

Growth of International Collaboration in Monitoring Volcanic Ash Eruptions in the North Pacific

John C. Eichelberger and Christina Neal
U.S. Geological Survey

The northern Pacific “Ring of Fire” is a dangerous place



Kodiak, Alaska, 1964



Sarychev, Kurils, 2009



Tohoku, 2011

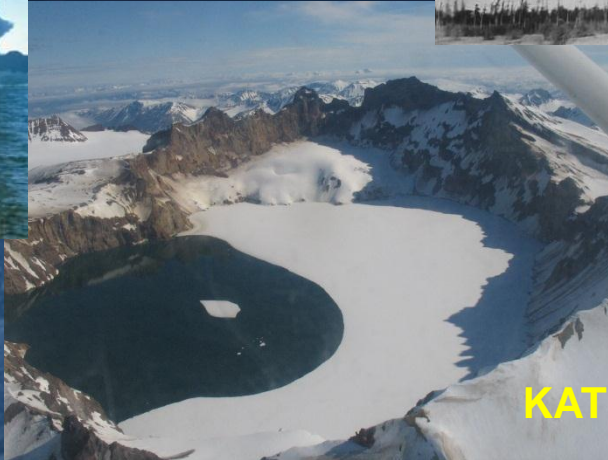


BEZYMIANNY 1956 3 km³

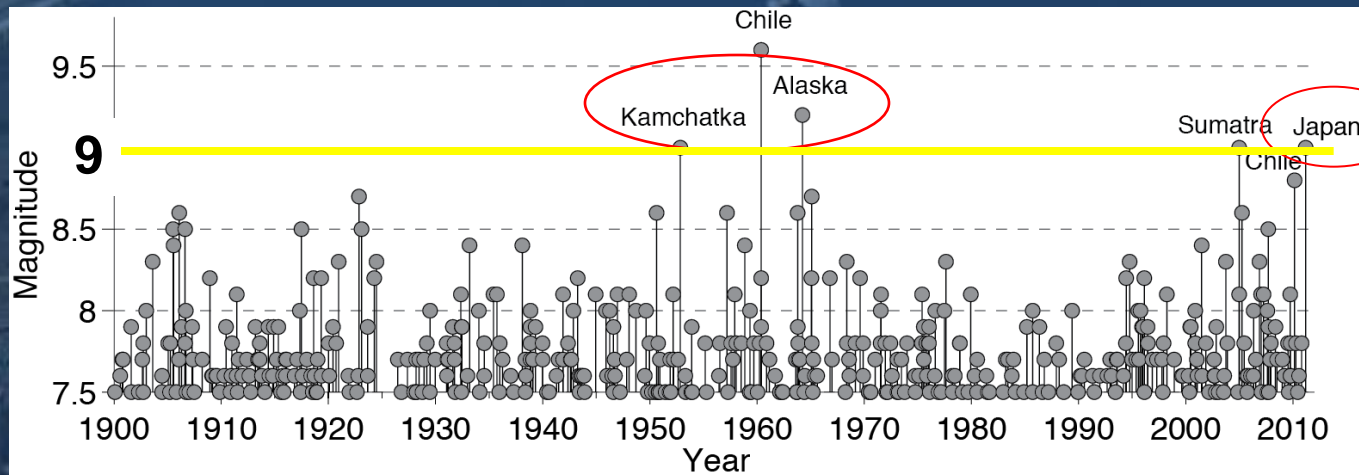
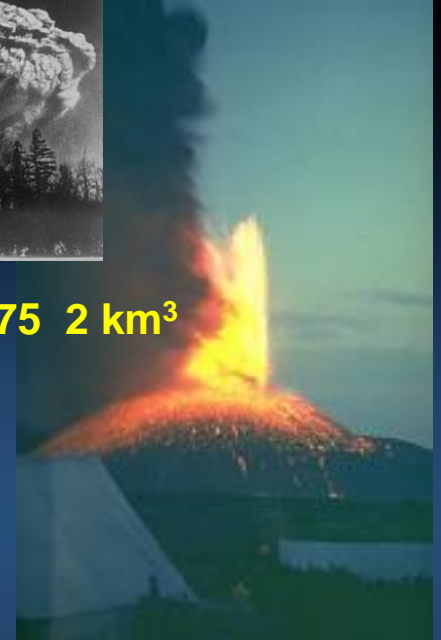


TOLBACHIK 1975 2 km³

USU 1663 3 km³

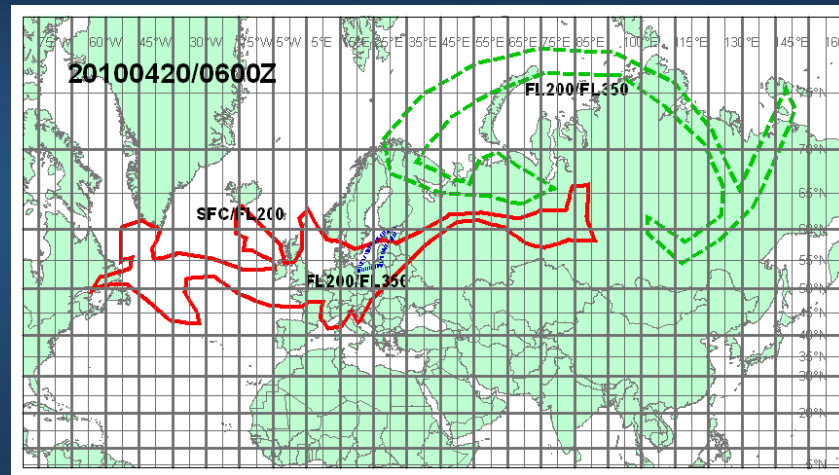
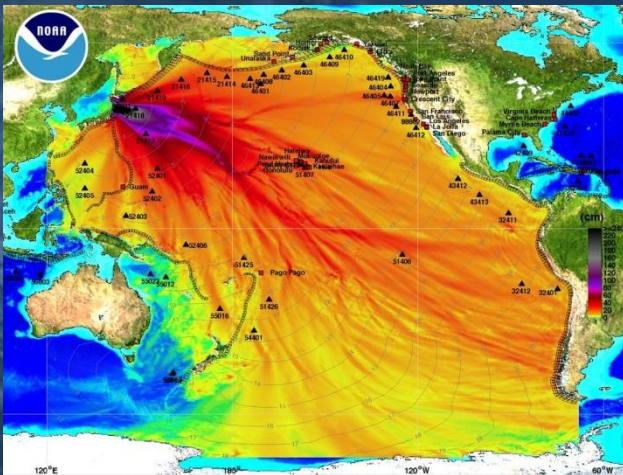


KATMAI 1912 30 km³



Recent Lessons

- Extreme geophysical events have international impact.



- Even the most capable countries need help sometimes.

POMPEI and VESUVIUS



VIEW FROM VESUVIUS TODAY:

We are becoming much more vulnerable



Hyogo Framework for Action



United Nations
International Strategy for Disaster Reduction

Hyogo Framework
for Action 2005-2015:

Building the Resilience of Nations
and Communities to Disasters

- **Priority Action 1: Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.**
- **Priority Action 2: Identify, assess and monitor disaster risks and enhance early warning.**
- **Priority Action 3: Use knowledge, innovation and education to build a culture of safety and resilience at all levels.**
- **Priority Action 4: Reduce the underlying risk factors.**
- **Priority Action 5: Strengthen disaster preparedness for effective response at all levels.**

Hyogo Framework for Action



United Nations
International Strategy for Disaster Reduction

HFA

Hyogo Framework
for Action 2005-2015:

Building the Resilience of Nations
and Communities to Disasters

This paper:

**Volcanic ash hazard to
aviation**



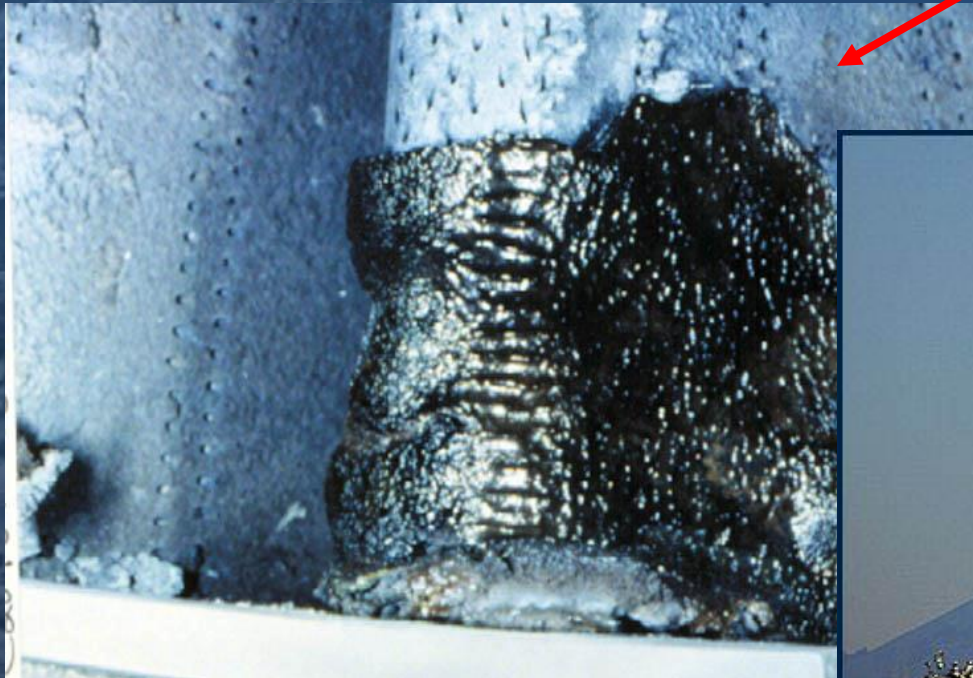
Priority Action 1: Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.

- **A crisis opens a window of opportunity to prepare for the next event.**

December 15, 1989: Anchorage, Alaska

- KLM 747 landed safely after in-flight failure of all four engines

- Melted ash on turbine blade



- **Since 1973, there have been ~125 encounters of aircraft with volcanic ash clouds reported worldwide. 60% involved aircraft damage, including ten incidents of in-flight engine flame out.**

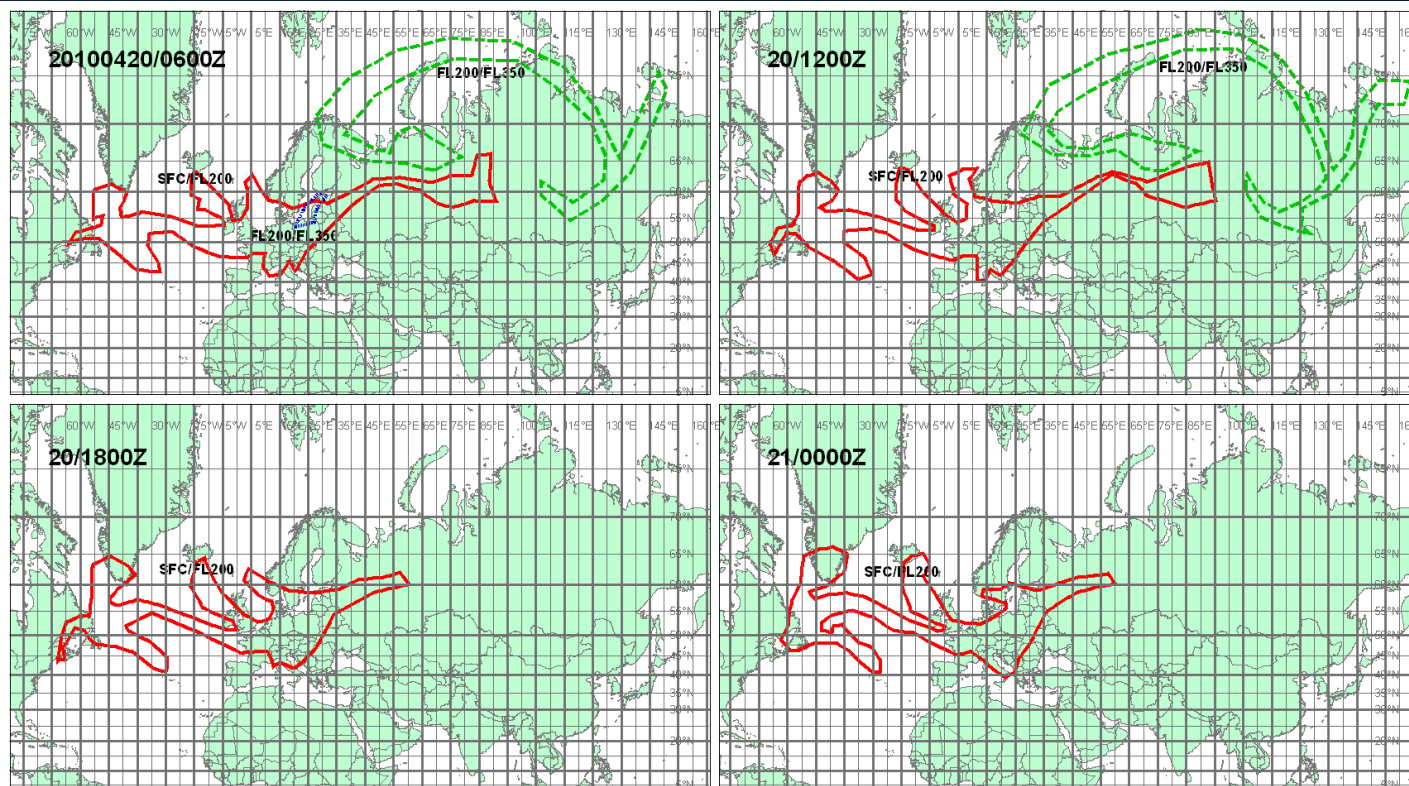
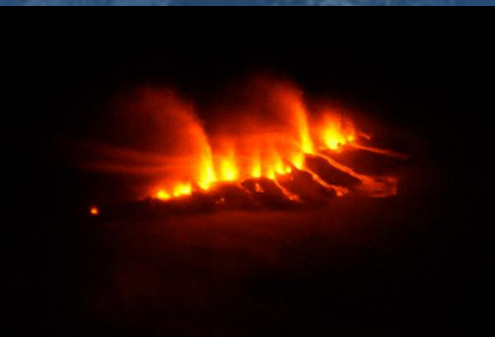
Priority Action 2: Identify, assess and monitor disaster risks and enhance early warning.

- Understanding the problem and focusing the resources.

Cost of encounters

- **Cost of an engine inspection is ~\$30k.**
- **Cost of complete engine overhaul is ~\$3M.**
- **Cost of an engine replacement >\$10M.**
- **Possibility of loss of aircraft, passengers, and crew.**

Until Eyjafjallajokull, no one realized that volcanic ash could cause an international financial disaster



VA ADVISORY
DTG: 20100420/0600Z
VAAC: LONDON
VOLCANO:
EYJAFJALLAJOKULL 1702-02
PSN: N6338 W01937
AREA: ICELAND

SUMMIT ELEV: 1666M
ADVISORY NR: 2010/025
INFO SOURCE: ICELAND MET OFFICE
AVIATION COLOUR CODE: RED
ERUPTION DETAILS: ERUPTION CONTINUING
TO AROUND 4000M WITH LAVA VISIBLE IN THE
CRATER.

RMK: NO SIG ASH ABOVE FL350, AND FROM 20/1800Z NO SIG ASH
ABOVE FL200
NXT ADVISORY: 20100420/1200Z

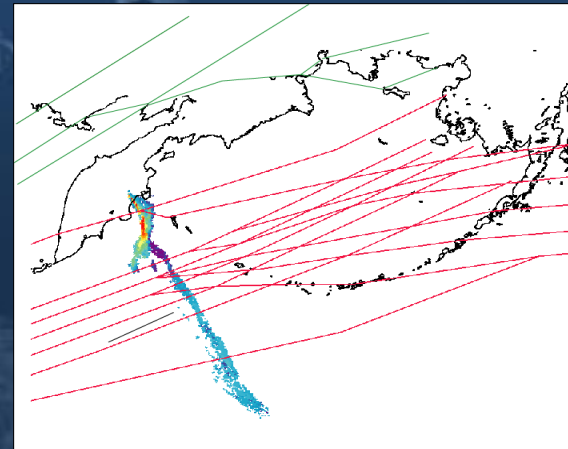
April 17, 2010

**What's
wrong
with this
picture?**



Mitigating the ash risk to aviation over Alaska:

- Even remote volcanoes under active air routes should have monitoring networks because satellites detect an eruption only after the hazard exists.
- Warnings are not enough: they must be delivered in the right way at the right time through an established relationship- i.e., they must be actionable.
- Much of the ash on the North Pacific air route comes from Russian volcanoes.

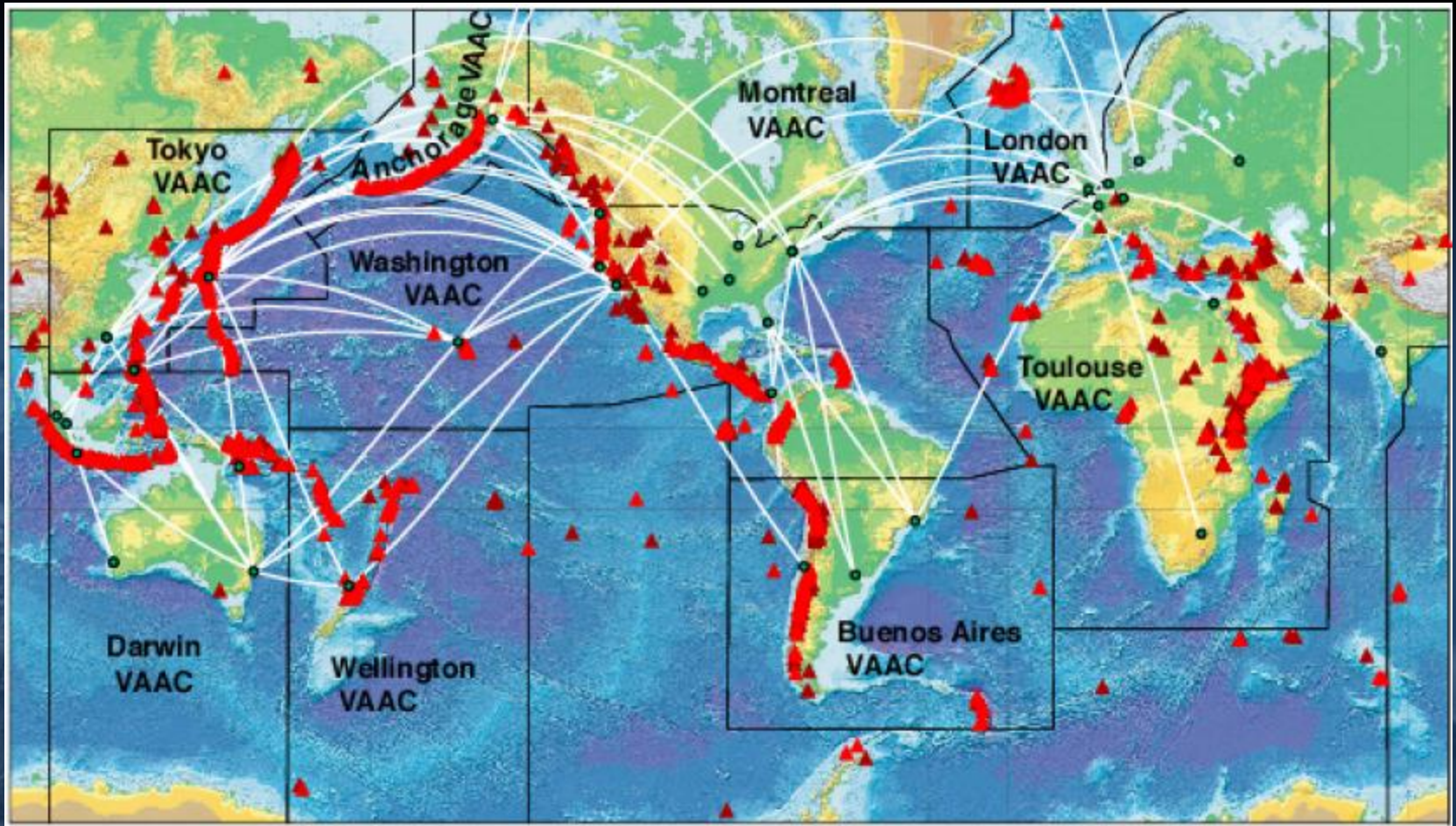


Cooperation with Russia

- **Ash clouds:** More than 20,000 passengers/day transit the northern Pacific where ash frequently reach flight levels.
- **RFE volcano observatories:** Russian scientists, assisted by USGS colleagues, established the Sakhalin Volcanic Eruption Response Team (SVERT) and Kamchatka Volcanic Eruption Response Team (KVERT).
- **Warnings to airlines:** AVO, KVERT, and SVERT work closely together to detect volcanic activity and provide air carriers with timely ash warnings.



Volcanic Ash Advisory Centers (VAACs)



Where Network Funds Go

- Aviation needs – helicopter and fixed wing support
- Logistics – Shipping, freight, transportation
- Instrumentation, batteries, solar panels, etc.
- Data processing



- **Priority Action 3: Use knowledge, innovation and education to build a culture of safety and resilience at all levels.**
- **Priority Action 4: Reduce the underlying risk factors.**

Warning

If you inadvertently enter a Volcanic Ash Cloud:

Indications:

- Smoke or very fine dust in cabin
- Acrid odor (like electrical smoke)
- Low airspeed indications
- Cargo fire warnings (caused by Volcanic Ash triggering smoke detectors)
- Static discharges (St. Elmo's Fire) around windscreen or on wing/stabilizer/fin tips
- White glow (searchlight effect) shining out of engine inlets
- Multiple engine malfunctions (increasing EGT, power loss, stall or flame out)

Your weather radar will **not** detect volcanic ash clouds.

General Recommended Pilot Actions:

Exit Ash Cloud as quickly as possible (180 degree turn)
Do Not Attempt to Climb Out of the Ash Cloud

- Auto-throttleDisconnect
- Throttles.....Minimum
(Terrain permitting)
- IgnitionOn
- Bleed air systemsFull on
(Air conditioning, engine and wing anti-ice, etc.)
- APU (If available)Start
- Engine EGT limits.....Monitor
- Engine re-start.....If Required
- Airspeed and pitch attitudeMonitor
- Crew oxygen masks (If required).....On/100%
- Transmit Special Air Report of Volcanic Activity
- Land at the nearest suitable airport

Note: Consult your Aircraft Operating Manual for specific procedures



U.S. Volcanoes and Current Activity Alerts

Activity Alerts: [Volcano Observatory Notices for Aviation \(VONA\)](#) | [Information Releases](#)

Zoom to Region: [Alaska](#) | [Hawaii](#) | [Mariana Islands](#) | [CA-NV](#) | [WA-OR](#) | [ID-WY](#) | [UT-CO-AZ-NM](#) | [U.S. Volcanoes](#)

Volcano Status: Elevated | Normal | Unassigned

Ground-based Volcano Alert Levels

Unassigned	Normal	Advisory	Watch	Warning
Increasing level of concern →				
Aviation Color Codes				
	Green	Yellow	Orange	Red



VONA

(1) VOLCANO OBSERVATORY NOTICE FOR AVIATION (VONA)

- (2) Issued: (20120218/2211Z)
(3) Volcano: Kanaga (CAVW# 1101-11-)
(4) Current Color Code: **YELLOW**
(5) Previous Color Code: green
(6) Source: Alaska Volcano Observatory
(7) Notice Number: 2012/A3
(8) Volcano Location: N 51 deg 55 min W 177 deg 9 min
(9) Area: Aleutians Alaska
(10) Summit Elevation: 4288 ft (1307 m)
(11) Volcanic Activity Summary: Possible explosive activity and a likely ash cloud indicate new unrest at Kanaga Volcano. AVO is increasing the Aviation Color Code to **YELLOW** and the Volcano Alert Level to **ADVISORY**.

Volcanic tremor was detected from 15:23-15:27 UTC (6:23 AM AKST) followed by numerous small events for about an hour at Kanaga Volcano. A possible weak ash cloud was also detected in AVHRR satellite data from 15:35 UTC about 39 km (24 mi) NE of the volcano.

This new unrest indicates a possibility for sudden explosions of ash to occur at any time, and ash clouds exceeding 20,000 feet above sea level may develop. If a large, explosive, ash-producing event occurs, the local seismic network, satellite ash alarms, infrasound, and volcanic lightning will alert AVO to the new activity.

- (12) Volcanic cloud height: Unknown
(13) Other volcanic cloud information: Unknown



Standard Volcano Icons

Ground-based Volcano Alert Levels

Normal Advisory Watch Warning



Aviation Color Codes

Green Yellow Orange Red

————— Increasing level of concern —————>

На предстоящую неделю от 20 февраля 2012 г.

На Камчатке и Северных Курилах (о. Парамушир и Атласова) находится 36 активных вулканов. KVERT проводит ежедневный мониторинг вулканов с 1993 г.

Камчатка:

Вулкан Безымянный

Авиационный цветовой код: **ОРАНЖЕВЫЙ**

Активность вулкана постепенно повышается. Сильное эксплозивное извержение вулкана с подъемом пепловой тучи до 13 км н.у.м. возможно в течение следующих 2-х недель. Аэрозольные и пепловые шлейфы могут представлять опасность для полетов по международным и местным авиалиниям.

Вулкан Шивелуч

Авиационный цветовой код: **ОРАНЖЕВЫЙ**

Эксплозивно-экструзивно-эффузивное извержение вулкана продолжается. В любое время возможны пепловые выбросы выше 10 км над уровнем моря. Аэрозольные и пепловые шлейфы могут представлять опасность для полетов по международным и местным авиалиниям.

Вулкан Кизимен

Авиационный цветовой код: **ОРАНЖЕВЫЙ**

Эффузивное извержение вулкана продолжается – мощный вязкий лавовый поток выжимается на его склон. Пепловые выбросы до 8-10 км н.у.м. возможны. Аэрозольные и пепловые шлейфы могут представлять опасность для полетов по международным и местным авиалиниям.

Вулкан Карымский

Авиационный цветовой код: **ОРАНЖЕВЫЙ**

Эксплозивное извержение вулкана продолжается. Существует опасность пепловых выбросов выше 6 км над уровнем моря. Аэрозольные и пепловые шлейфы могут представлять опасность для полетов по местным авиалиниям.

Вулкан Горелый

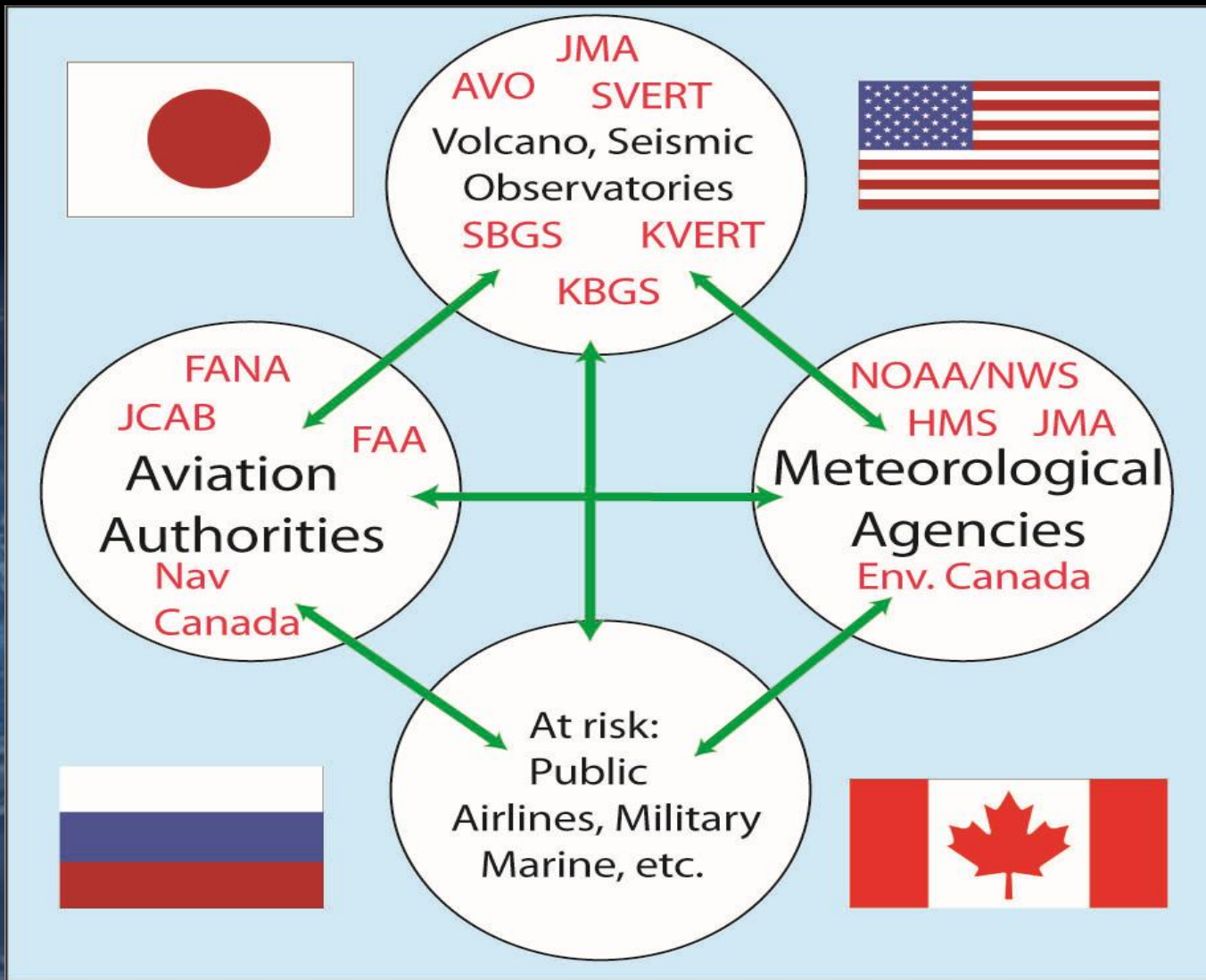
Авиационный цветовой код: **ЖЕЛТЫЙ**

Priority Action 5: Strengthen disaster preparedness for effective response at all levels.

Alaska Interagency Operating Plan for Volcanic Ash Episodes



MAY 1, 2008



Beyond Geo-Hazards:

“Since we’re neighbors, let’s be friends”



Kamchatka

Alaska

Moscow

Washington



Image © 2006 MDA EarthSat
© 2006 National Geographic Society

© 2005 Google

Pointer 77°09'21.00" N 84°40'47.44" W

Streaming | 100%

Eye alt 5550.86 mi


Japan-Kamchatka-Alaska Subduction Processes Workshops

A trilateral geohazard science community rotates meetings
~biennially through Kamchatka, Alaska, Hokkaido

7th Meeting: Kamchatka, 25-30 August 2011

Next: Hokkaido 2014!

7th BIENNIAL WORKSHOP on JAPAN-KAMCHATKA-ALASKA SUBDUCTION PROCESSES:
MITIGATING RISK THROUGH INTERNATIONAL VOLCANO, EARTHQUAKE,
AND TSUNAMI SCIENCE
(JKASP-2011)



Institute of Volcanology and Seismology FEB RAS (IVS)
Petropavlovsk-Kamchatsky, Russia, August 25th-30th, 2011

SECOND CIRCULAR AND CALL FOR ABSTRACTS

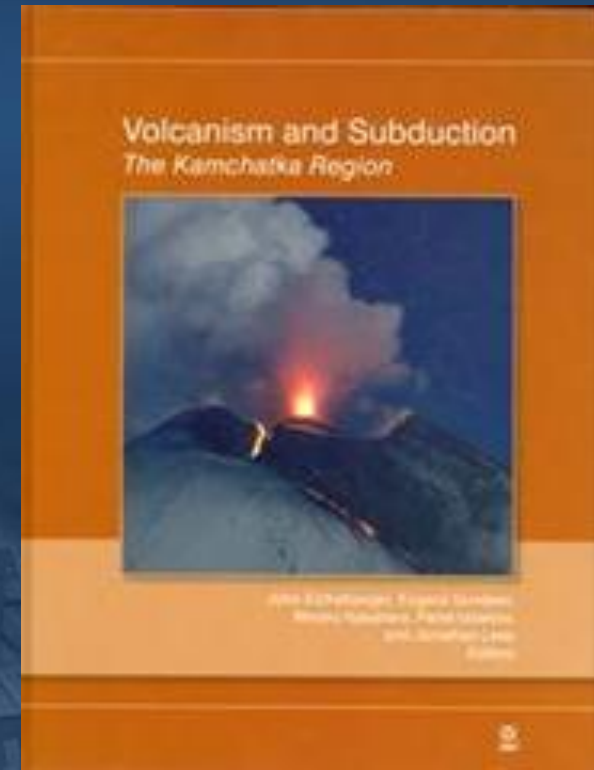
Objectives:
The 7th international workshop on the Japan- Kurile-Kamchatka-Aleutian volcanic arcs, among the most volcanically and seismically active areas on Earth, will be held August 25th-30th, 2011 in Petropavlovsk-Kamchatsky, Russia. The region includes transitions from ocean-ocean to ocean-continent convergence, arc rifting by oblique convergence, an exceptional subduction "cusp", and a newly defined micro-plate. High rates of lithospheric flow help to illuminate linkages among plate interaction, seismicity and volcanism and resultant hazards from earthquakes, tsunamis, and eruptions. The interdisciplinary and international nature of the workshop brings together scientists to solve problems that cross unchanged through international borders. The fusion of many geophysical techniques in this unique natural laboratory will allow us to more effectively monitor its hazards and mitigate risks of natural disaster.

Session themes are:

- Recent or ongoing volcanic eruptions and recent major earthquakes;
- New results from tectonic, volcanological, seismological, and marine research
- New developments in ground-, air-, and satellite-based monitoring techniques and in modeling and forecasting hazard events.

A special discussion will focus on how we can extend geophysical monitoring and improve crisis response through bilateral and/or trilateral initiatives. Activities to be proposed may include joint installation of new monitoring networks, joint field studies including scientific cruises, and real-time sharing of monitoring data. Past outcomes from the JKASP series of meetings, which cycle biennially among Petropavlovsk-Kamchatsky, Sapporo, and Fairbanks, are new international projects, a field school (<http://www.uaf.edu/geology/field-studies/international-volcanology/>), and publications including an AGU Geophysical Monograph 172.

ABSTRACT DEADLINE: JUNE 1st 2011



Education



Mutnovsky 2008



University of Alaska Fairbanks and Kamchatka State University
announce:

International Volcanological Field School GEOS 495/695, 3 credits UAF, Summer 2010

Session A: June 6-19 - field trip to Katmai National Park, Alaska

or

Session B: August 6-19 - field trip to Mutnovsky and Gorely volcanoes, Kamchatka, Russia

Objectives:

- *Understanding basic processes of physics and chemistry through direct examination of active volcanic phenomena.*
- *Knowledge of the eruptive behavior of volcanoes and resulting products.*
- *Experience with different cultures and languages, and with the conduct of scientific field work in a harsh environment*.*
- *Introduction to techniques of geology, geochemistry, and geophysics.*
- *Introduction to a wide range of volcanic phenomena and research opportunities in the North Pacific subduction region.*
- *Discussion of current controversies and themes in volcanology.*

* Students must be in good health, be capable undertaking long, strenuous hikes carrying substantial loads, and be willing to camp under primitive and remote conditions.

For further information and application forms (US students): www.uaf.edu/geology

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Dmitry Melnikov Department of Geology and Geophysics,
Kamchatka State University and Institute of Volcanology
and Seismology, Petropavlovsk-Kamchatksky, Russia; e-
mail: dvm@kscnet.ru



US-Russia partnership in volcano research

RAS – NSF - USGS

Russian-American volcano twins

Before



After

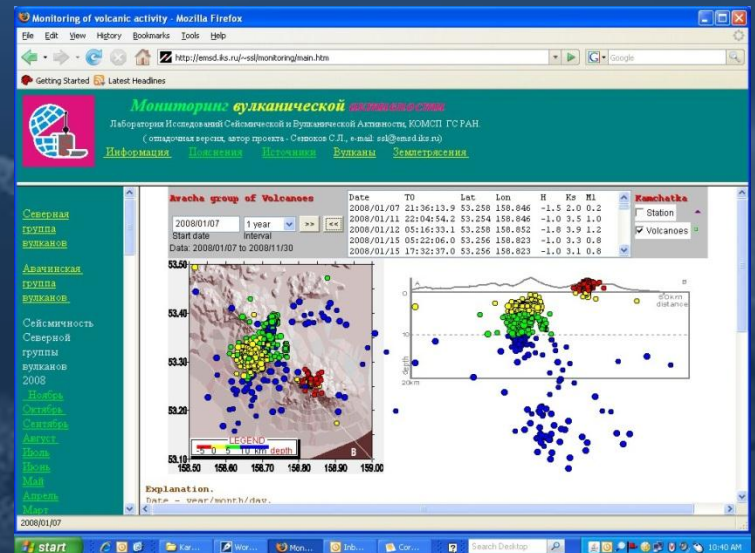


Bezymianny

Mt St Helens

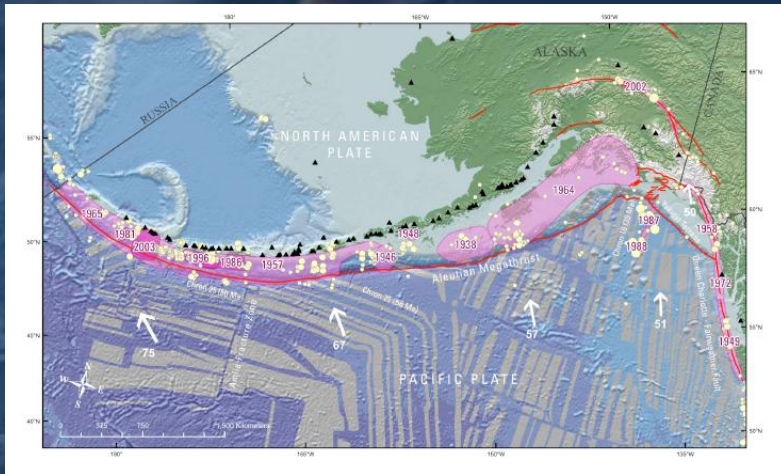


• Joint field team installing seismic/GPS station on Bezymianny

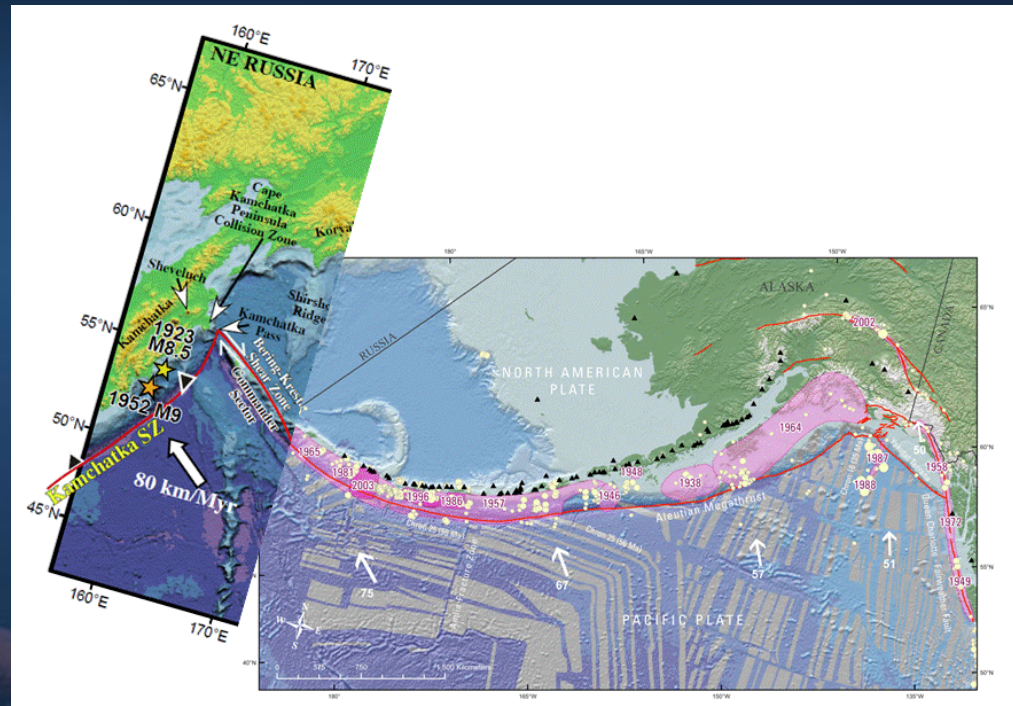


Which is a better way to study Aleutian subduction?

A.



B.



If your answer was “B”, you are correct.

Bi-Presidential (Obama-Medvedev) Commissions

- **Science and Technology: MES, RAS, NSF, USGS**
- **Emergency Situations: FEMA, EMERCOM**
- **Why not create a working group or agreement on Geo-Hazards?**

Reasons for a bilateral working group and agreement



Umbrella



Personal interaction

- High-level attention (P.A. #1)
- Identify most promising areas for collaboration.
- Resolution of obstacles to cooperation (e.g., data, sample, site access, permitting)
- Facilitate broad participation through government endorsement (“What I want to do is part of....”)

US-Russia Geo-Hazards Workshop: Linking Geo-Science and Technology with Management of Emergency Situations

**Leads: MES+RAS and USGS+NSF
EMERCOM and FEMA**

**Others: ROSHYDROMET AND NOAA
ROSCOSMOS AND NASA**



MOSCOW, JULY 17-19, 2012

Outcomes?

- **Expansion of monitoring networks**
- **Joint geo-hazards research**
- **Sharing experiences and identifying best practices**
- **Sharing real-time data**
- **Joint response exercises and joint responses**

U.S. Volcanoes and Current Activity Alerts

Activity Alerts: [Volcano Observatory Notices for Aviation \(VONA\)](#) | [Information Releases](#)

Zoom to Region: [Alaska](#) | [Hawaii](#) | [Mariana Islands](#) | [CA-NV](#) | [WA-OR](#) | [ID-WY](#) | [UT-CO-AZ-NM](#) | [U.S. Volcanoes](#)

Volcano Status: Elevated | Normal | Unassigned

Ground-based Volcano Alert Levels

Unassigned	Normal	Advisory	Watch	Warning
△	▲	▲	▲	▲
	Increasing level of concern →			
	Aviation Color Codes			
	Green	Yellow	Orange	Red



Summary: To do list for volcanologists

- **Bilateral agreements to share expertise, technology, real-time monitoring data, and lessons learned.**
- **Develop a consistent format and reliable mechanism for global daily volcano observatory reporting.**
- **Collaborate to increase access to satellite remote sensing data from all international sources in as near real-time as possible (GEOSS).**
- **Involve young scientists and students to ensure continuity and vitality of volcano hazard science.**



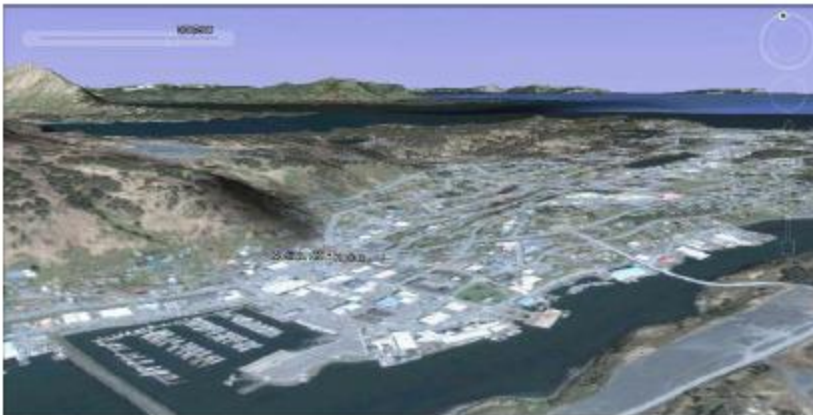
10.01,2009

Thank you for your attention!



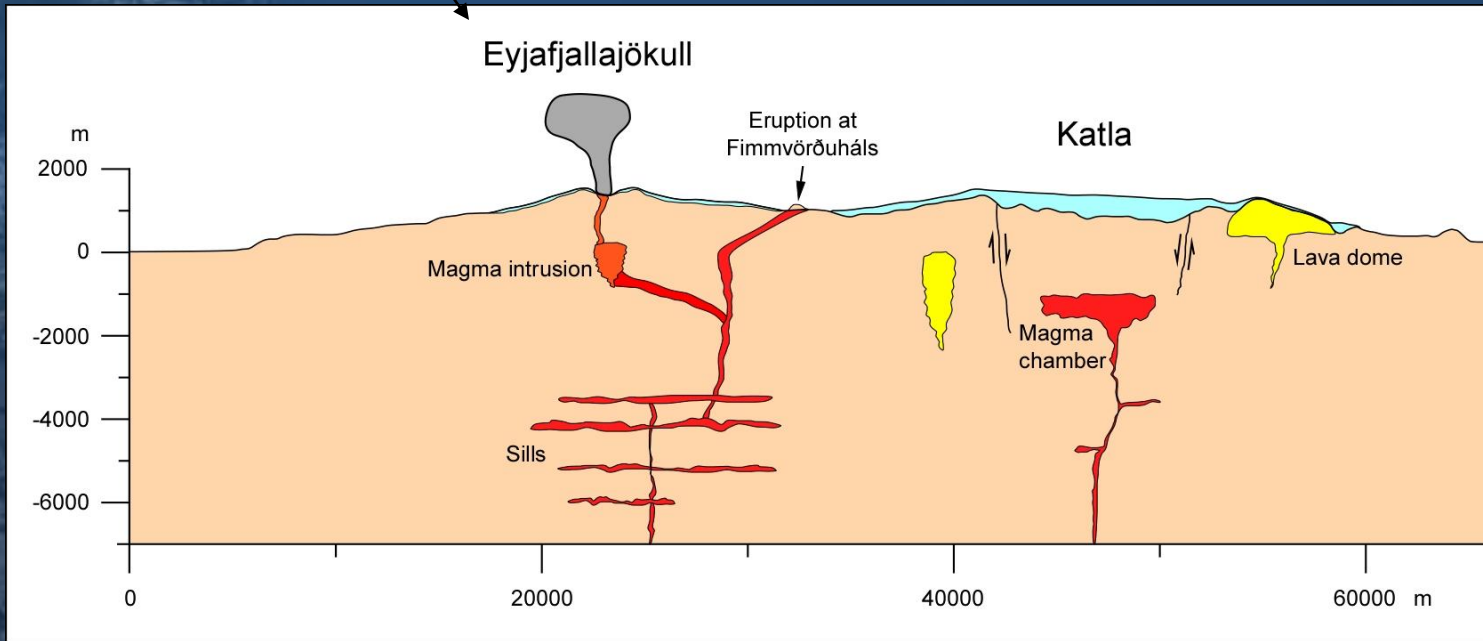
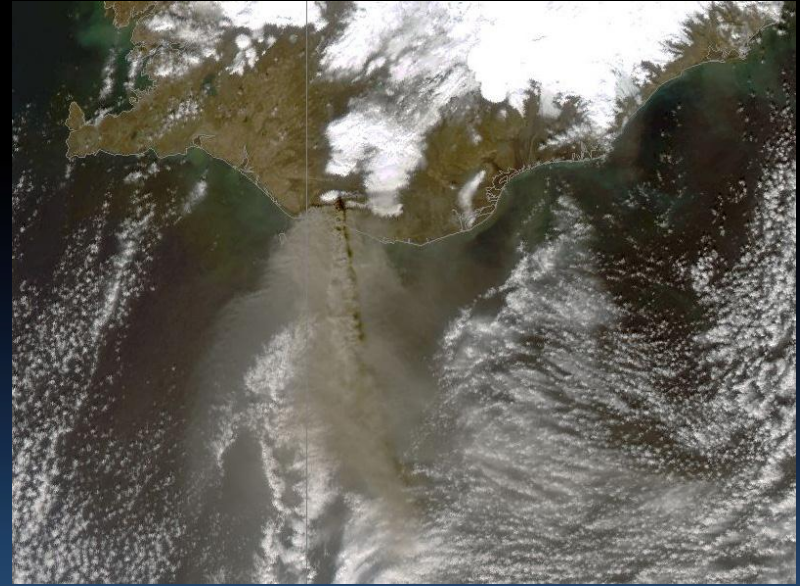
U.S. Department of the Interior
U.S. Geological Survey

**Russia-United States Bilateral Workshop on Geohazards and Disaster Risk
in the North Pacific Region**



1964 tsunami, Kodiak, Alaska, USA

2011 seismic retrofitting in Petropavlovsk-Kamchatsky, Russia



• what's wrong with this picture ?

•Volcano color code

Color	Status
GREEN	Volcano is in typical background, noneruptive state. <i>Or, after a change from a higher level:</i> Volcanic activity has ceased and volcano has returned to noneruptive state.
YELLOW	Volcano is exhibiting signs of elevated unrest above known background level. <i>Or, after a change from higher level:</i> Volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
ORANGE	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain. <i>Or,</i> Eruption is underway with no or minor volcanic-ash emissions [ash-plume height specified if possible].
RED	Eruption is imminent with significant emission of volcanic ash into the atmosphere likely <i>Or,</i> Eruption is underway or suspected with significant emission of volcanic ash into the atmosphere [ash-plume height specified if possible].