller, USGS)

USGS

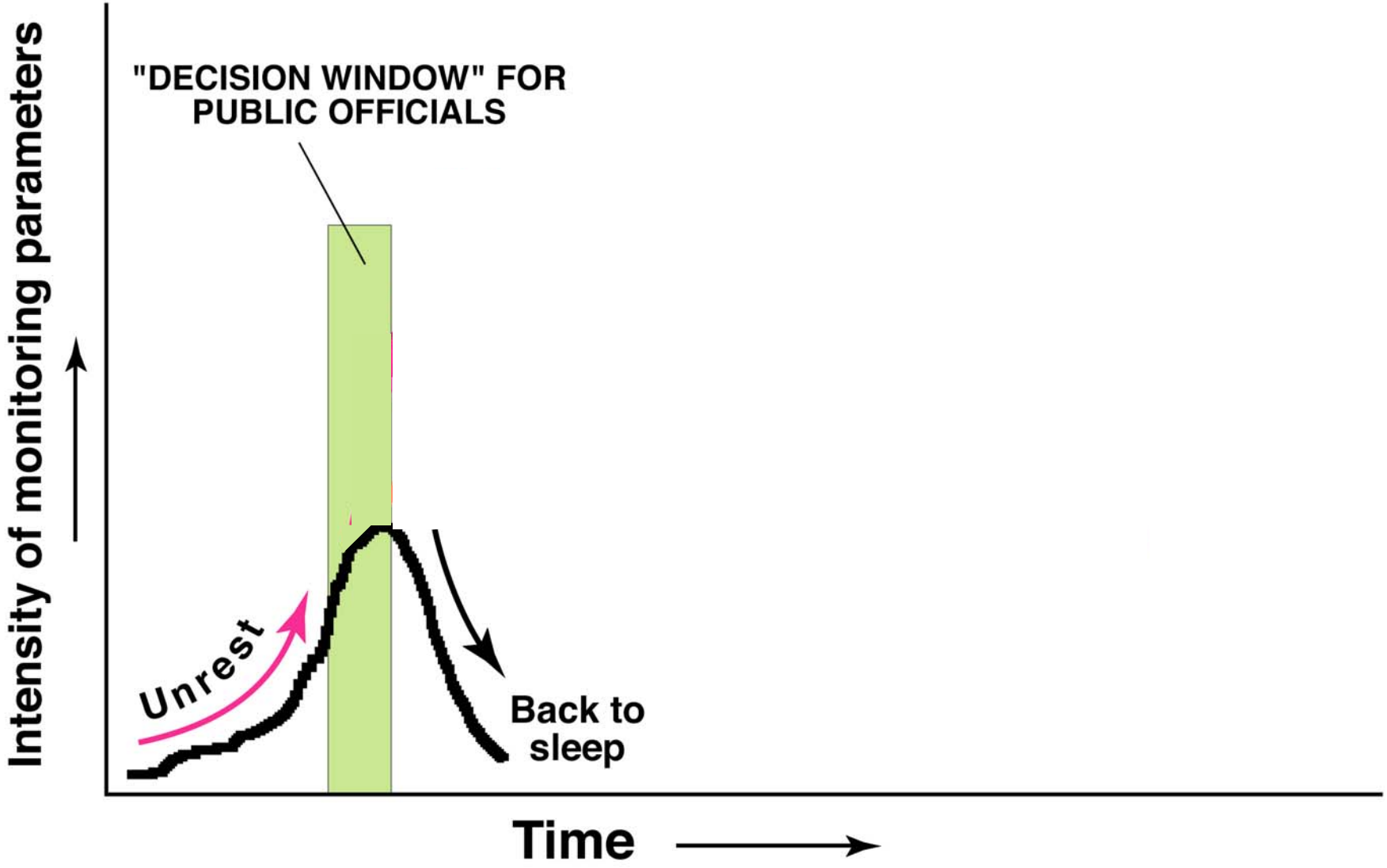
SCHEMATIC OF POSSIBLE SCENARIOS OF OUTCOMES OF ESCALATING VOLCANO UNREST



(After C. D. Miller, USGS)

USGS

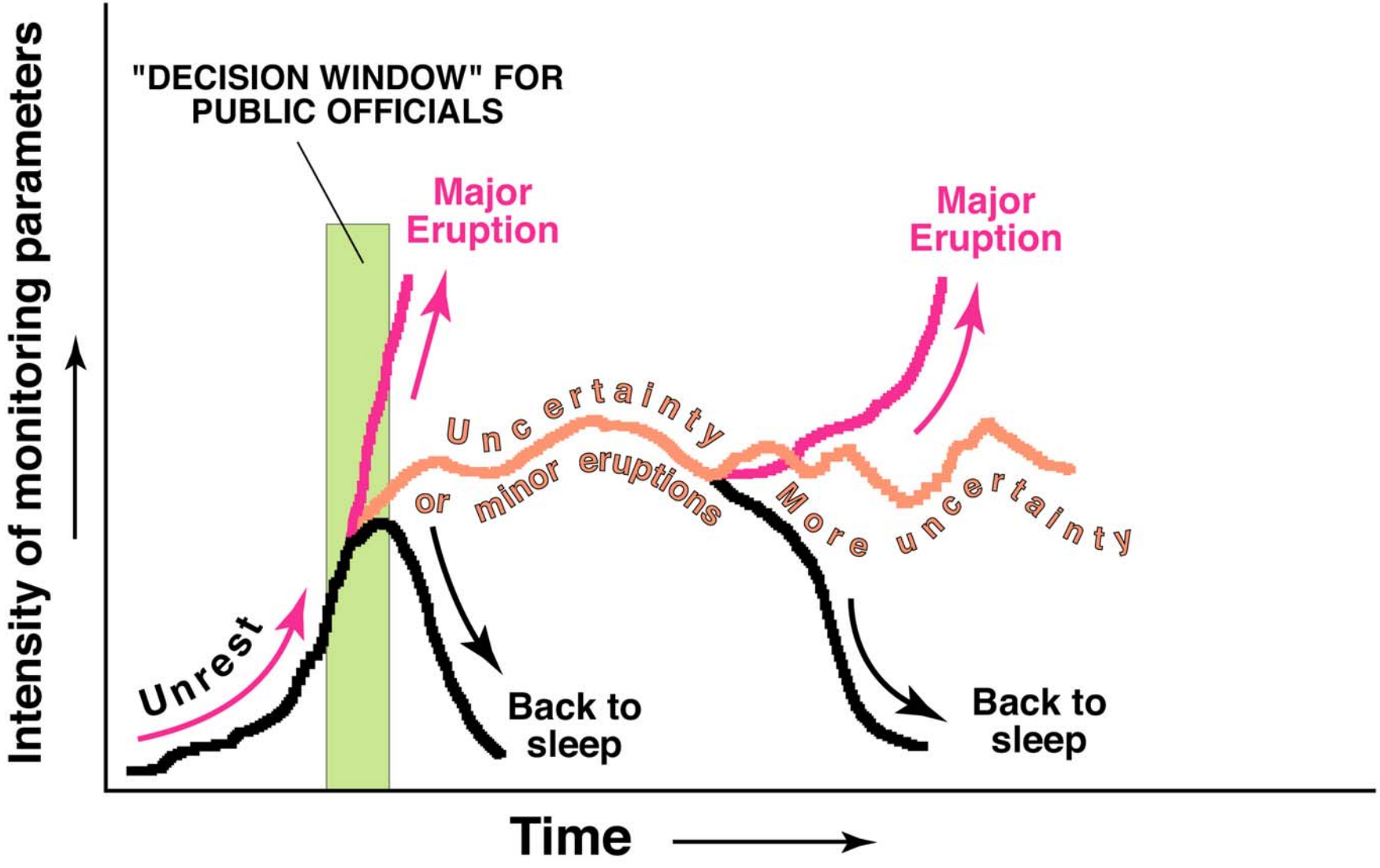
SCHEMATIC OF POSSIBLE SCENARIOS OF OUTCOMES OF ESCALATING VOLCANO UNREST



(After C. D. Miller, USGS)

USGS

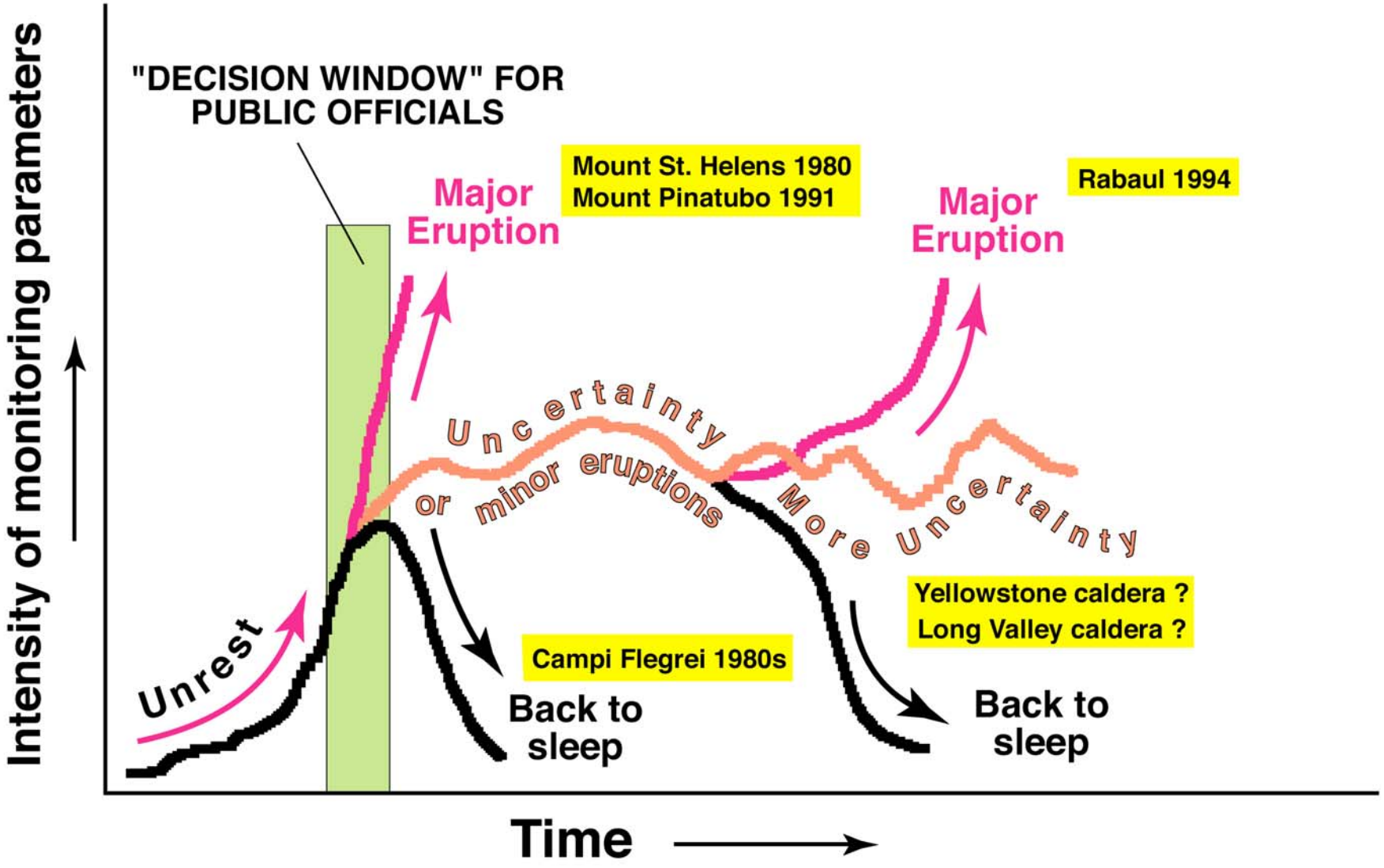
SCHEMATIC OF POSSIBLE SCENARIOS OF OUTCOMES OF ESCALATING VOLCANO UNREST



(After C. D. Miller, USGS)

USGS

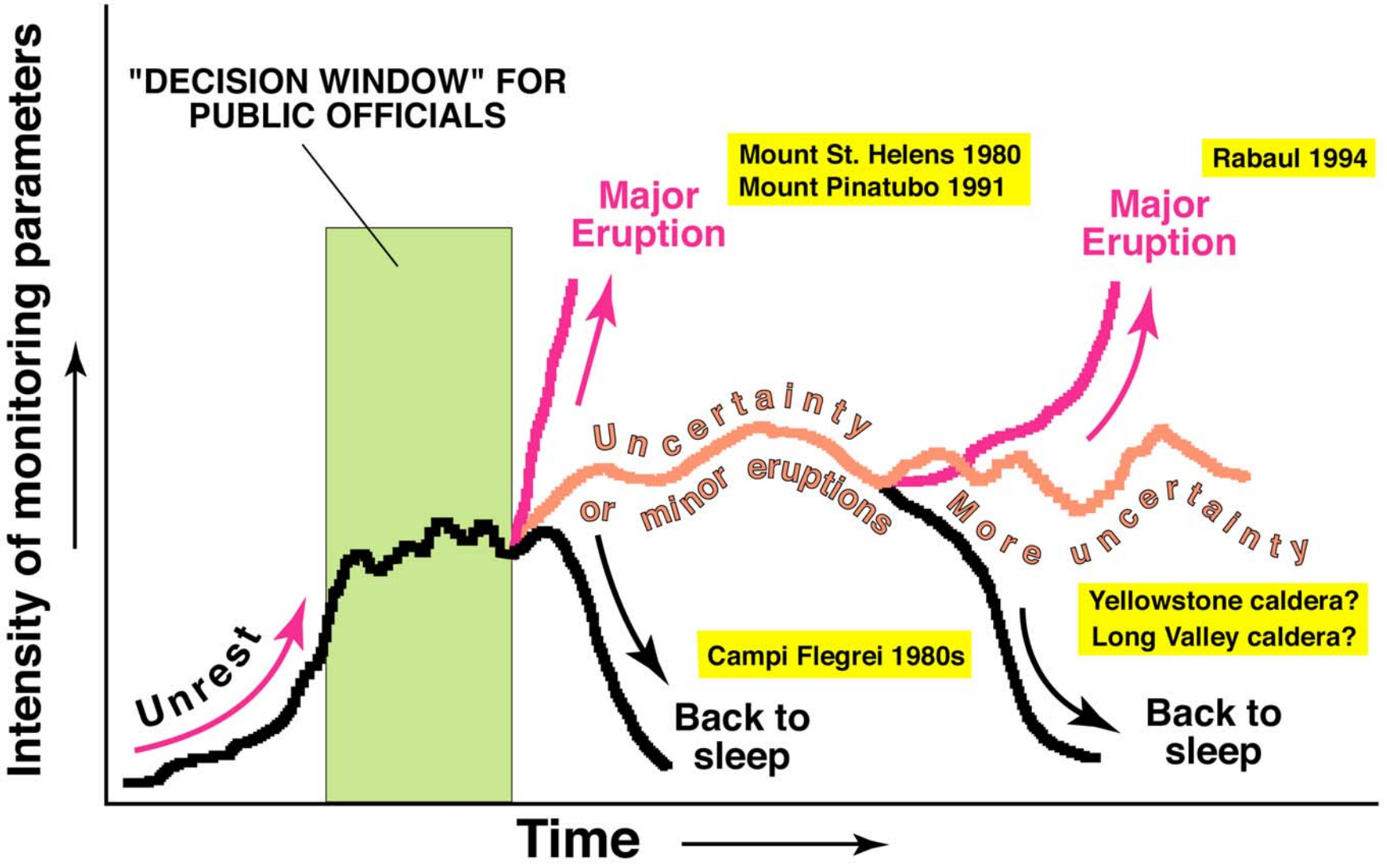
SOME EXAMPLES OF ACTUAL OUTCOMES OF HEIGHTENED VOLCANO UNREST OVER TIME



(After C. D. Miller, USGS)

USGS

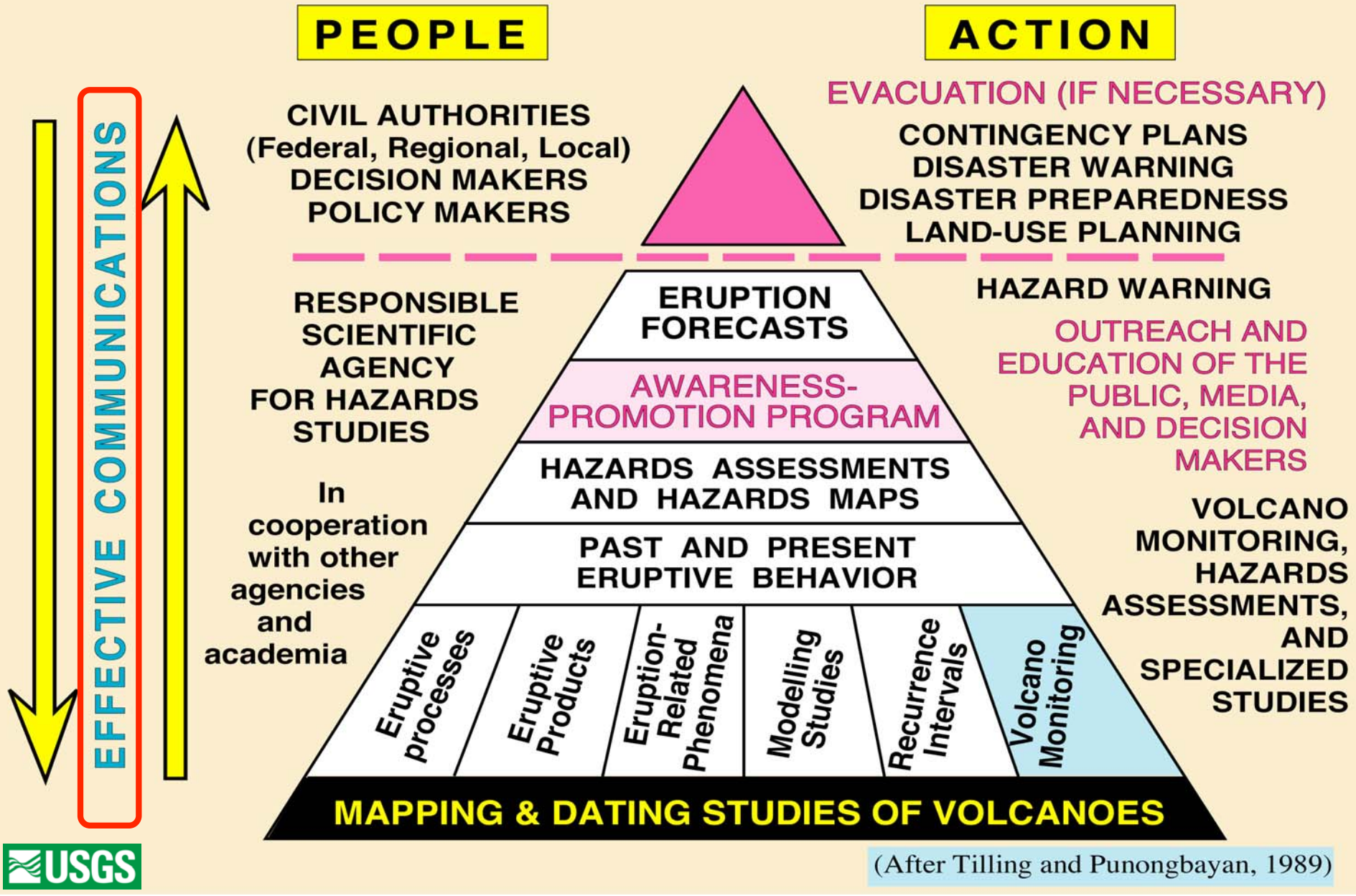
VOLCANO-MONITORING DATA ARE ESSENTIAL TO PROVIDE THE WIDEST POSSIBLE "DECISION WINDOW"



(After C. D. Miller, USGS)

USGS

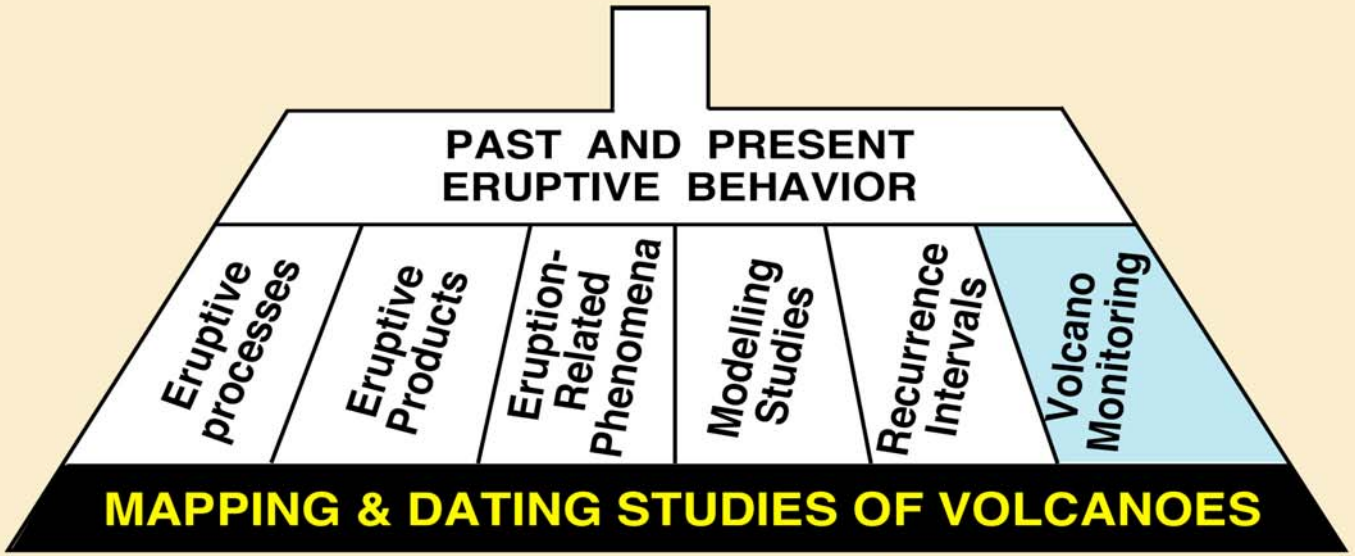
ELEMENTS OF AN EFFECTIVE PROGRAM TO REDUCE VOLCANO HAZARDS



VOLCANO-MONITORING DATA PROVIDE THE SCIENTIFIC BASIS FOR ERUPTION FORECASTS

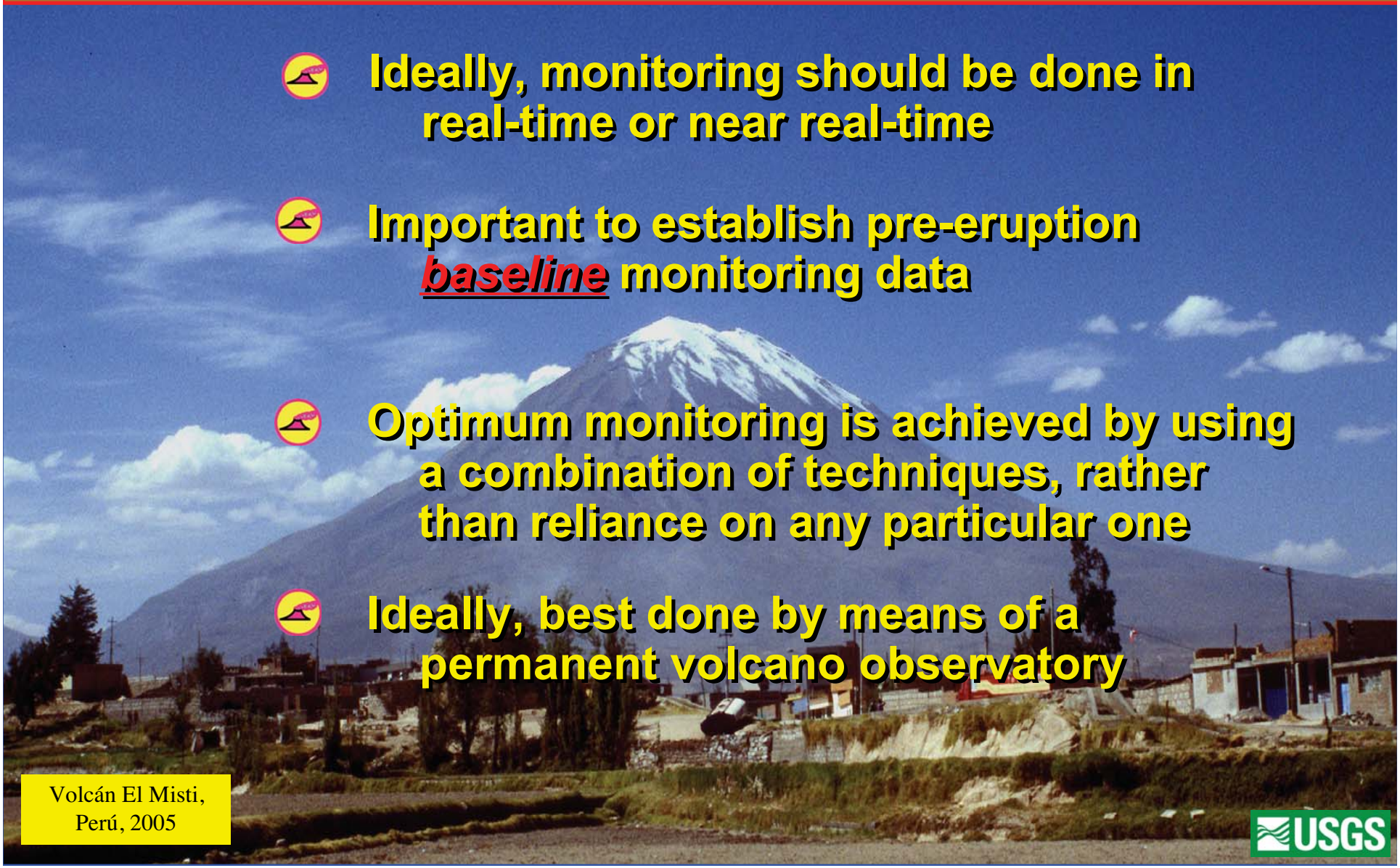
SHORT-TERM FORECASTS

POSSIBLE FUTURE BEHAVIOR



USGS

VOLCANO MONITORING: *The systematic collection, analysis, and interpretation of visual observations and instrumental measurements at volcanoes*



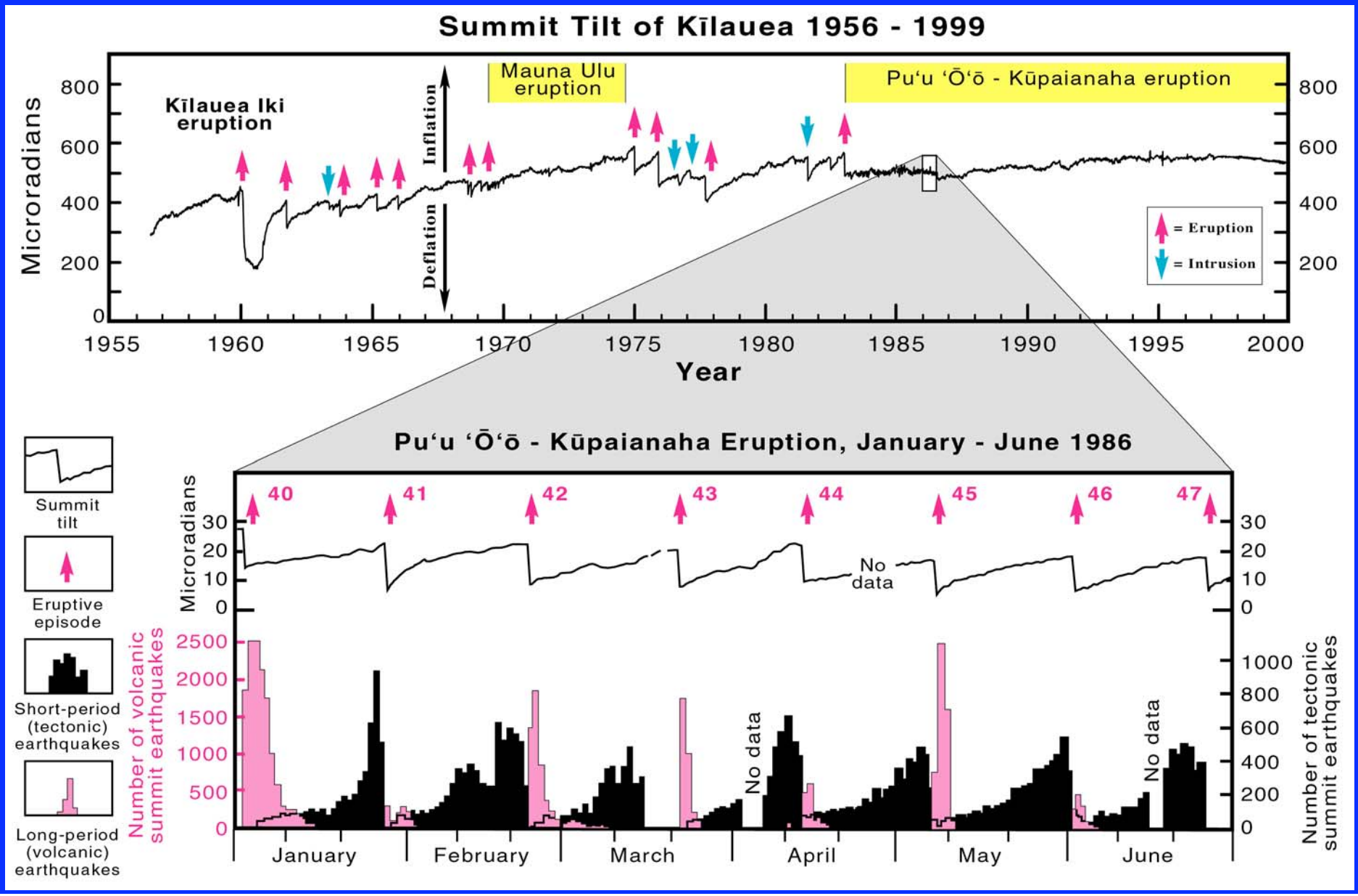
- **Ideally, monitoring should be done in real-time or near real-time**
- **Important to establish pre-eruption *baseline* monitoring data**
- **Optimum monitoring is achieved by using a combination of techniques, rather than reliance on any particular one**
- **Ideally, best done by means of a permanent volcano observatory**

Volcán El Misti, Perú, 2005

USGS

USGS HAWAIIAN VOLCANO OBSERVATORY, RIM OF KILAUEA CALDERA, HAWAII: VOLCANO MONITORING SINCE 1912

GOOD EXAMPLE OF LONG-TERM "BASELINE" MONITORING DATA, KILAUEA VOLCANO, HAWAII



SOME EXAMPLES OF RESPONSES TO VOLCANIC CRISES SINCE 1976

FAILURES

1976-1977 La Soufrière, Guadeloupe, Caribbean

1982 El Chichón, Mexico

1985 Nevado del Ruiz, Colombia

SUCCESSFUL

1980 Mount St. Helens, U.S.A.

1983-1985 Rabaul, Papua New Guinea

1991 Mount Pinatubo, Philippines

USGS

Volcán Parícutin, México.
1947-1952

EXAMPLES OF FAILURES IN RESPONDING TO RECENT VOLCANIC CRISES

- **EL CHICHÓN, MEXICO, MARCH-APRIL 1982: AN INEFFECTIVE RESPONSE LEADING TO A TRAGIC OUTCOME FROM THREE POWERFUL EXPLOSIVE ERUPTIONS IN ONE WEEK**

- **NEVADO DEL RUIZ, COLOMBIA, NOVEMBER 1985: A DISASTROUS OUTCOME DESPITE A HAZARDS MAP, VOLCANO MONITORING, AND SCIENTISTS' ADVICE AND WARNING**

USGS

Merapi Volcano, Java, Indonesia

GEOLOGIST FREDERICH MÜLLERREID "DISCOVERED" EL CHICHÓN VOLCANO, SOUTHERN MEXICO, IN 1928

HOW EL CHICHÓN VOLCANO PROBABLY LOOKED TO MÜLLERREID WHEN HE "DISCOVERED" IT

Photo by Rene Canul, March 1981

USGS

A NEW 1-KM-WIDE SUMMIT CRATER WAS FORMED DURING THE 1982 ERUPTION OF EL CHICHÓN

Photo by R. I. Tilling
2 June 1982

USGS

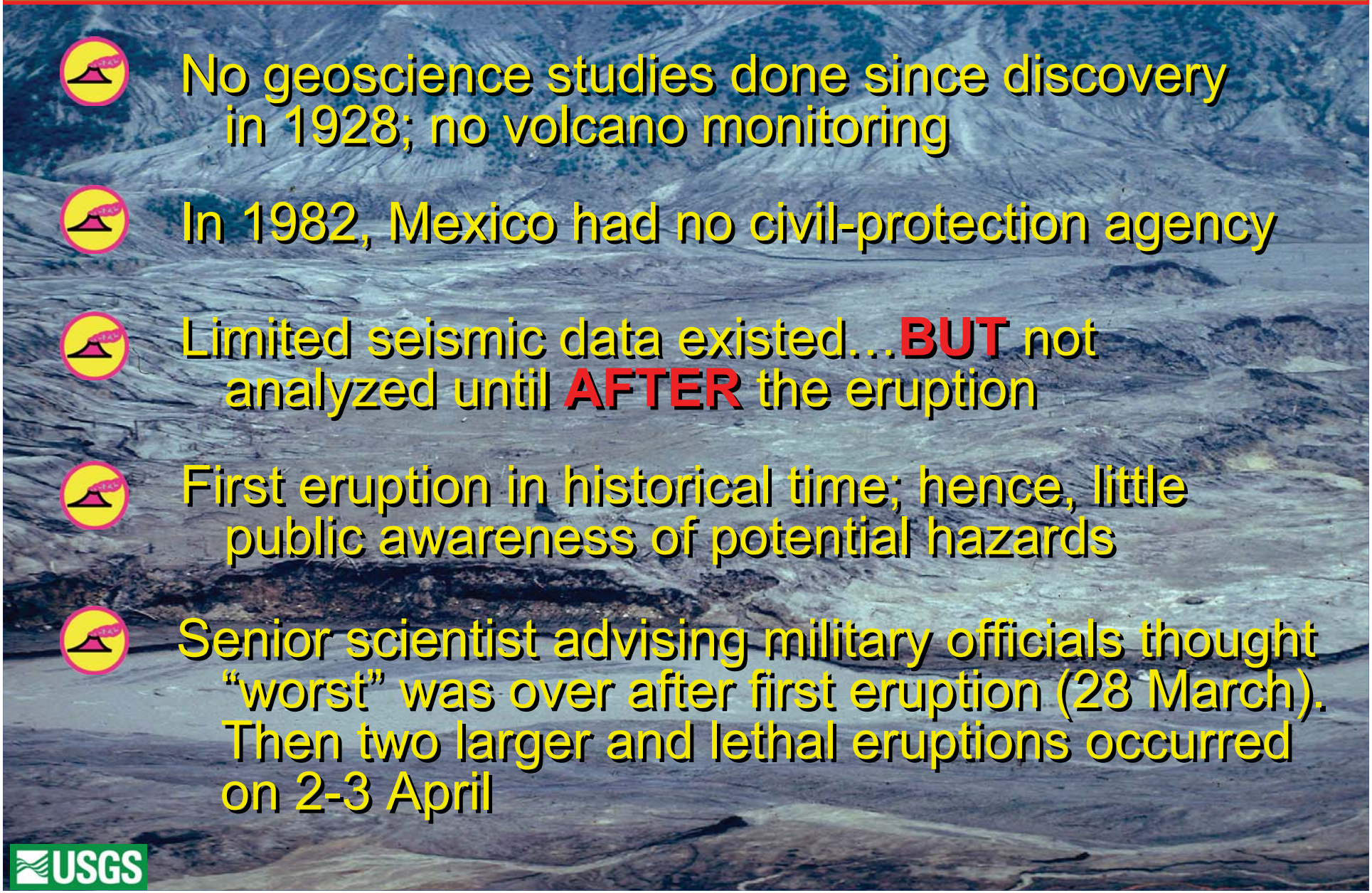
PRE-ERUPTION AERIAL VIEW OF FRANCISCO LEÓN VILLAGE, WITH ITS CHURCH AS THE MAIN STRUCTURE

POST-ERUPTION VIEW OF THE VILLAGE OF FRANCISCO LEÓN, OBLITERATED BY PYROCLASTIC SURGES DURING 2-3 APRIL ERUPTIONS OF EL CHICHÓN

USGS

Photo by R. I. Tiliing
2 June 1982

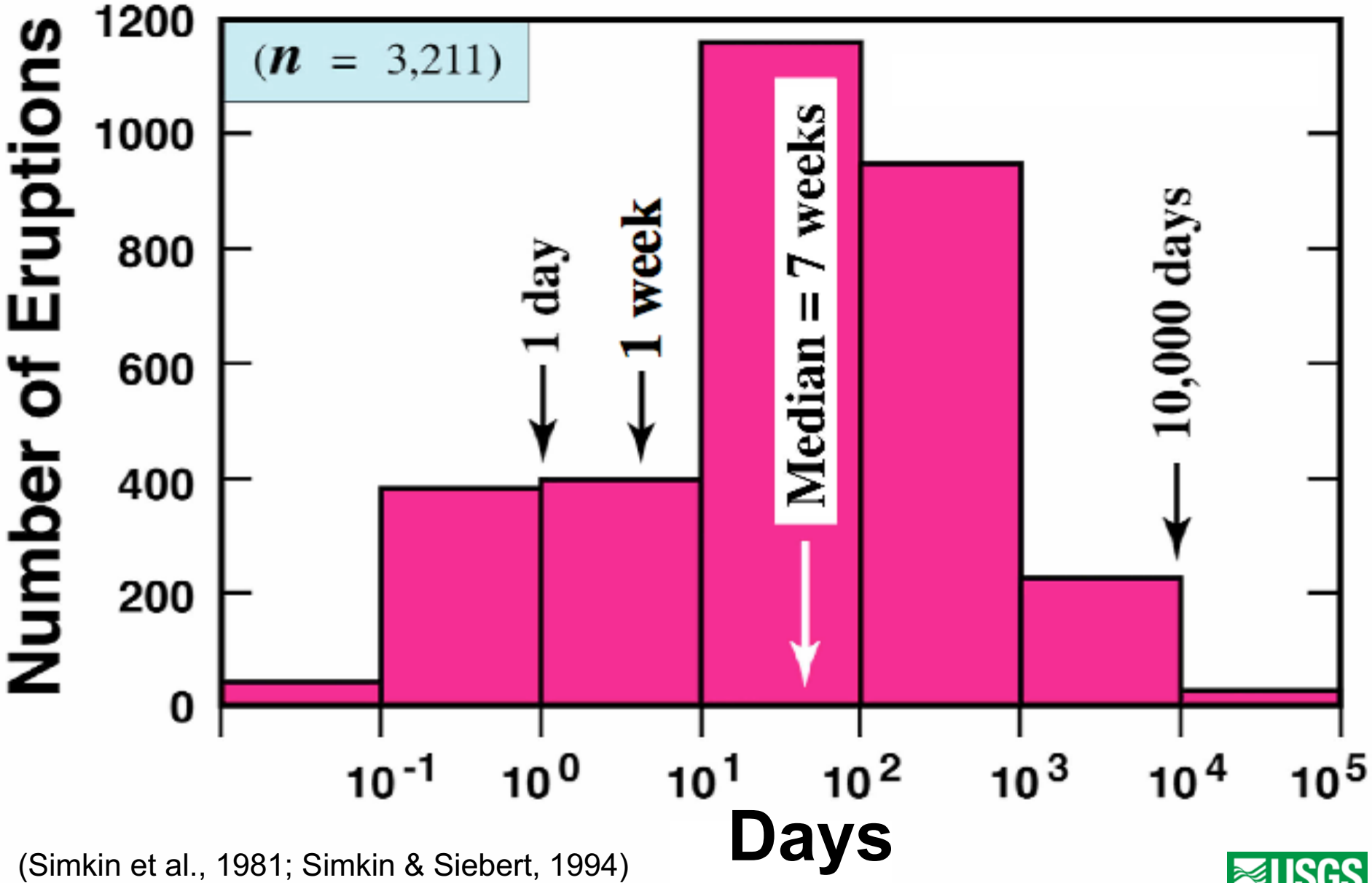
SOBERING OBSERVATIONS ON THE TRAGIC OUTCOME OF THE MARCH-APRIL 1982 EL CHICHÓN ERUPTION (VEI 5)



- No geoscience studies done since discovery in 1928; no volcano monitoring
- In 1982, Mexico had no civil-protection agency
- Limited seismic data existed…**BUT** not analyzed until **AFTER** the eruption
- First eruption in historical time; hence, little public awareness of potential hazards
- Senior scientist advising military officials thought "worst" was over after first eruption (28 March). Then two larger and lethal eruptions occurred on 2-3 April

USGS

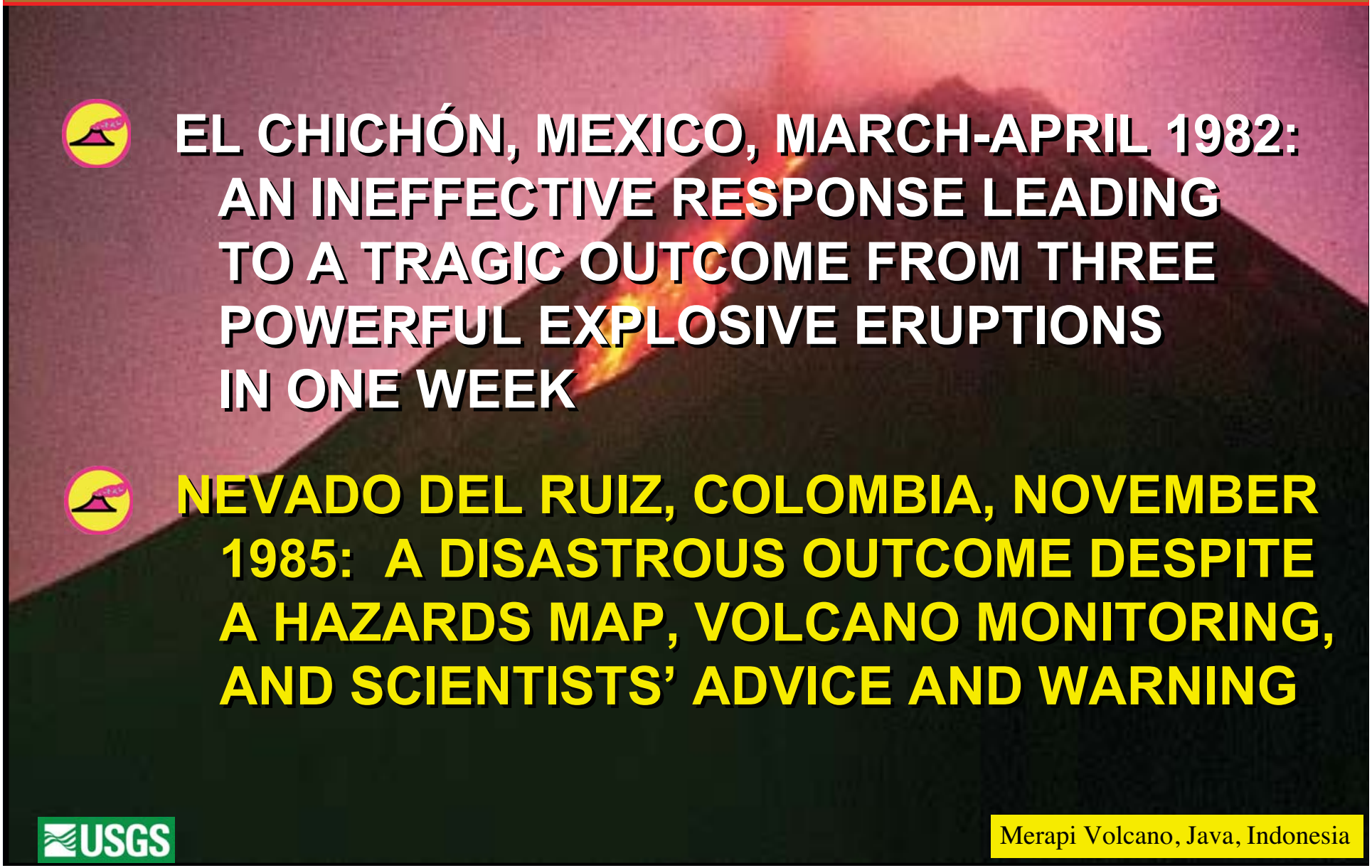
WORLDWIDE EXPERIENCE SHOWS THAT MOST ERUPTIONS LAST MUCH LONGER THAN ONE WEEK



(Simkin et al., 1981; Simkin & Siebert, 1994)

USGS

EXAMPLES OF FAILURES IN RESPONDING TO RECENT VOLCANIC CRISES



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USGS

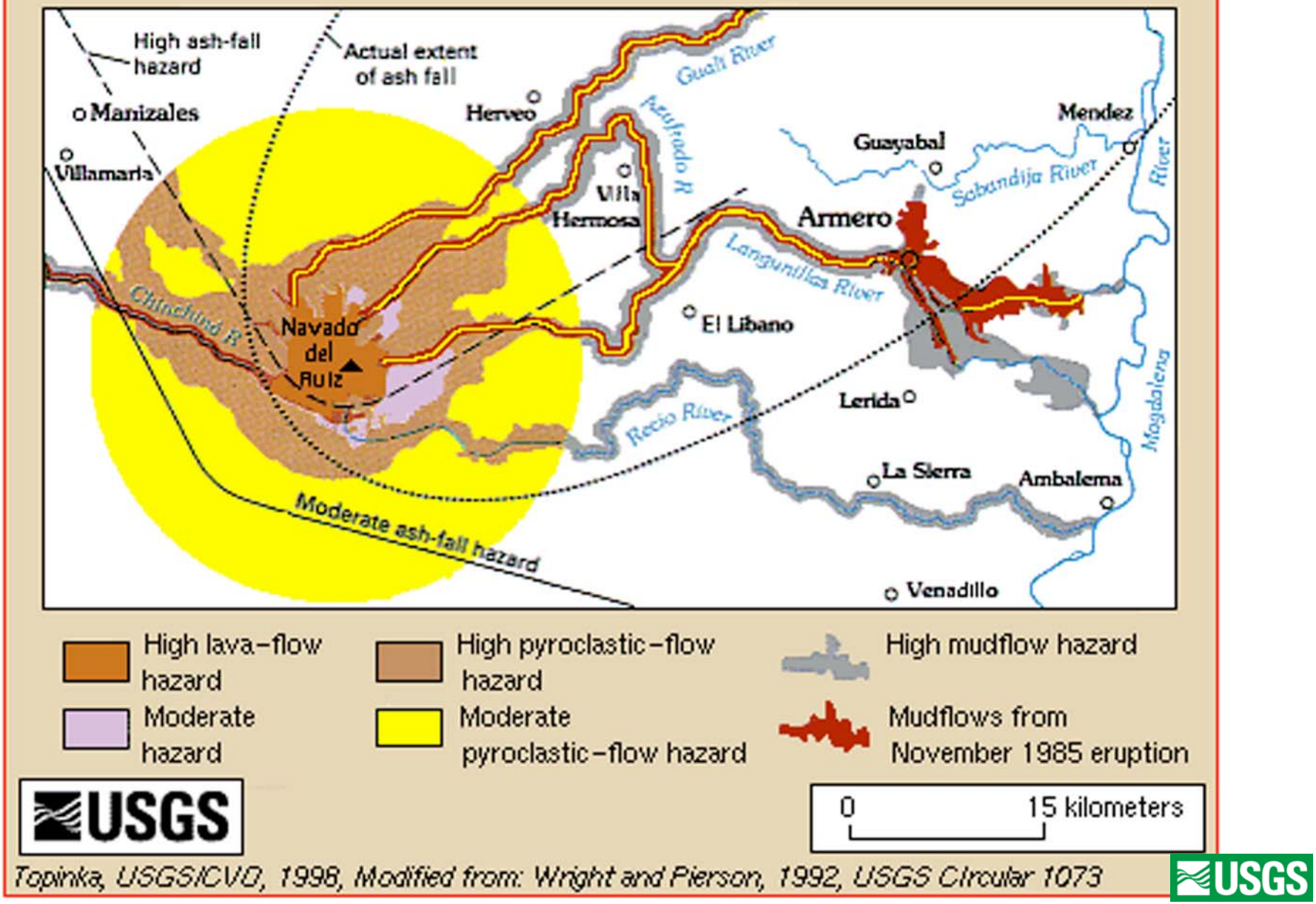
Merapi Volcano, Java, Indonesia

SUMMIT OF VOLCAN NEVADO DEL RUIZ, COLOMBIA, FEW DAYS AFTER 13 NOVEMBER 1985 ERUPTION

NEVADO DEL RUIZ VOLCANO, COLOMBIA, SHOWING SOME PATHS OF LAHARS GENERATED BY THE 1985 ERUPTION

Volcán Nevado del, Ruiz, Colombia 1985

HAZARDS-ZONATION MAP, NEVADO DEL RUIZ, COLOMBIA, PUBLISHED 7 OCTOBER 1985



Topinka, USGS/CVO, 1998, Modified from: Wright and Pierson, 1992, USGS Circular 1073

USGS

DEVASTATION OF ARMERO, COLOMBIA, BY LAHARS TRIGGERED BY A VERY SMALL ERUPTION OF NEVADO DEL RUIZ, 13 NOV. 1985, KILLING ~ 25,000

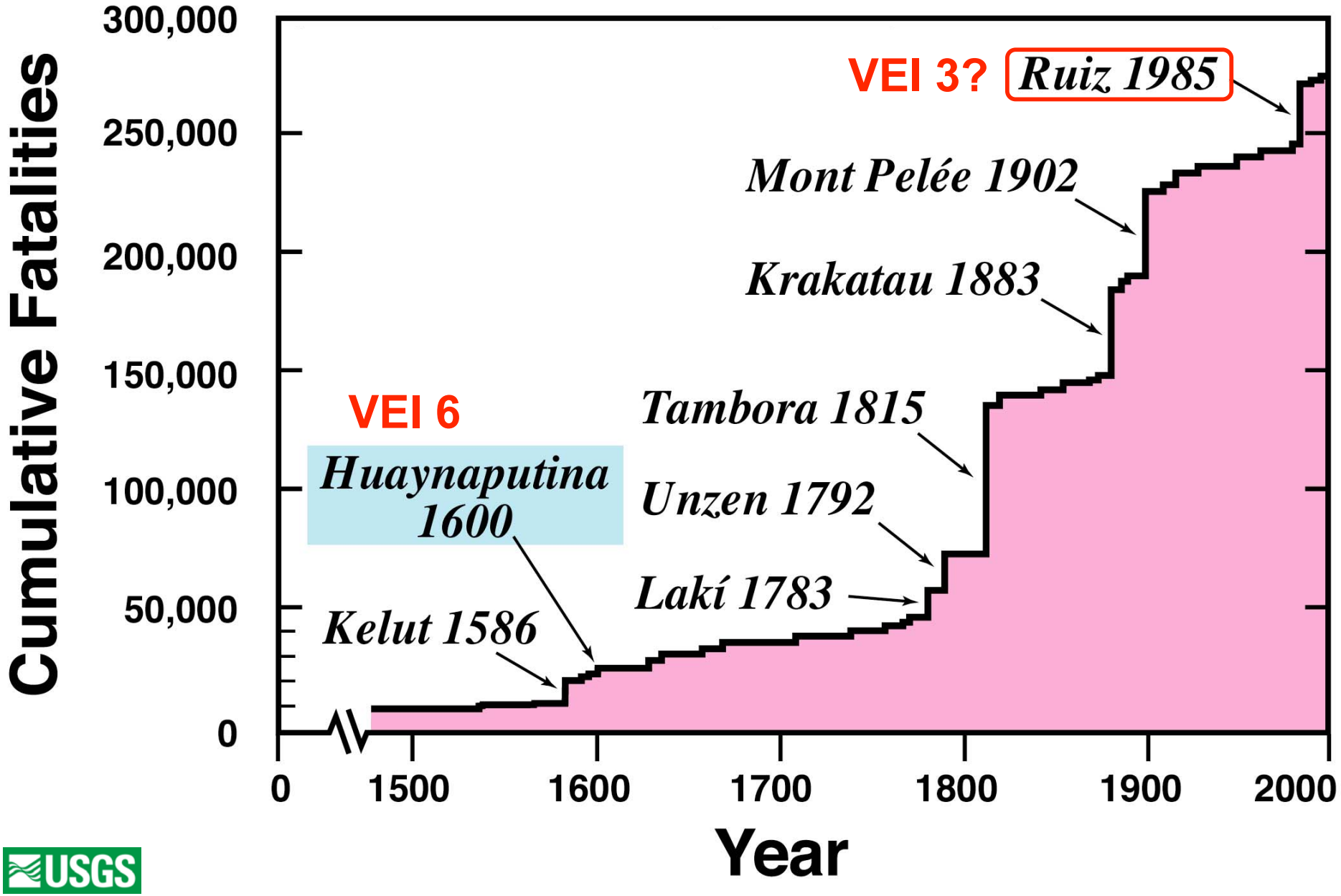
THE 1985 NEVADO DEL RUIZ DISASTER

- ~ 25,000 DEATHS FROM LAHARS (VOLCANIC MUDFLOWS)
- WORST VOLCANIC DISASTER IN SOUTH AMERICA
- WORST VOLCANIC DISASTER IN THE WORLD SINCE 1902 MONT PELEE ERUPTION (MARTINIQUE)
- INEFFECTIVE COMMUNICATIONS AMONG SCIENTISTS, CIVIL AUTHORITIES, AND POPULACE
- AUTHORITIES FAILED TO TAKE TIMELY ACTIONS

Volcán Nevado del, Ruiz, Colombia 1985

USGS

ERUPTION-RELATED FATALITIES: 1500 AD - 2000



VDAP OF THE USGS: RAPID-RESPONSE "MOBILE" VOLCANO OBSERVATORY. PROGRAM BEGAN IN 1986, SPURRED BY THE RUIZ TRAGEDY

- **VDAP**
  (Volcano Disaster Assistance Program)

- **JOINTLY FUNDED WITH OFDA/USAID**
  (Office of Foreign Disaster Assistance)

- **SOME EXAMPLES OF VDAP RESPONSES:**
  PINATUBO 1991, RABAUL 1994,
  POPOCATEPETL 1994-Present,
  TUNGURAHUA 1999-Present,
  CHAITEN, 2008-Present

USGS

EXAMPLES OF SUCCESSFUL RESPONSES TO RECENT VOLCANIC CRISES

- MOUNT ST. HELENS, USA, MARCH-MAY 1980: A GENERALLY SUCCESSFUL RESPONSE AND OUTCOME TO ITS REAWAKENING AFTER 123 YEARS OF DORMANCY

- MOUNT PINATUBO, PHILIPPINES, APRIL-JUNE 1991: A HIGHLY SUCCESSFUL RESPONSE TO THE LARGEST ERUPTION IN WORLD SINCE 1912. ACCURATE ERUPTION FORECAST AND EFFECTIVE COMMUNICATIONS.

USGS

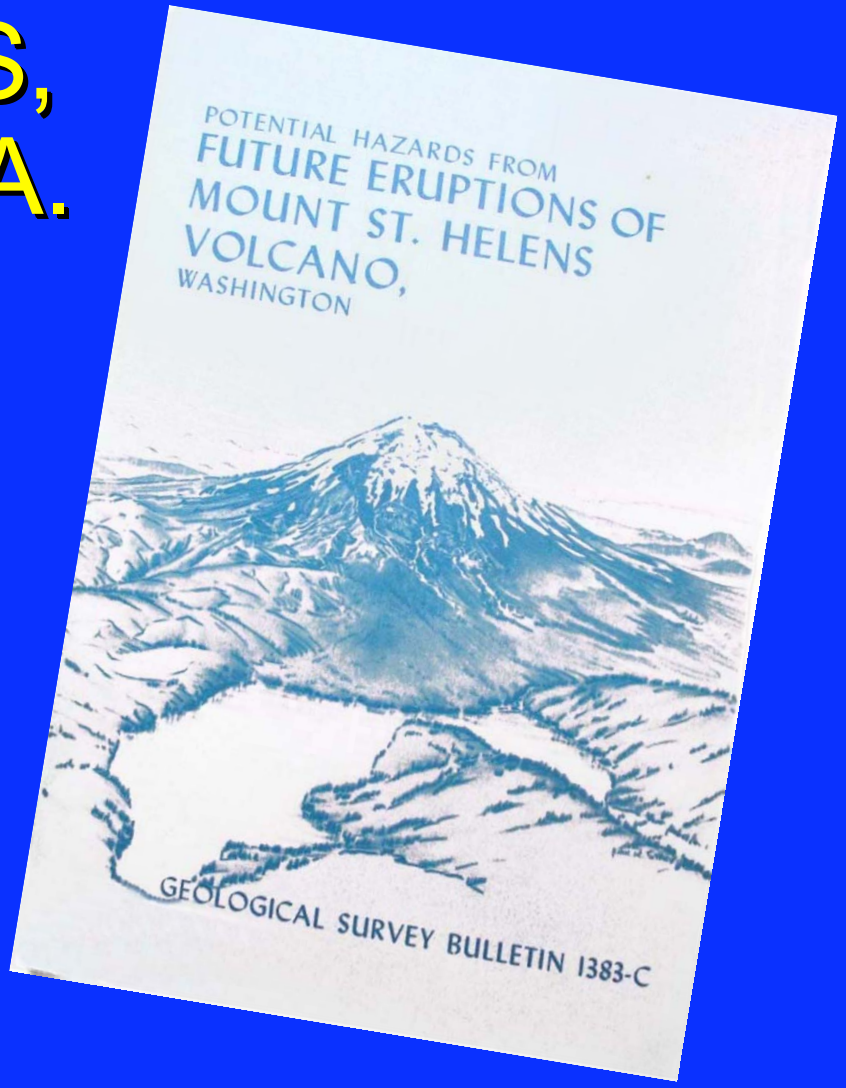
Merapi Volcano, Java, Indonesia

HAZARDS COMMUNICATIONS BEFORE THE VOLCANO'S REAWAKENING IN 1980

MOUNT ST. HELENS, WASHINGTON, U.S.A.

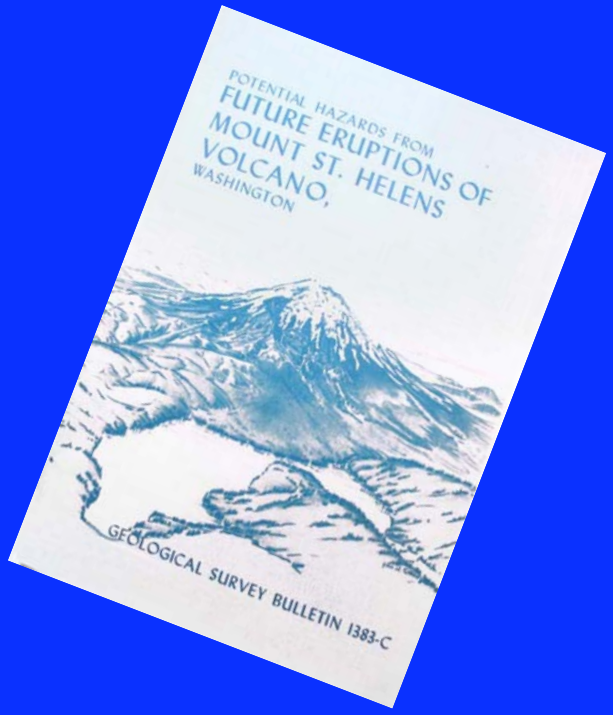
ASSESSMENT OF VOLCANO HAZARDS
(Crandell & Mullineaux, 1978)

Published by USGS
In 1978



USGS

A SUCCESSUL LONG-TERM FORECAST OF REACTIVATION AND ERUPTION



"The volcano's behavior pattern suggests that the current quite interval will not last as long as a thousand years; instead, an eruption is more likely to occur within the next hundred years, and perhaps even before the end of this century."

—D.R. Crandell and D.R. Mullineaux, 1978

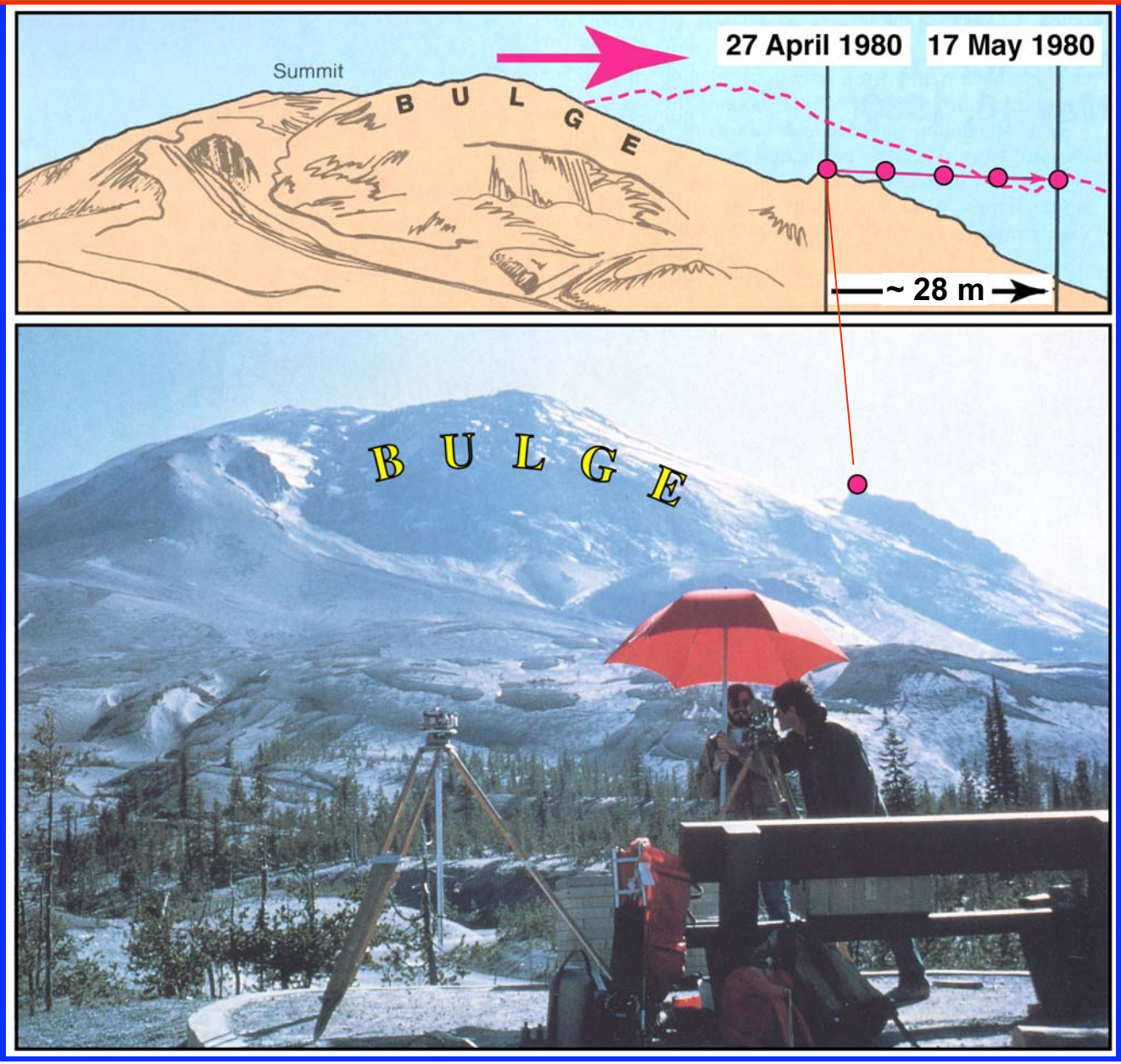
USGS

LESS THAN 2 YEARS LATER…PHREATIC ERUPTIONS BEGIN AT MOUNT ST. HELENS

First eruption
on 27 March 1980;
phreatic eruptions
and seismicity
continue through
17 May 1980

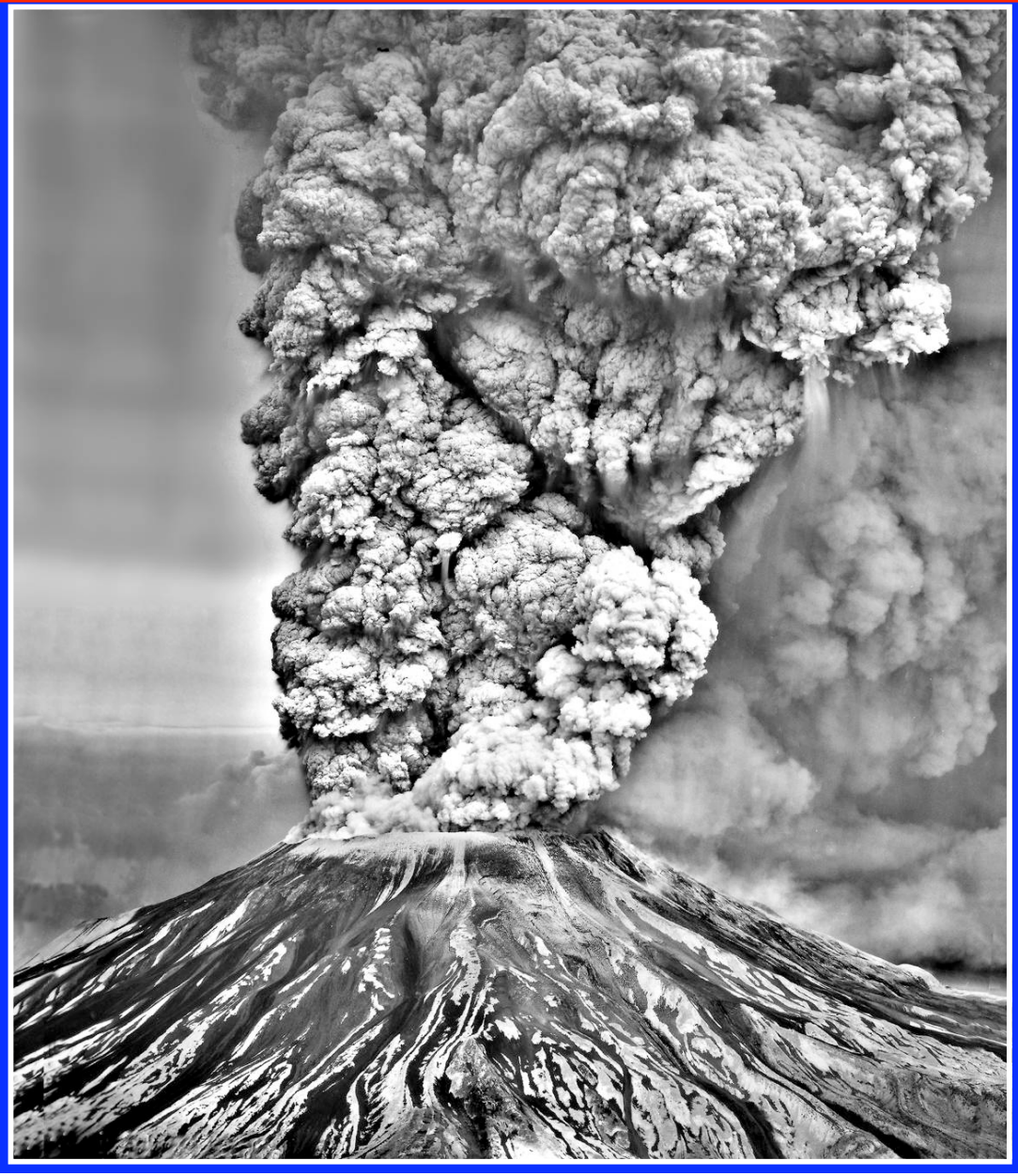
USGS

MONITORING THE FAST-MOVING MOVEMENT OF THE "BULGE" AT MOUNT ST. HELENS, 1980



USGS

THE PLINIAN PLUME OF THE ERUPTION OF 18 MAY 1980 AT MOUNT ST. HELENS

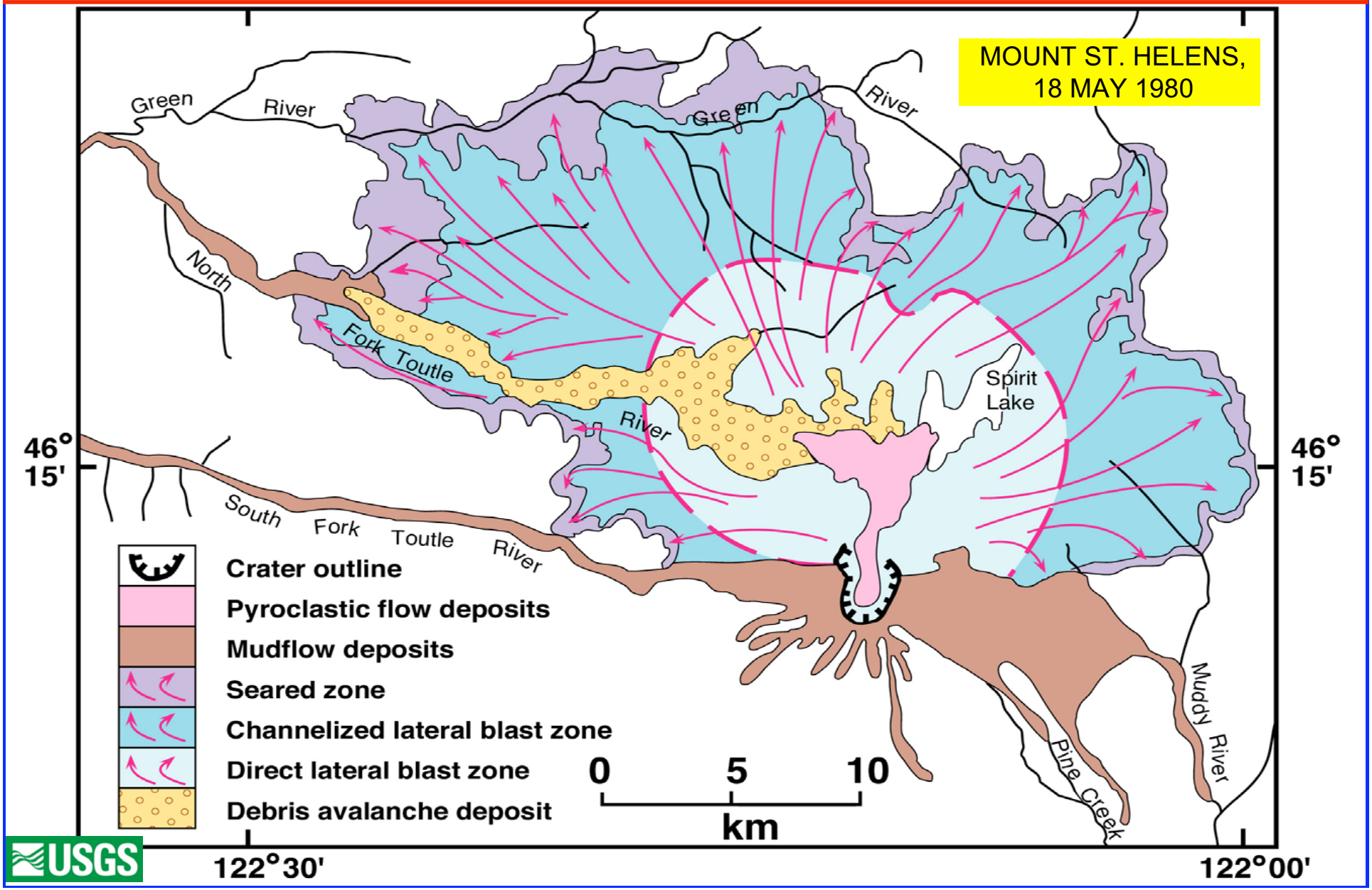


The eruption reached its climax on 18 May

USGS

ADVANCING ATMOSPHERIC ASH CLOUD OF 18 MAY ERUPTION, SEEN DOWNWIND > 200 km DISTANT, EASTERN WASHINGTON

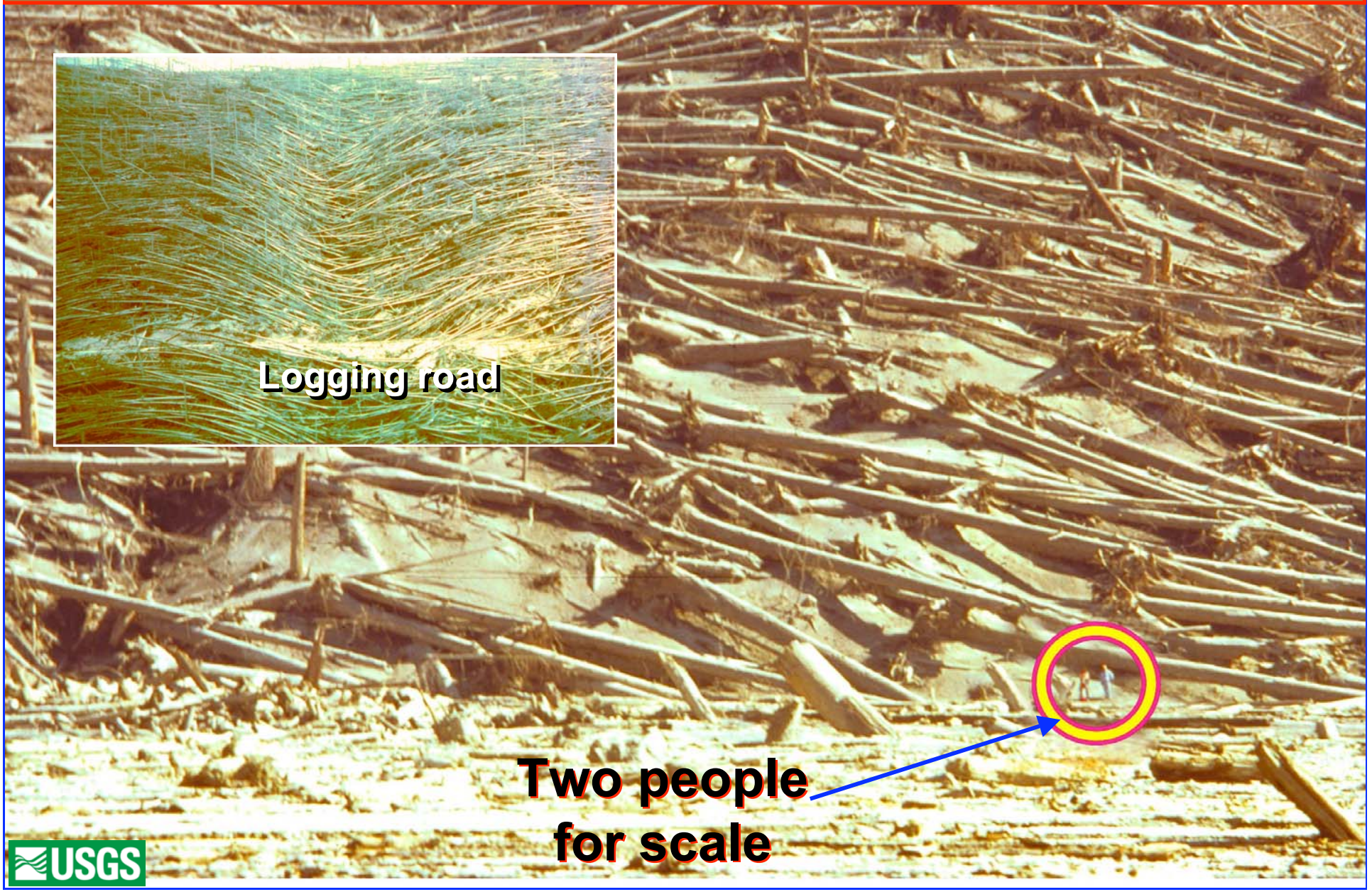
ERUPTIONS CAN PRODUCE MULTIPLE VOLCANO HAZARDS FROM A SINGLE EVENT, IN HOURS



MOUNT ST. HELENS: "BEFORE" 18 MAY 1980

MOUNT ST. HELENS: "AFTER" 18 MAY 1980

LATERAL "BLAST" OF THE 18 MAY ERUPTION FLATTENED LARGE DOUGLAS FIR TREES



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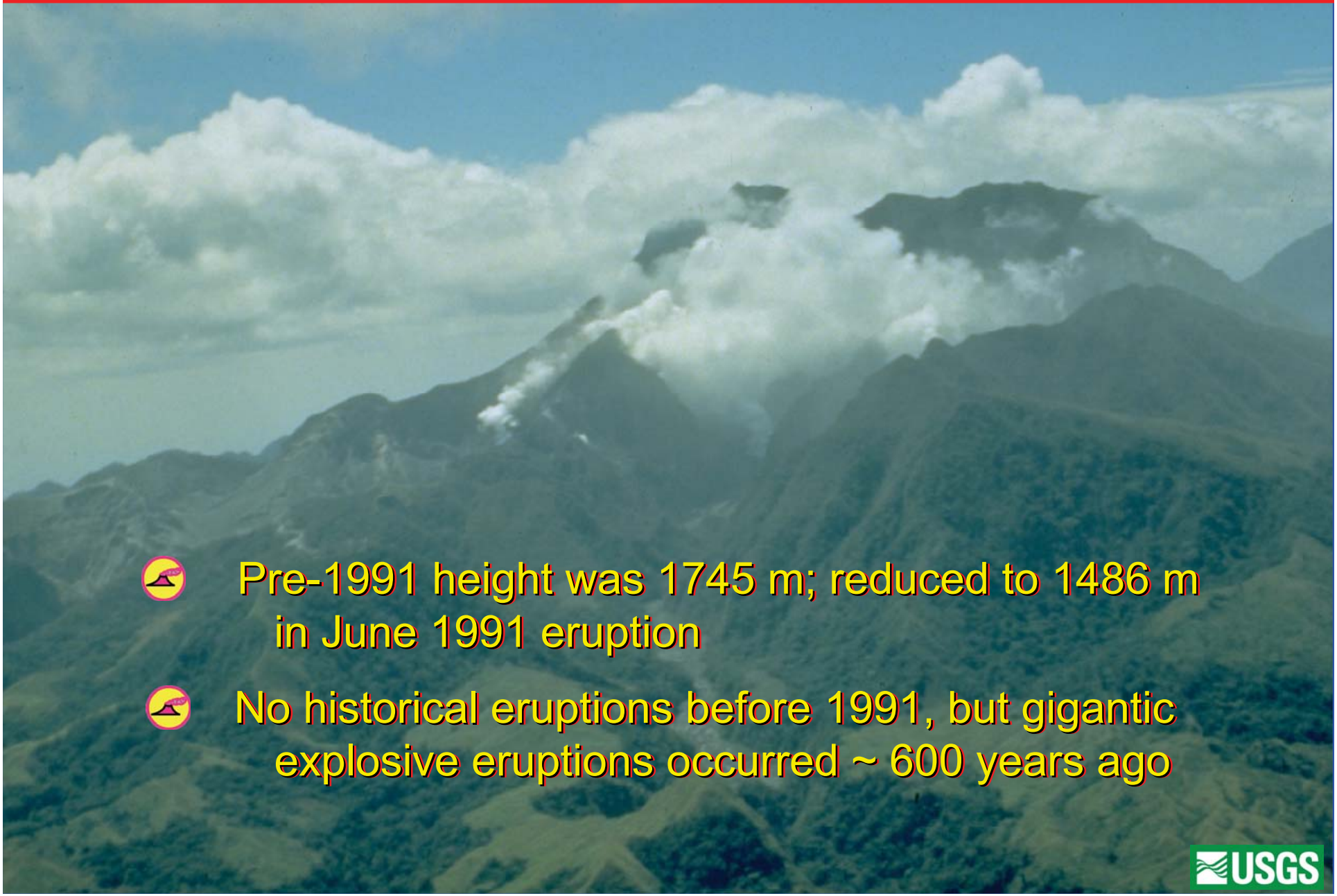
USGS

Merapi Volcano, Java, Indonesia

PRE-1991 VIEW OF MOUNT PINATUBO, PHILIPPINES

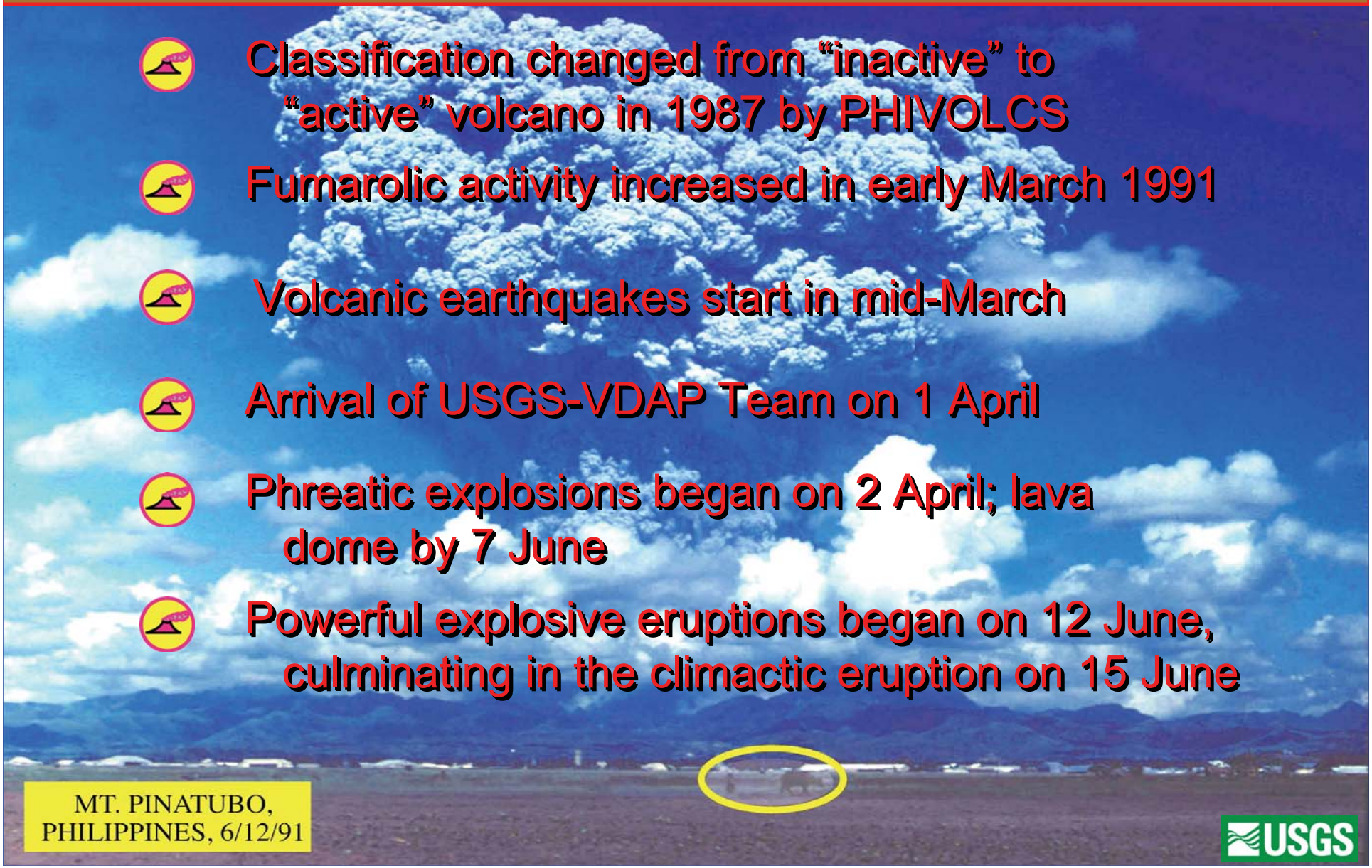


- Pre-1991 height was 1745 m; reduced to 1486 m in June 1991 eruption
- No historical eruptions before 1991, but gigantic explosive eruptions occurred ~ 600 years ago

USGS

CHRONOLOGY OF THE ERUPTION OF MOUNT PINATUBO, PHILIPPINES, 1991

- Classification changed from "inactive" to "active" volcano in 1987 by PHIVOLCS
- Fumarolic activity increased in early March 1991
- Volcanic earthquakes start in mid-March
- Arrival of USGS-VDAP Team on 1 April
- Phreatic explosions began on 2 April; lava dome by 7 June
- Powerful explosive eruptions began on 12 June, culminating in the climactic eruption on 15 June



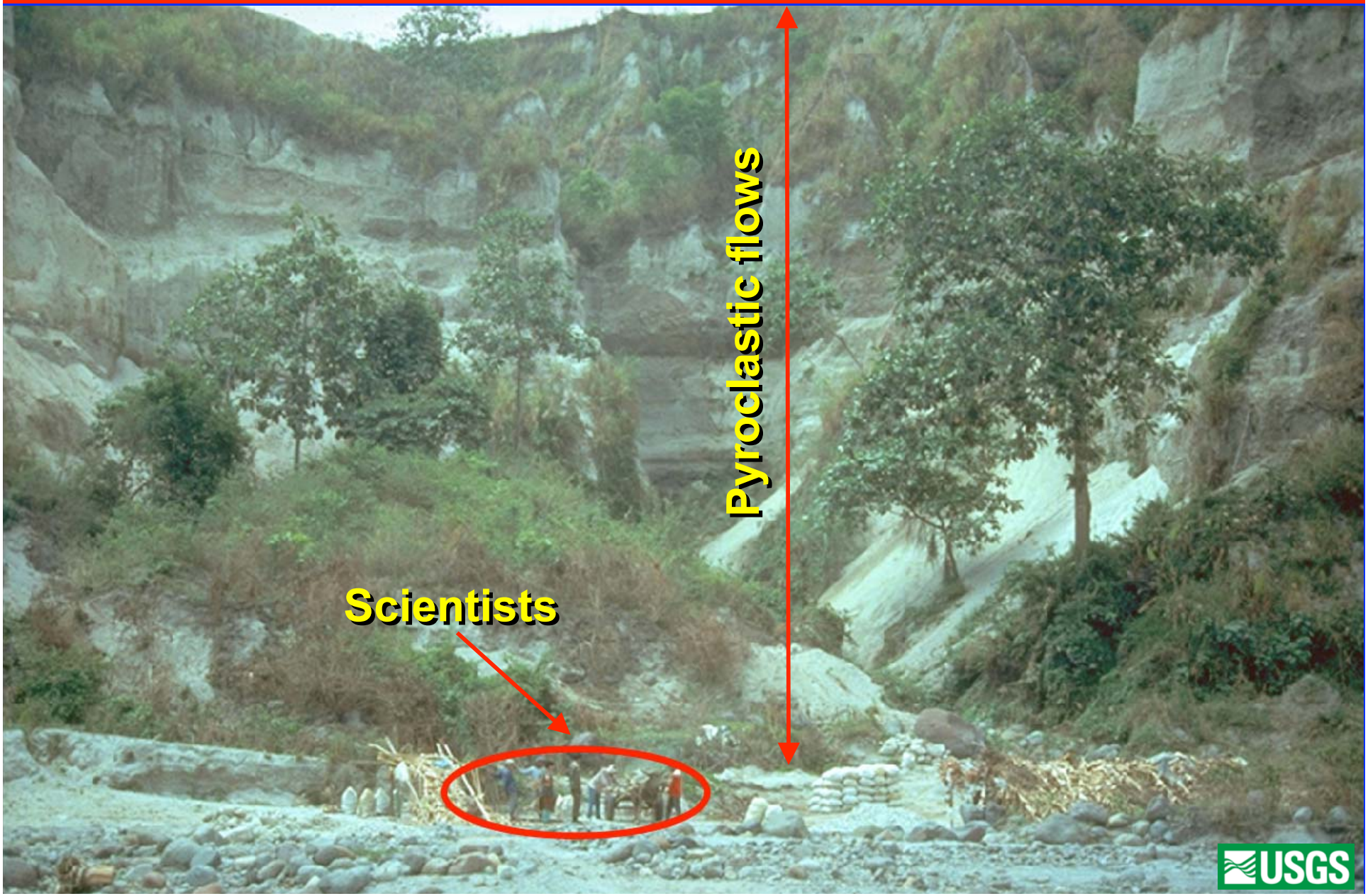
USGS

EARLY ACTIVITY OF MOUNT PINATUBO, PHILIPPINES, APRIL-MAY 1991

INITIAL ERUPTIVE ACTIVITY OF MOUNT PINATUBO, APRIL 1991

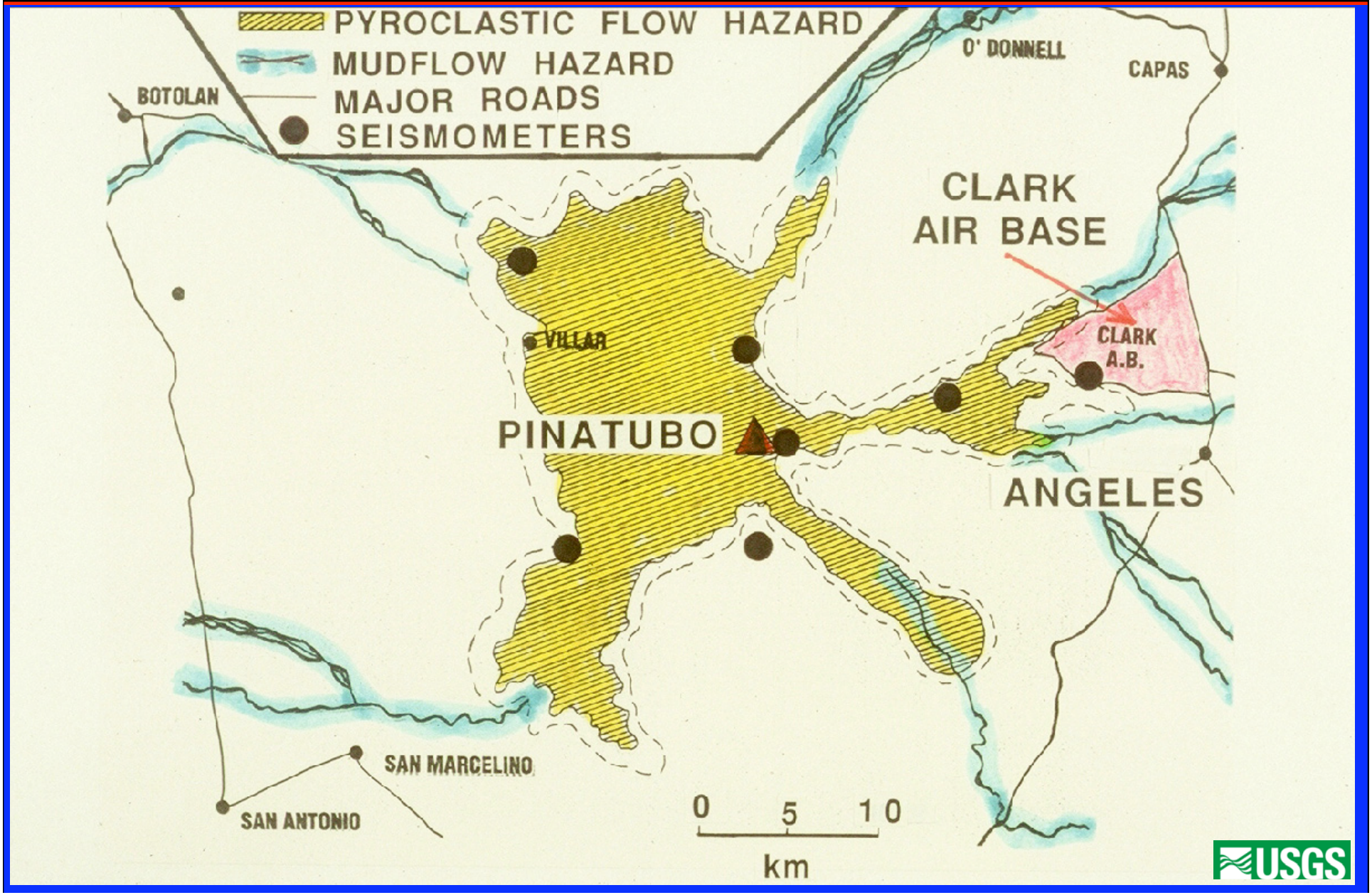
USGS

FIELDWORK INDICATES THAT PINATUBO HAS PRODUCED GIGANTIC EXPLOSIVE ERUPTIONS IN GEOLOGIC PAST



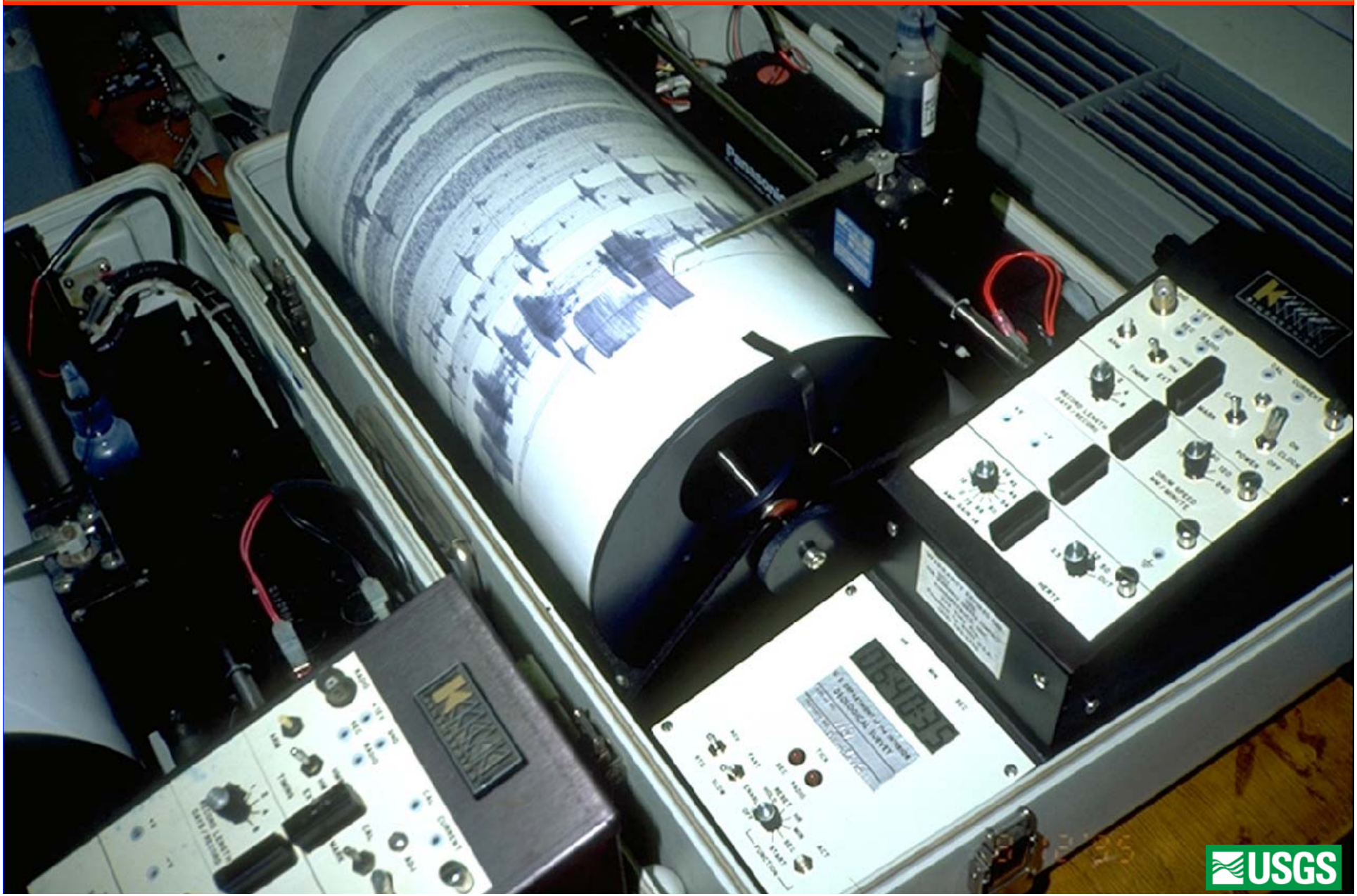
USGS AND PHIVOLCS SCIENTISTS DISCUSSING FIELD OBSERVATIONS AT MOUNT PINATUBO

VOLCANO HAZARDS MAP QUICKLY MADE BY PHIVOLCS AND USGS SCIENTISTS FOR MOUNT PINATUBO IN 1991

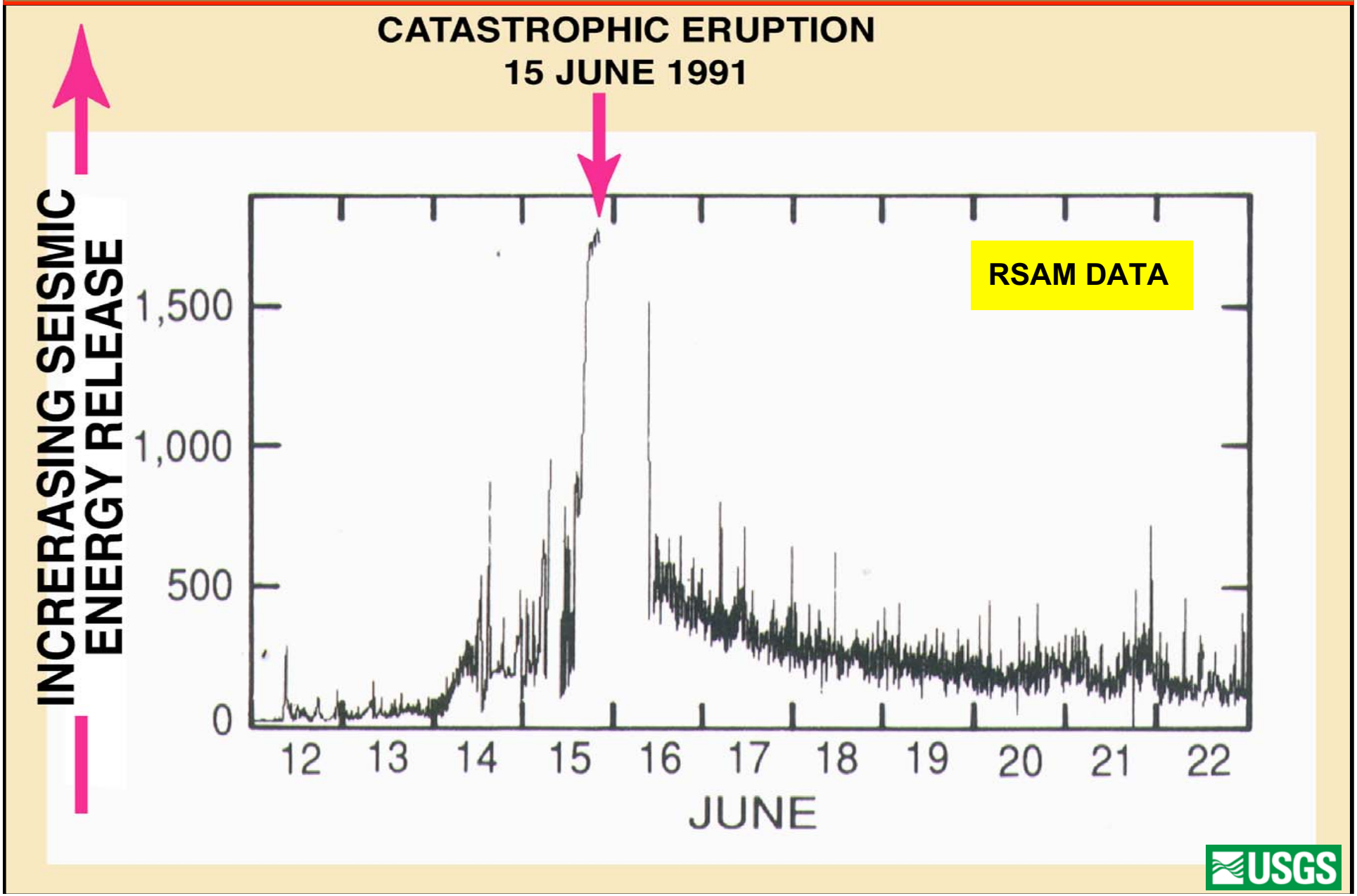


PHIVOLCS AND USGS SCIENTISTS INSTALLING VOLCANO-MONITORING EQUIPMENT AT PINATUBO

MONITORING EARTHQUAKE ACTIVITY AT PINATUBO, 1991



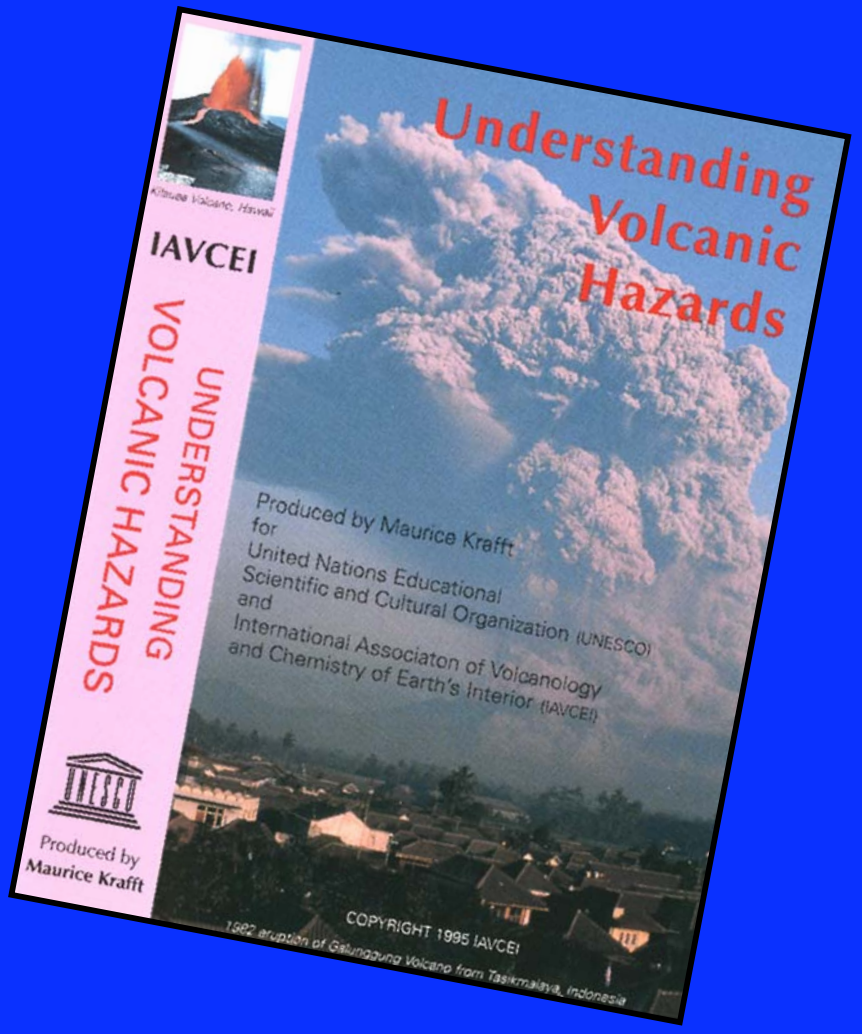
SEISMIC MONITORING AT MOUNT PINATUBO, JUNE 1991



BUILDING UP TO CLIMACTIC ERUPTION, MOUNT PINATUBO, 12 JUNE 1991

IAVCEI VIDEO "UNDERSTANDING VOLCANIC HAZARDS" WAS USED EFFECTIVELY BY PHIVOLCS AND USGS SCIENTISTS TO EDUCATE OFFICIALS AND PEOPLE AT RISK OF THE HAZARDS POSED BY MOUNT PINATUBO

AN EXAMPLE OF VERY EFFECTIVE COMMUNICATIONS !



USGS

AIRFALL OF CLIMACTIC 15 JUNE ERUPTION, FALLING SAME TIME AS "TYPHOON YUNYA" STRIKES CLARK AIR BASE

USGS

LIFE AT CLARK AIR BASE JUST A FEW DAYS BEFORE PINATUBO'S CLIMACTIC ERUPTION ON 15 JUNE 1991

COLLAPSED WAREHOUSES FROM WEIGHT OF ASHFALL FROM PINATUBO, CLARK AIR BASE, PHILIPPINES

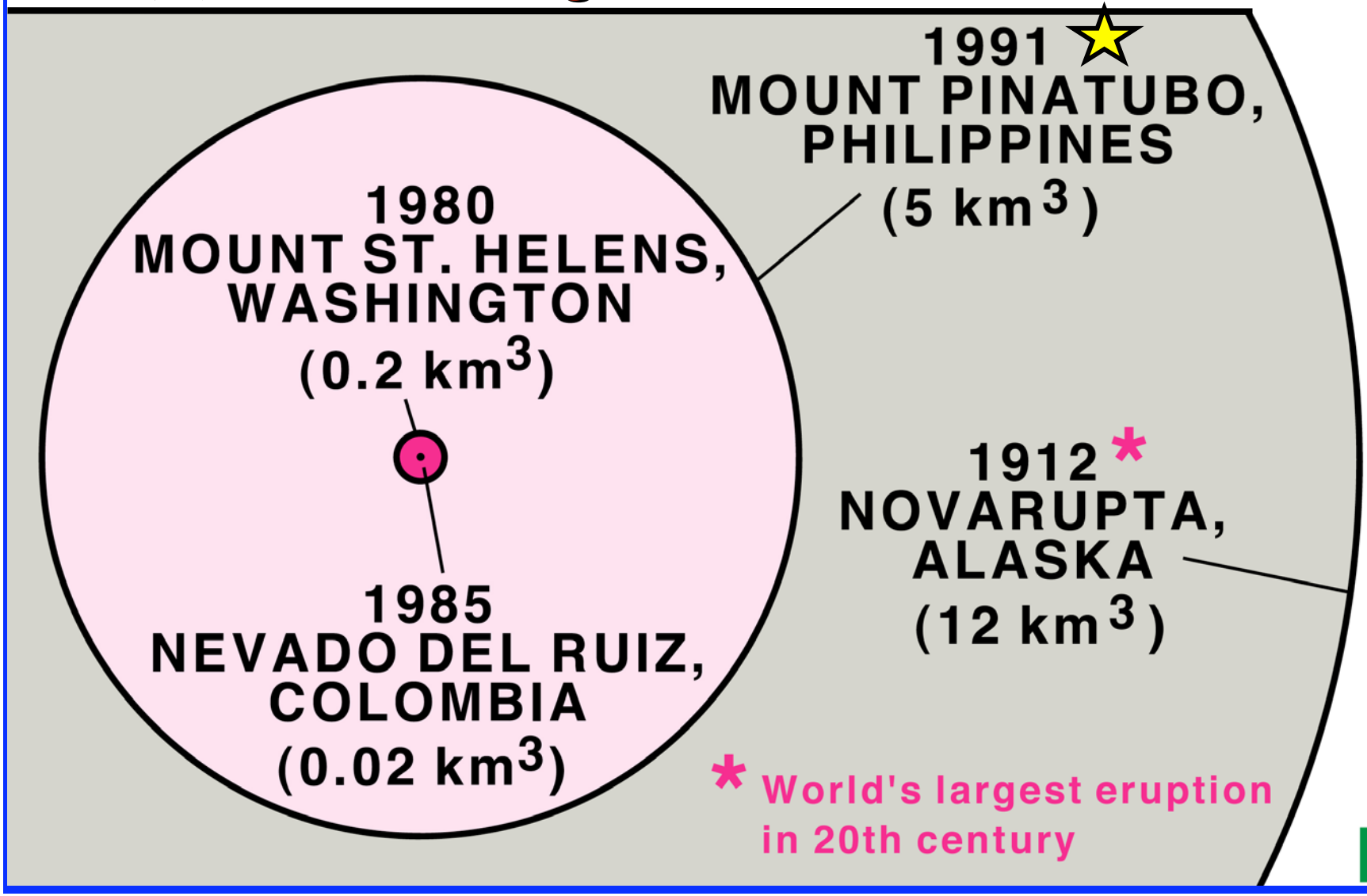
BRIDGE DETROYED BY LAHARS DURING THE ERUPTION OF MOUNT PINATUBO VOLCNO IN 1991

THE BAMBAN RIVER VALLEY "BEFORE" BURIAL BY SECONDARY (POST-ERUPTION) LAHARS, PINATUBO

THE BAMBAN RIVER VALLEY "AFTER" BURIAL BY SECONDARY (POST-ERUPTION) LAHARS, PINATUBO

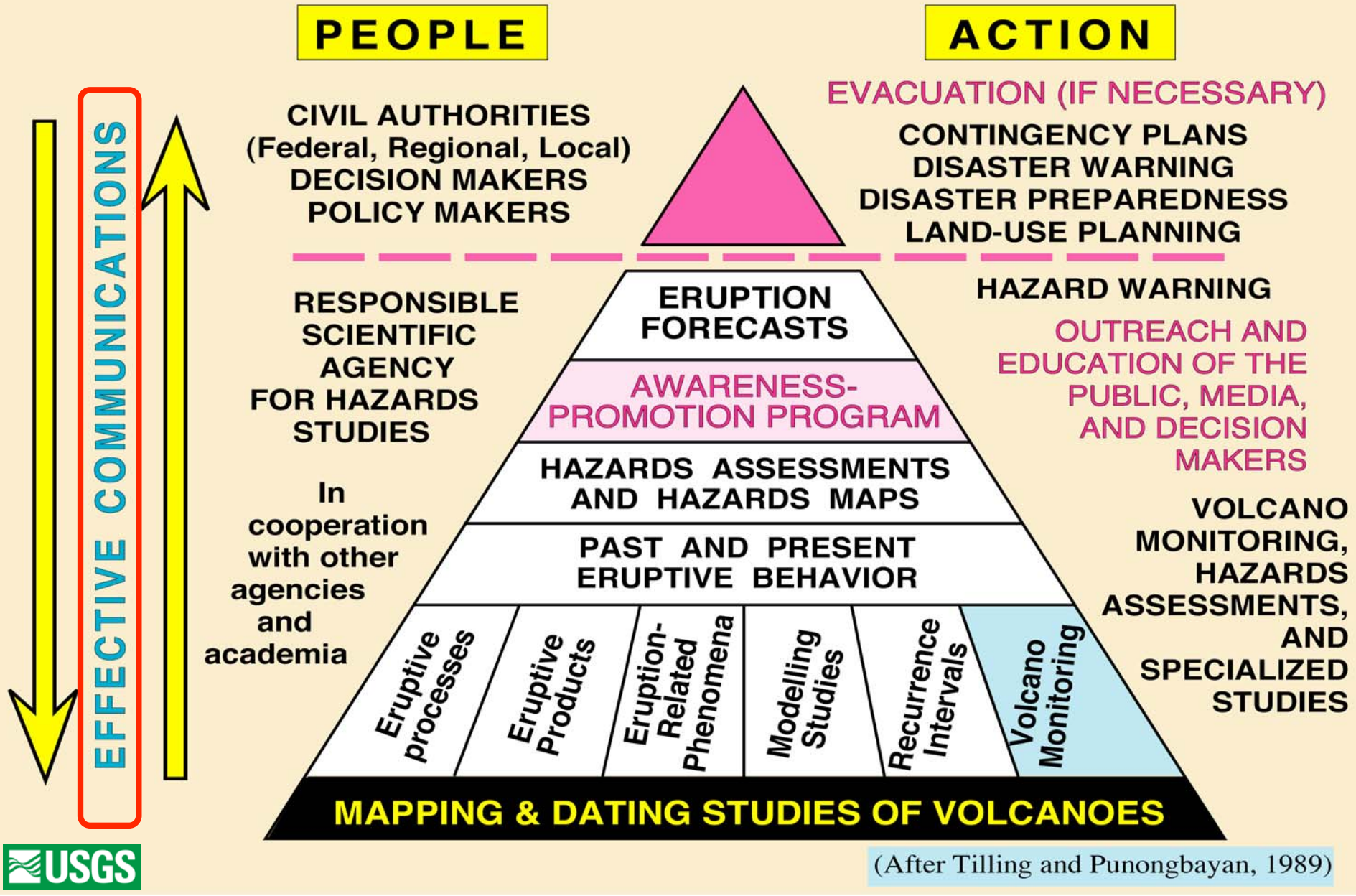
COMPARISON OF ERUPTIVE VOLUMES FOR SOME HISTORICAL ERUPTIONS

☆ World's largest since 1912



USGS

ELEMENTS OF AN EFFECTIVE PROGRAM TO REDUCE VOLCANO HAZARDS



1985 RUIZ TRAGEDY: VOLCANO MONITORING & WARNINGS BY SCIENTISTS *ALONE* CANNOT GUARANTEE SUCCESSFUL RISK REDUCTION