



*Volcanic disaster mitigation
programs in Japan
with special reference to large-scale eruptions*

14 November, 2013

The 1st Asia Parks Congress

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Yamanashi Institute of Environmental Sciences

JAPAN

Total number of

national parks

30

Parks in volcanic area

22

Number of active volcanoes

110

DEFINITION OF ACTIVE VOLCANOES

by JMA (Japan Meteorological Agency)

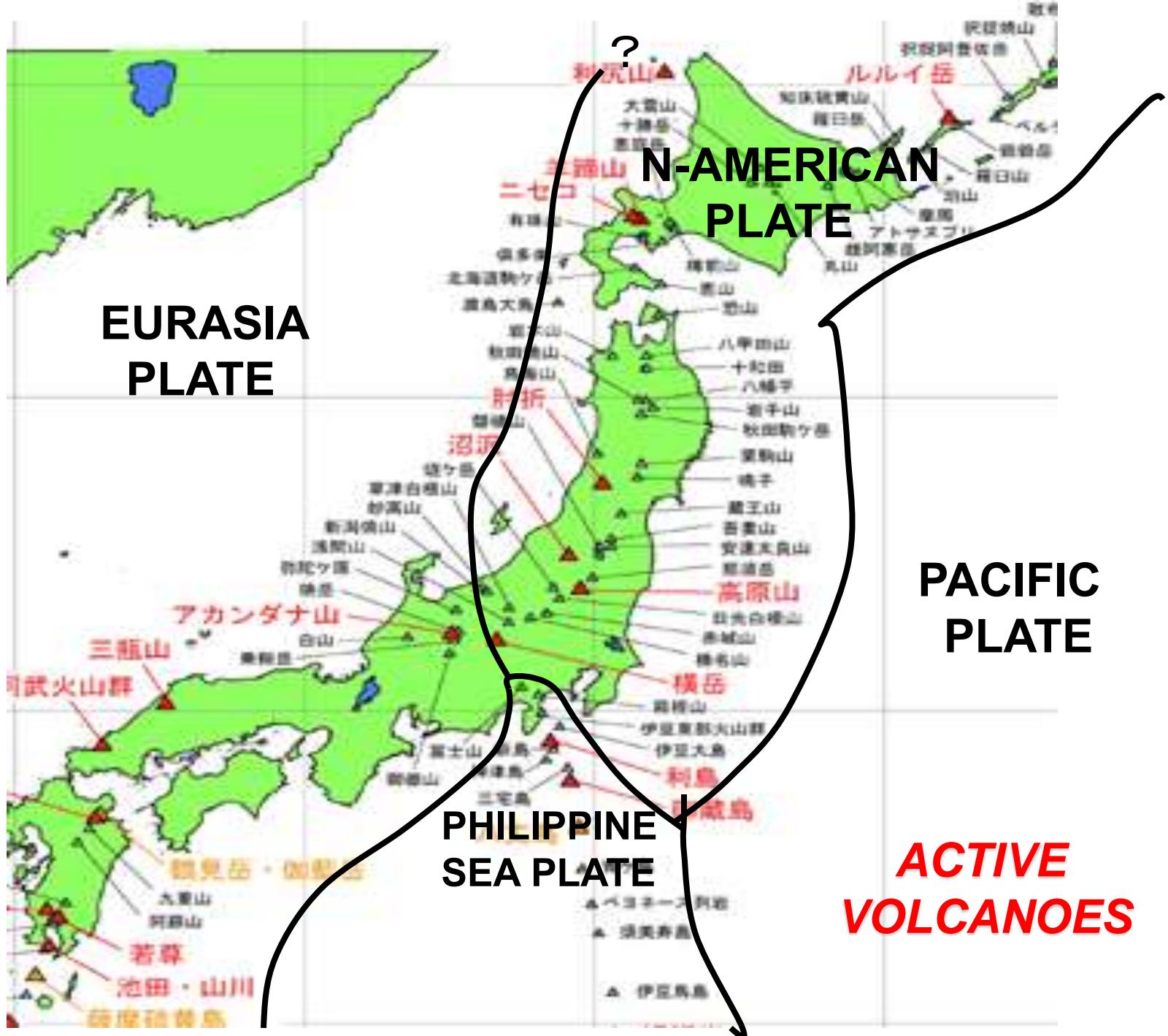
- 1. Volcano currently erupting**
- 2. Volcano with record of eruption
in last 10,000 years**
- 3. Volcano with active solfatara and
fumarolic fields**

*Note: Academic definition is
not at all clear-cut.*



Quaternary volcanoes 350 (0-1.7 Ma)

110
volcanoes

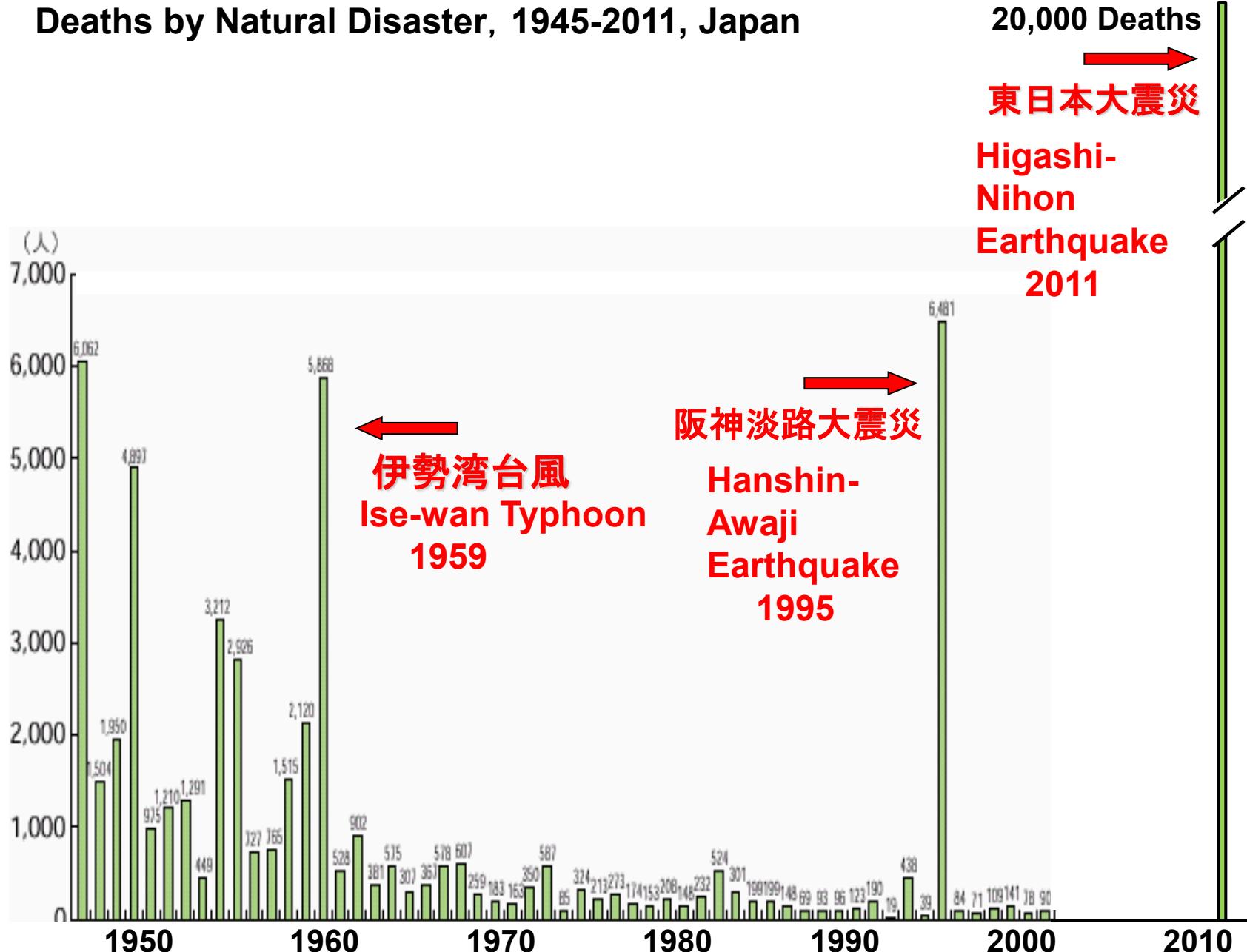


Volcanic Eruptions in Japan 1977-2011

日本の火山噴火 1977-2011

- No of active volcanoes 活火山の数 ca約 **110**
- No of volcanoes erupted 噴火した火山の数 **30**
- Eruptions (Year) 噴火回数(年数) **134**
- Average **4+** eruptions / year 平均 **4+** 噴火/年
Many more **crises** 異常活動はこのほか多数
- Casualties 死者
 - Usu 1977 有珠1977 **3**
 - Unzen 2001 雲仙普賢岳2001 **44**
- People evacuated 避難者数 ca約 **42000**
in **8** events **8** 噴火で

Deaths by Natural Disaster, 1945-2011, Japan



有珠噴火, 1977 Usu Eruption , 1977

プリニ一式噴火を4回

Four Plinian eruptions



火碎流噴火の危険性が大きかった

Grave danger of pyroclastic flows



火碎流を口に出すことに強い反対

Strong opposition against public declaration of
pyroclastic flow





有珠1977噴火の前後 During-after Usu 1977 Eruption

- ・プリニー式噴火の後、火碎流の発生が危惧された。
After Plinian eruption, possibility of pyroclastic flows was feared by scientists.
- ・防災担当者内部でも「火碎流」という語を公表することにとよい抵抗があった。
Strong opposition to publicly announcing “pyroclastic flow” was wide held among mitigation specialists.
- ・研究者の意見は地域住民・当局者に無視された。
Scientists advice was ignored by local authority.

伊豆大島 Izu-Oshima 1986

1986年11月 November 1986

中規模なストロンボリ式噴火. 溶岩が火口を埋める.
溶岩流がカルデラ床に溢流.

Moderate **Strombolian eruption**, filling of old pit, overflow
the crater, lava flows spill over caldera floor.

突然2kmの長さの噴火割れ目が生じる. 激しい溶岩噴泉.
火碎成溶岩流. 外輪山斜面の溶岩流が元町へ接近.

Sudden formation of **fissure 2 km long**,
Vigorous fire fountains, clastogenic lava flows
One flow threatens the largest town on island.

全島の避難命令. 5時間以内に10000人が島を脱出.

Evacuation of the whole island ordered.

10000 people evacuated within 5 hours.

1ヶ月後に全島民が帰島.

Islanders returned home after 1 month.







Lava FLow





雲仙 Unzen 1991

1990年11月 水蒸気爆発

November 1990 Phreatic eruptions.

1991年5月19日 溶岩ドーム成長開始

May 19, 1991 Lava dome starts growing.

5月24日 最初の火碎流発生

May 24 Generation of first pyroclastic flow.

5月25日 気象庁、火碎流発生を発表

May 25 JMA announces that pyroclastic flows occurred.

6月3日 火碎流により43名死亡

June 3 Pyroclastic flow killed 43.

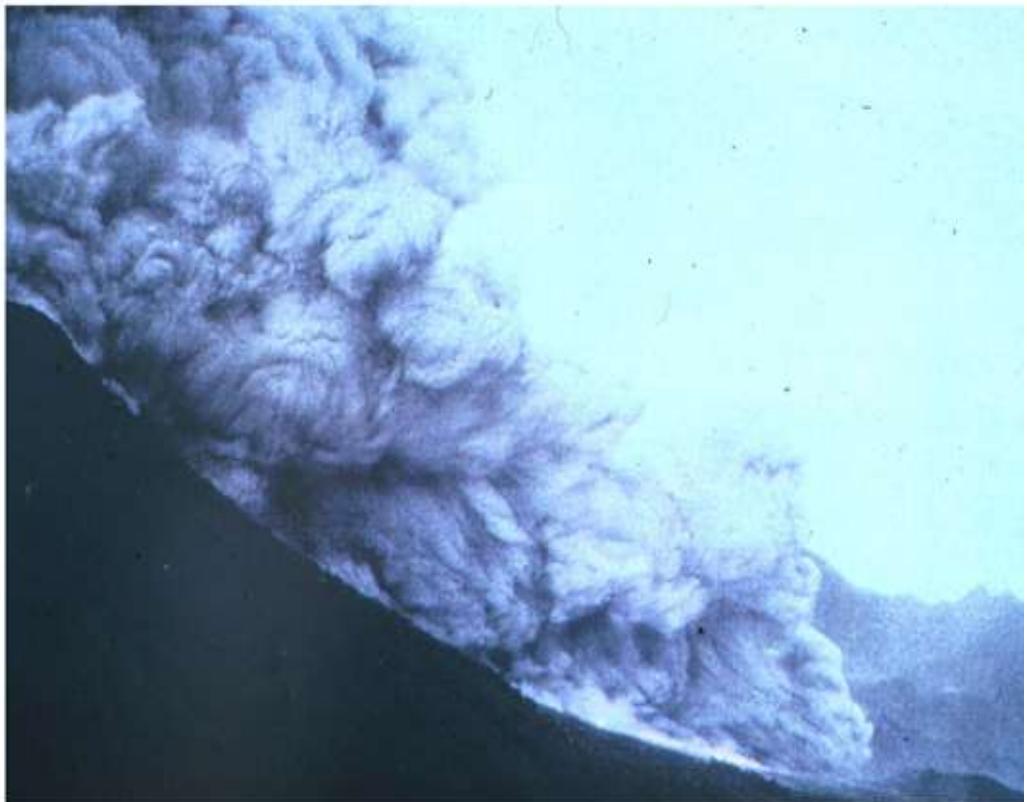
1995年まで 数千回の火碎流発生。溶岩ドームの成長。

Till 1995, thousands of pyroclastic flows occurred.
Slow growth of lava dome.



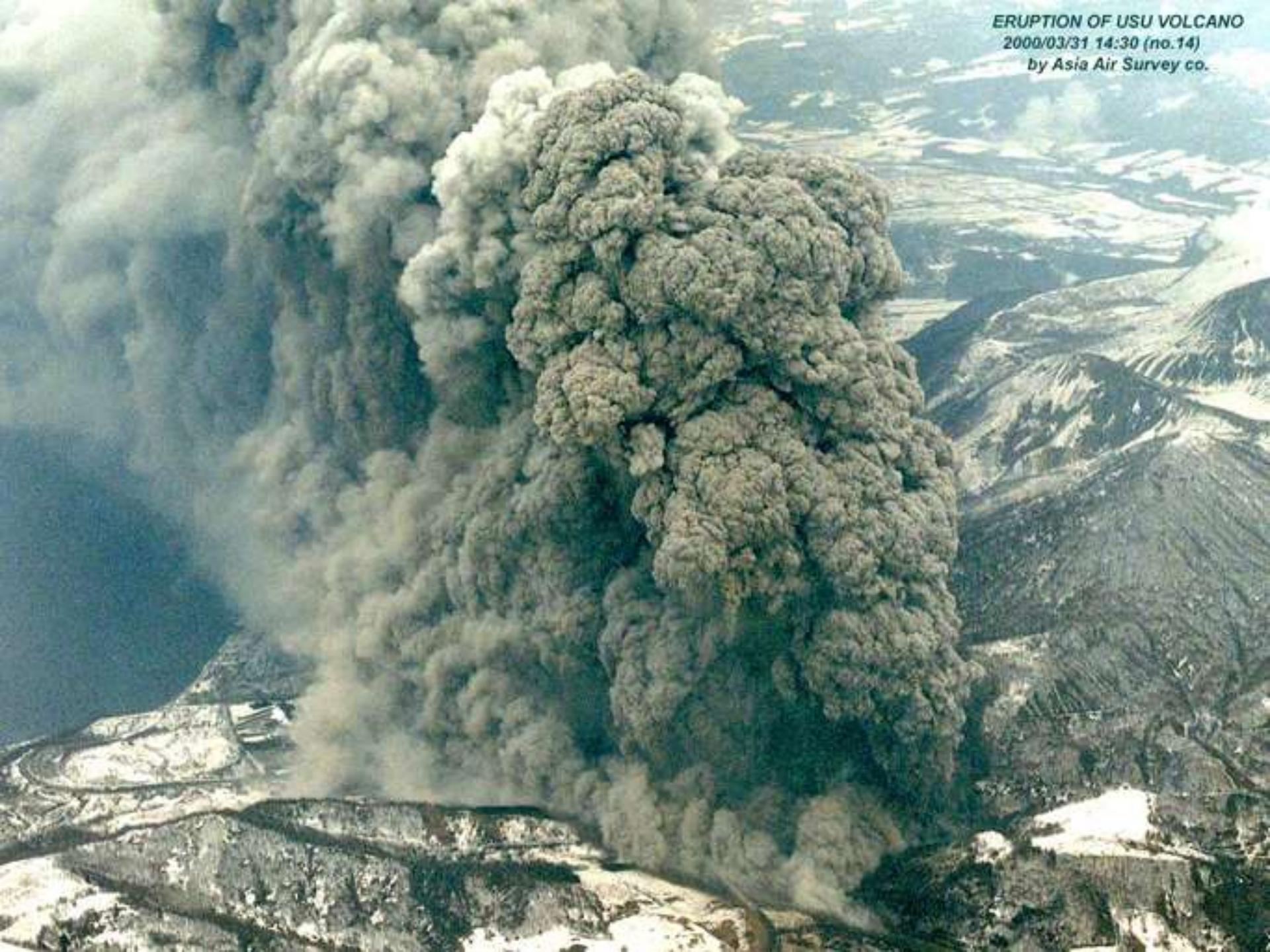


雲仙普賢岳
1991年6月3日
火碎流





ERUPTION OF USU VOLCANO
2000/03/31 14:30 (no.14)
by Asia Air Survey co.



2000/03/31 14:30 by Asia Air Survey co.



no.18

新しい噴火警報・レベル

New Volcanic Eruption Warning and Levels

噴火警戒レベル Warning Level

レベル1 Level 1 平常 Normal

レベル2 Level 2 火口周辺注意
Attention Close to Crater

レベル3 Level 3 注意 Advisory

レベル4 Level 4 避難準備
Prepare for Evacuation

レベル5 Level 5 避難 Evacuate

WARNING



三宅島2000
初期

山頂火口の陥没
末期

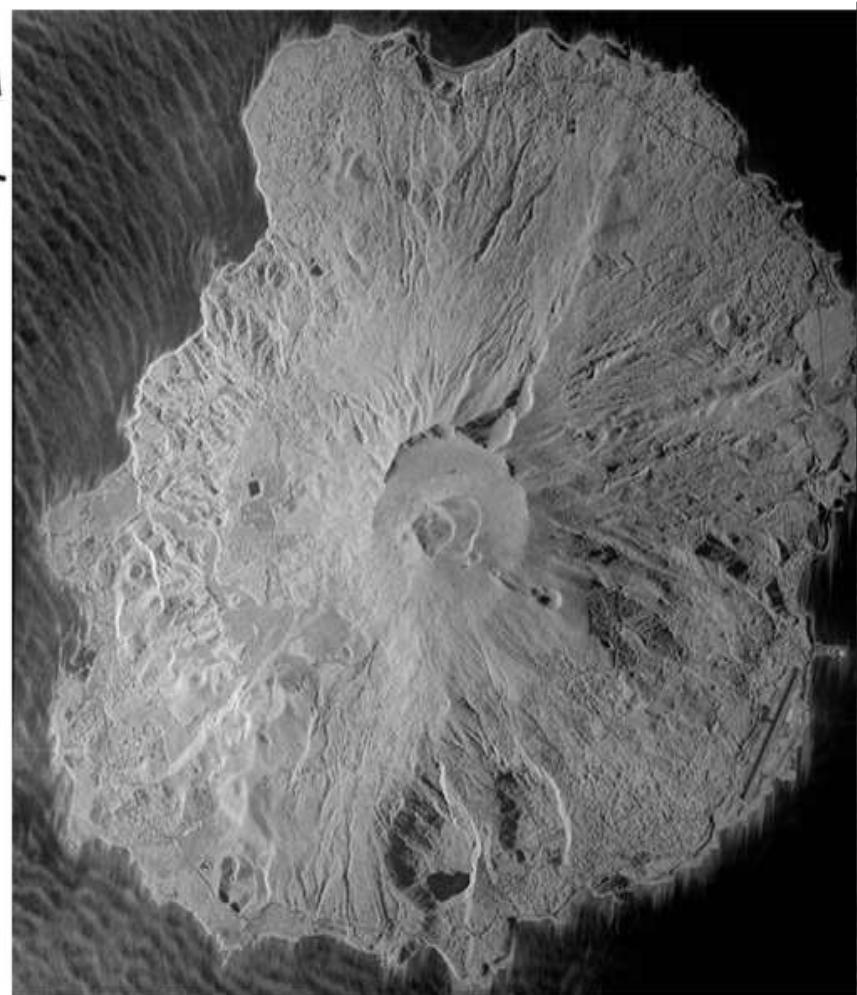


Early stage of collapse of the crater of Miyakejima. Taken on 7 July, 2000 by Asia Air



Collapsed and enlarged crater of Miyakejima. Taken on 22 July, 2000 by Asia Air Survey.

三宅島山頂火口の陥没



July 6, 2000



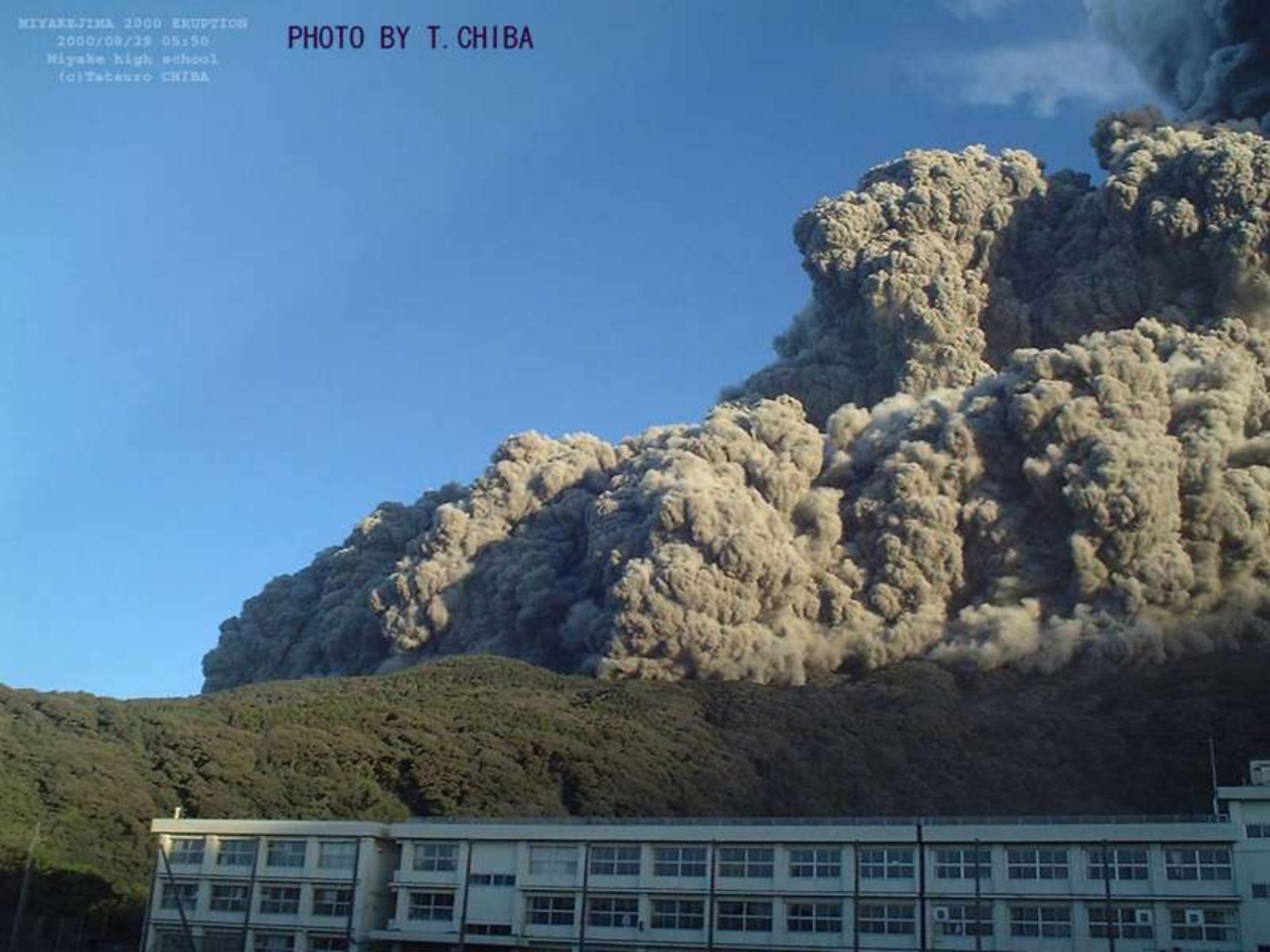
August 2, 2000

北

東

MIYAKEJIMA 2000 ERUPTION
2000/08/29 05:50
Miyake High school
(c)Takuzo CHIBA

PHOTO BY T. CHIBA



1,000,000

COSPEC Results -- MIYAKEJIMA SO₂ Flux Daily Average

latest data May15, 2002
JMA, GSJ and KSVO

SO₂

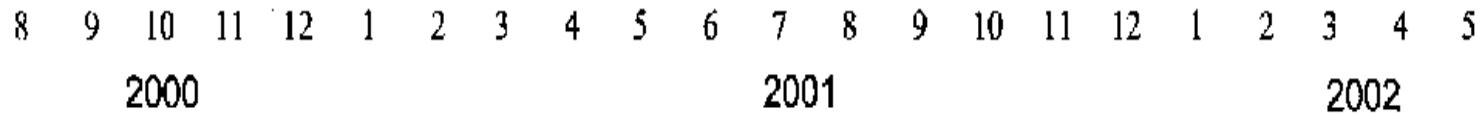
100,000 ton/day

SO₂ flux (ton/day)

100,000

10,000

1,000



ECONOMIC AND HUMAN LOSS ESTIMATES

COMBINED TOKAI-NANKAI EARTHQUAKE M > 8.5

**ca. 8×10^{13} Yen 12,500 dead
(700 BILLION US\$)**

FUJI VOLCANO

(equivalent of 1707 eruption)

**ca. 2.5×10^{12} Yen NONE DEAD
(20 BILLION US\$)**

NATIONAL BUDGET SPENT FOR MITIGATION OF DISASTERS

JAPANESE GOVERNMENT WHITE PAPER 2003

FOR EARTHQUAKS, TSUNAMIS

16 BILLION US\$

FOR VOLCANIC ERUPTIONS

0.11 BILLION US\$

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NATURAL DISASTERS IN JAPAN

ECONOMIC LOSS + DEATH TOLLS

METEOROLOGICAL DISASTERS

TYPHOONS, TORRENTIAL RAIN, FLOODS,
DEBRIS FLOWS, SNOW, HEAT & COLD



EARTHQUAKES + TSUNAMIS



VOLCANIC ERUPTIONS

SIGNIFICANT SOCIAL IMPACTS!!

MITIGATION of VOLCANIC DISASTERS -2

FORTELLING VOLCANIC ERUPTIONS and RESULTANT DISASTERS

1. ERUPTION FORECASTING through

INSTRUMENTAL MONITOIRNG

DETERMINISTIC APPROACH

2. CREATING HAZARD MAPS

PROBABLISTIC APPROACH

HAZARDOUS VOLCANIC PHENOMENA

- **BALLISTICS**
- **PYROCLASTIC FALL**
- **LAVA FLOW**
- **PYROCLASTIC FLOW, SURGE**
- **MUD, DEBIRS FLOW**
- **GROUND DEFORMATION**
- **DEBRIS AVALANCHE**
- **GROUNDWATER ANOMALY**
- **GEOTHERMAL ANOMALY**
- **TSUNAMIS**
- **GAS**
- **SHOCK WAVE**
- **EARTHQUAKE**

Coordination Committee of Prediction of Volcanic Eruption

Cabinet Office

**Ministry of Education, Culture, Sports, Science and
Technology ← University Observatories**

**Sabo (Erosion and Sediment Control) Department,
Ministry of Land, Infrastructure and Transport**

Geographical Survey Institute

Japan Meteorological Agency

Maritime Safety Agency

**National Research Institute for Earth Science and
Disaster Prevention**

**National Institute of Advanced Industrial Science and
Technology**

Person of learning and experience

Volcanic Disaster Mitigation

Cabinet Office (Disaster Mitigation)

Other Ministries incl. Japan Meteorological Agency

Prefectural Governments

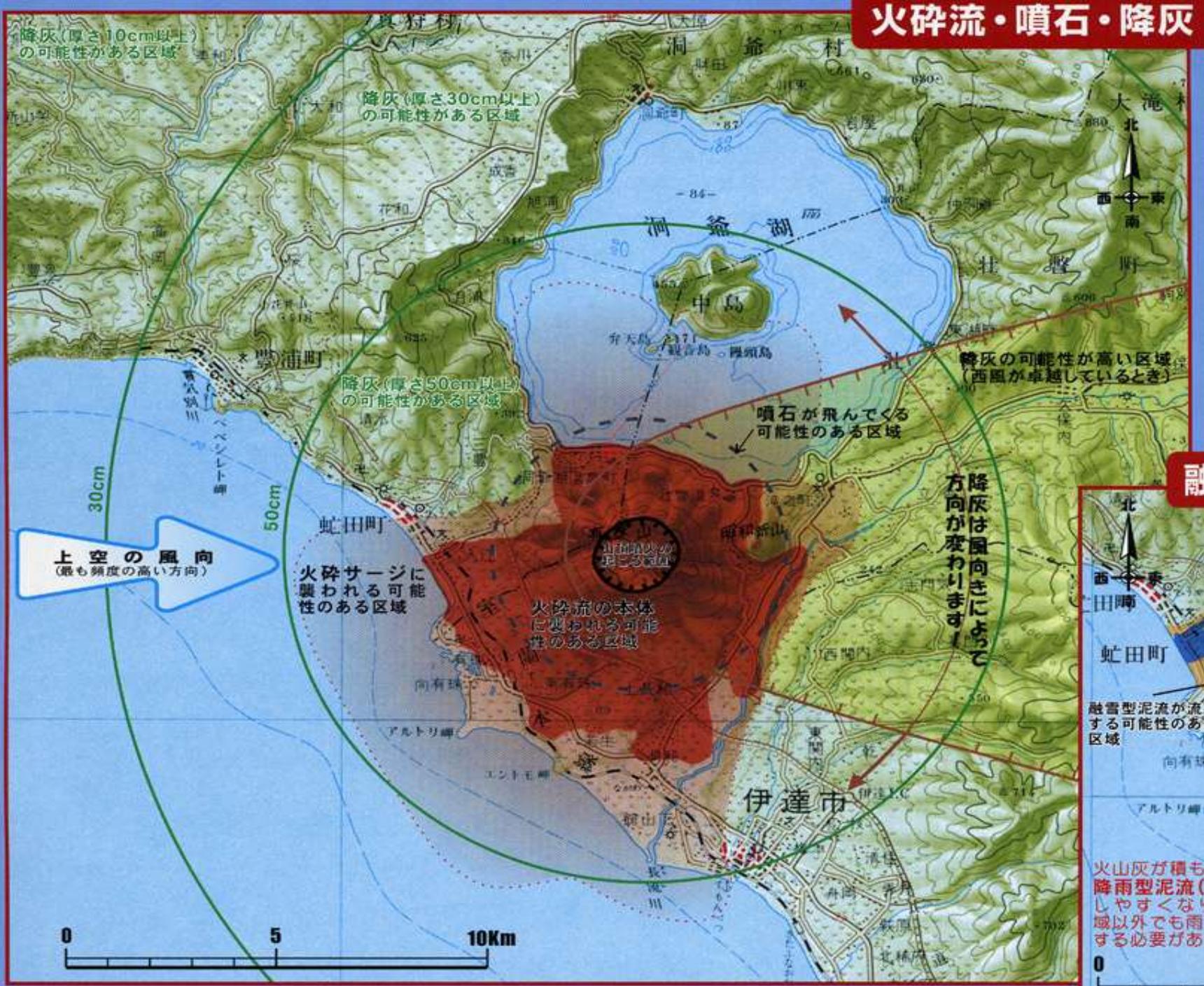
Cities, Towns, Villages

**Mayors have the right and responsibility of
Ordering Evacuation, etc.**

焼山周辺拡大図の範囲



火碎流・噴石・降灰



「この地図は、国土地理院長の承認を得て、同院発行の20万分の1の地勢図を複製したものである。(承認番号)平13道復第663号」

水蒸気噴火発生

約百年に1回

降灰厚さ5cm

降灰厚さ10cm



西風が吹く
場合の降灰域

那須町

風向きによって
降灰域は変わります

水蒸気噴火の危険区域予測図（降灰・噴石のみ）

0 1 2 km

岩手山ハザードマップ



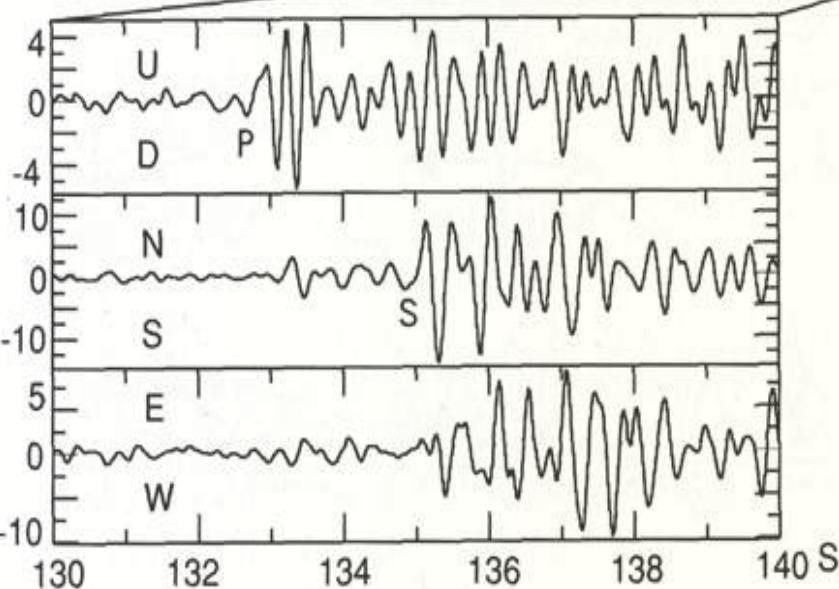
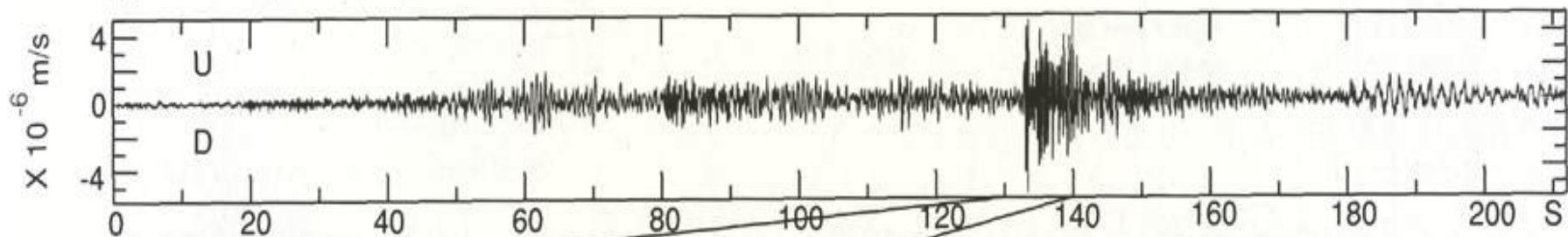
Mt. Fuji





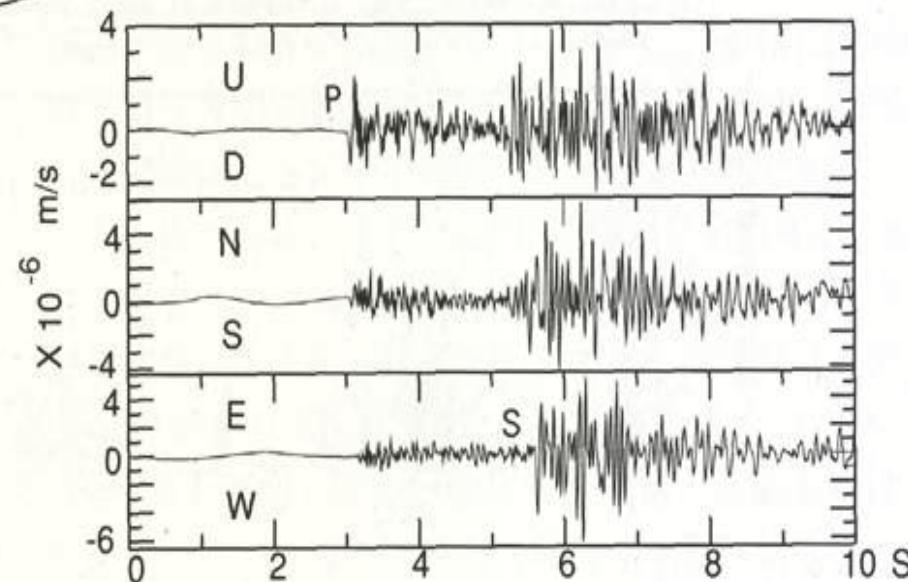
富士山の火山性地震

(a) LF earthquake 2000/11/12 FJN



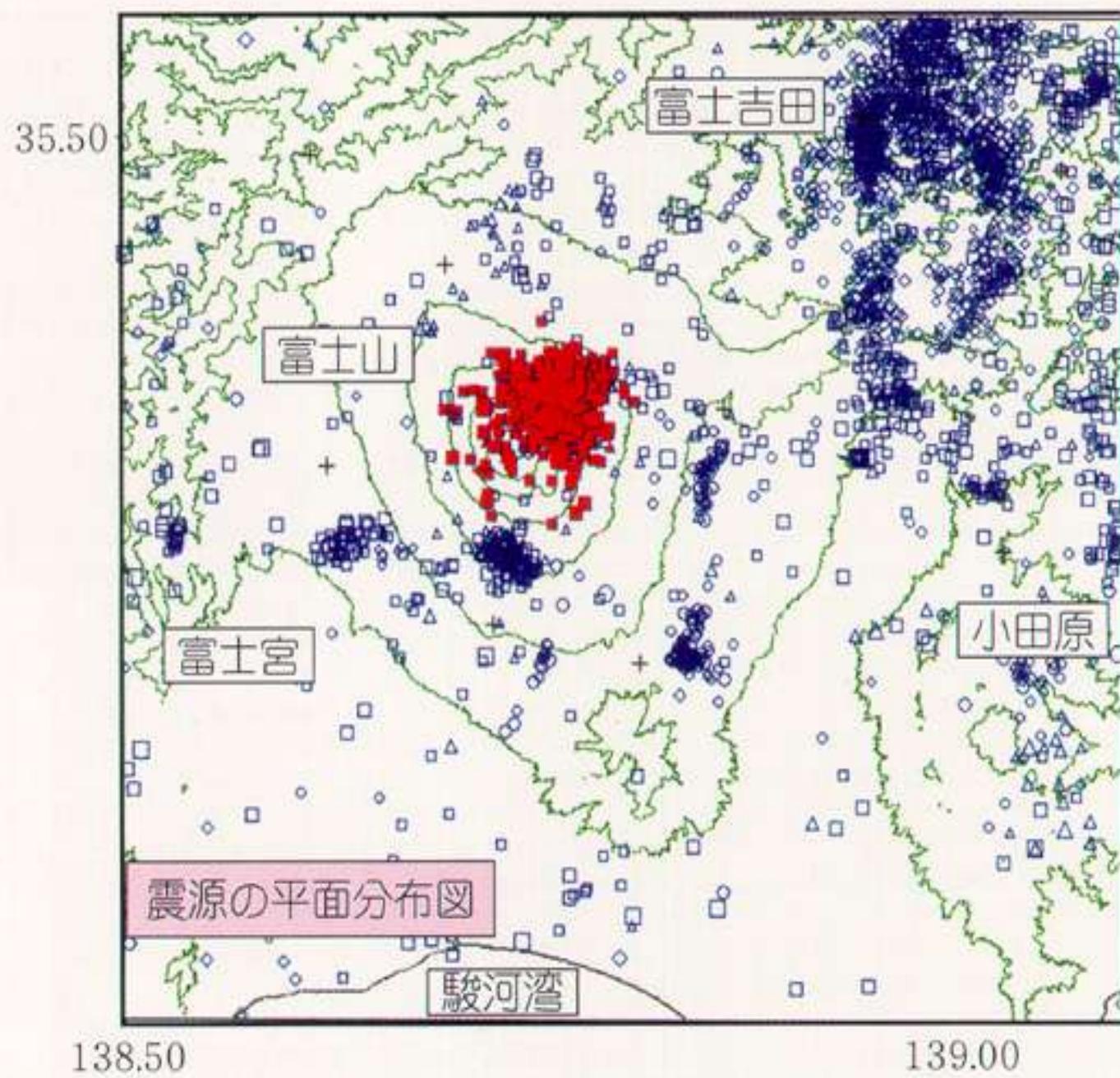
(b) LF earthquake 2000/11/12 FJN

Low Frequency Earthquakes

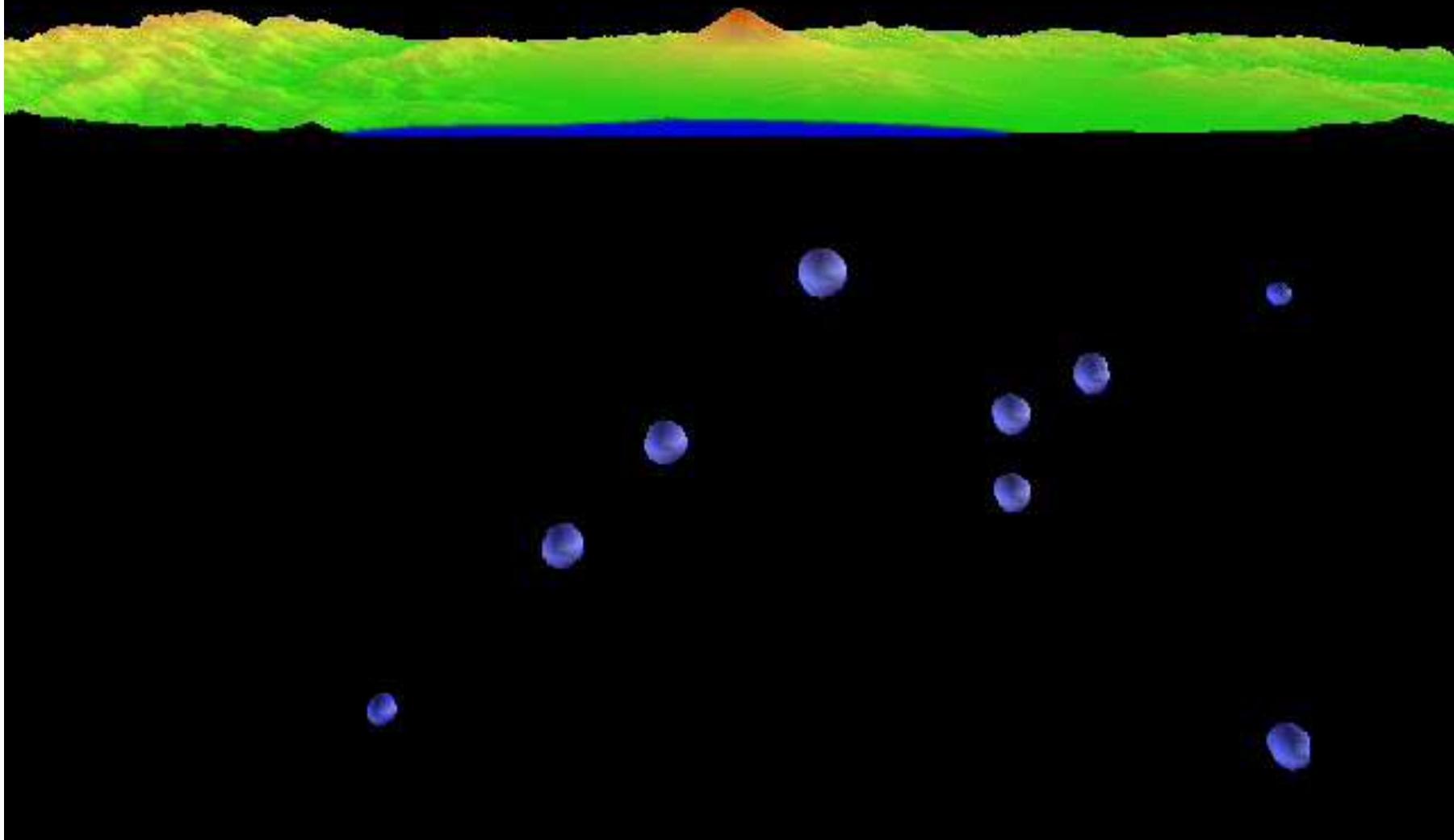


(C) Tectonic earthquake 2001/2/17 FJN

High Frequency Earthquakes



1995/01



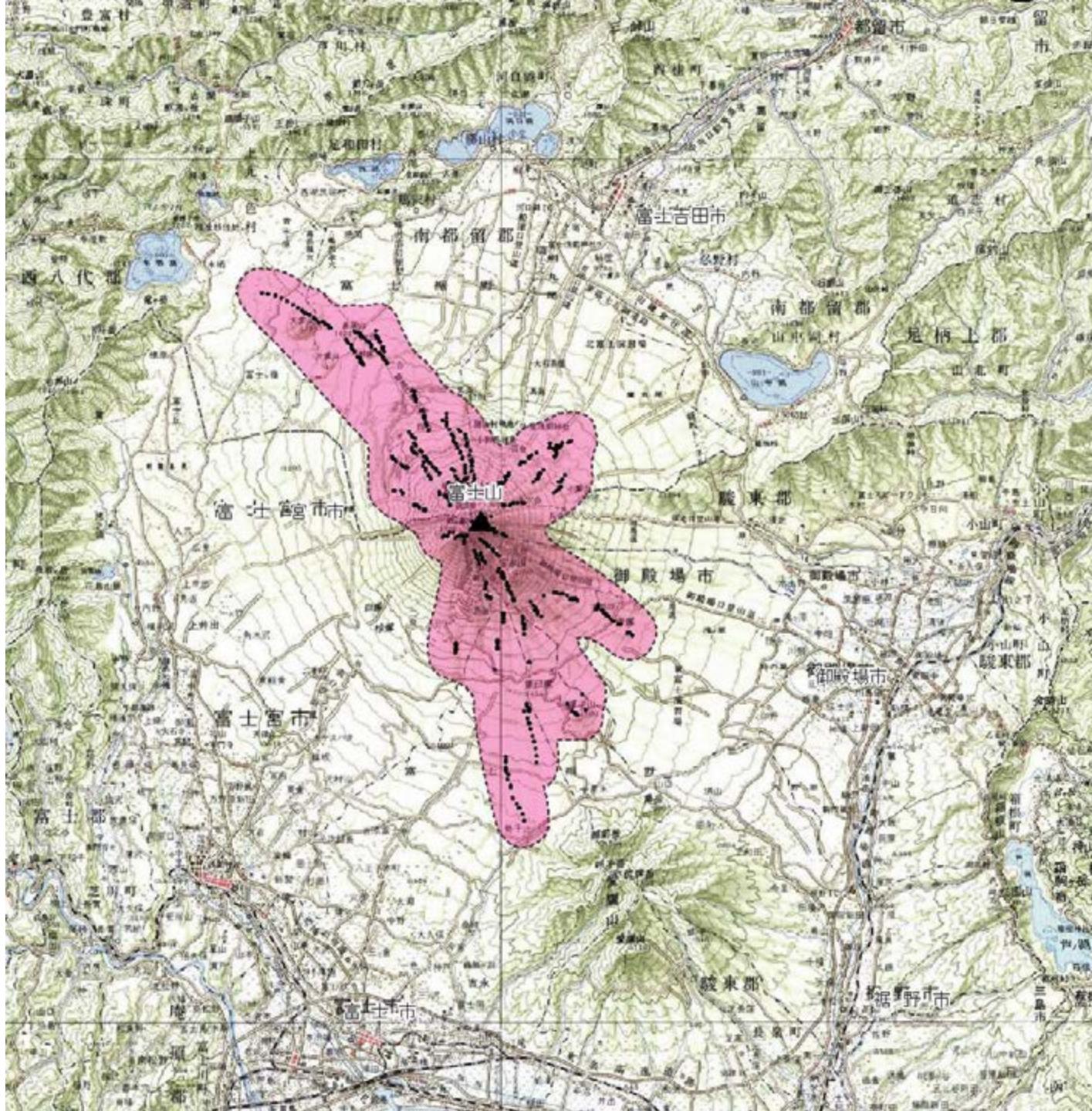
PEOPLE AT RISK

AROUND FUJI VOLCANO

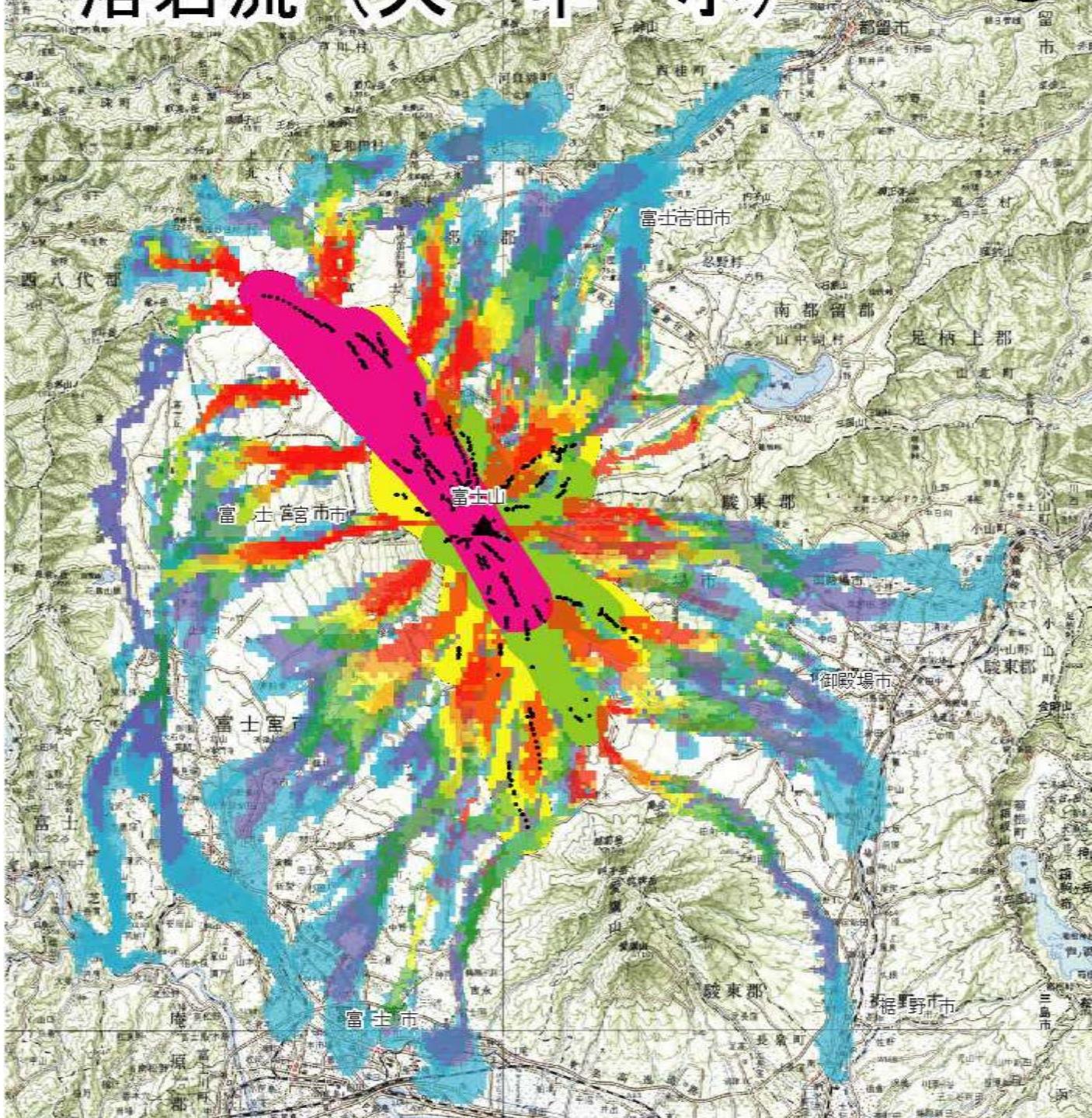
0.7 MILLION RESIDENTS

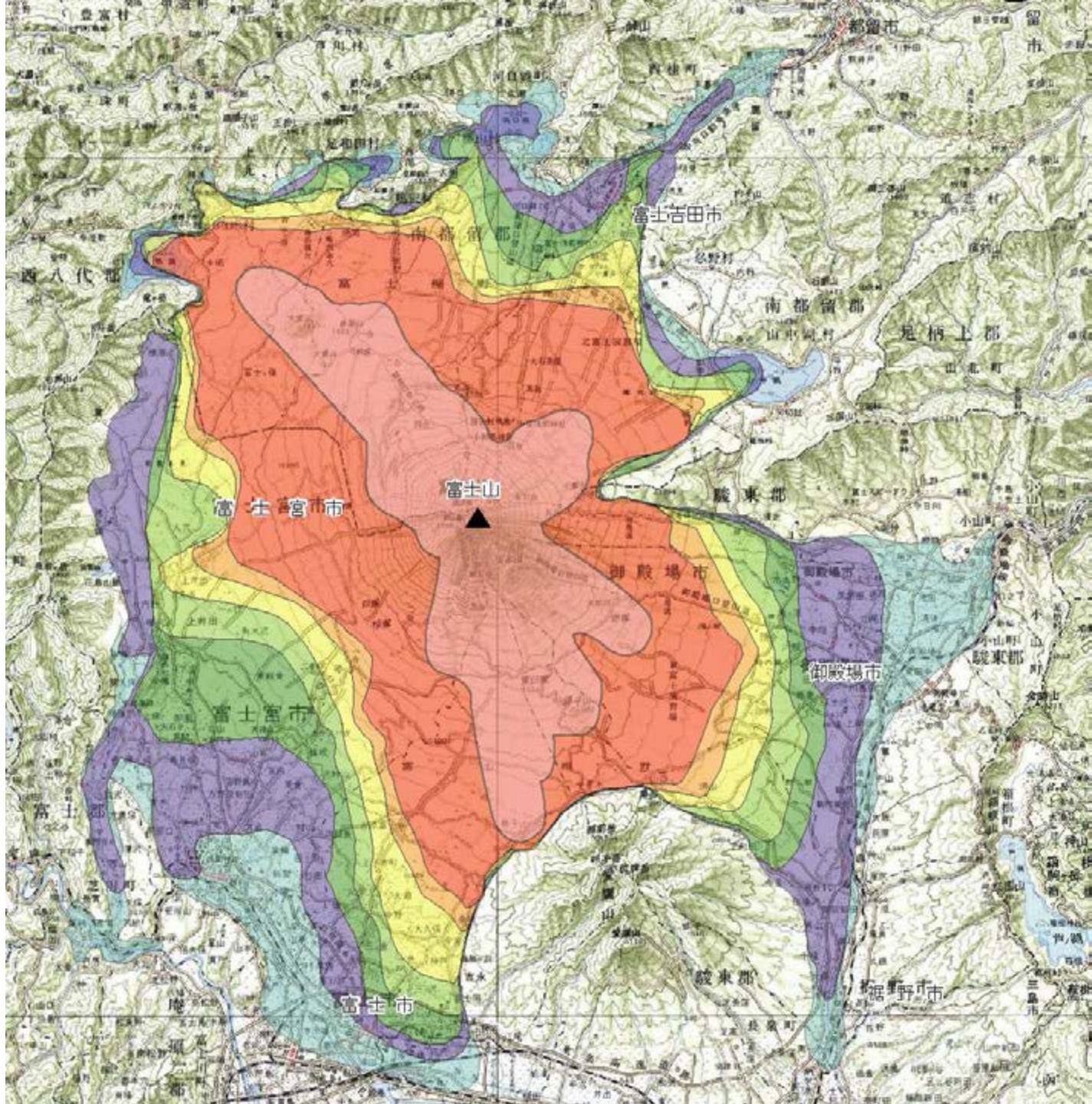
30 MILLION VISITORS/YR

**(SIGHTSEEING, CLIMBING, CAMPING,
VACATIONING, WATER SPORTS...)**

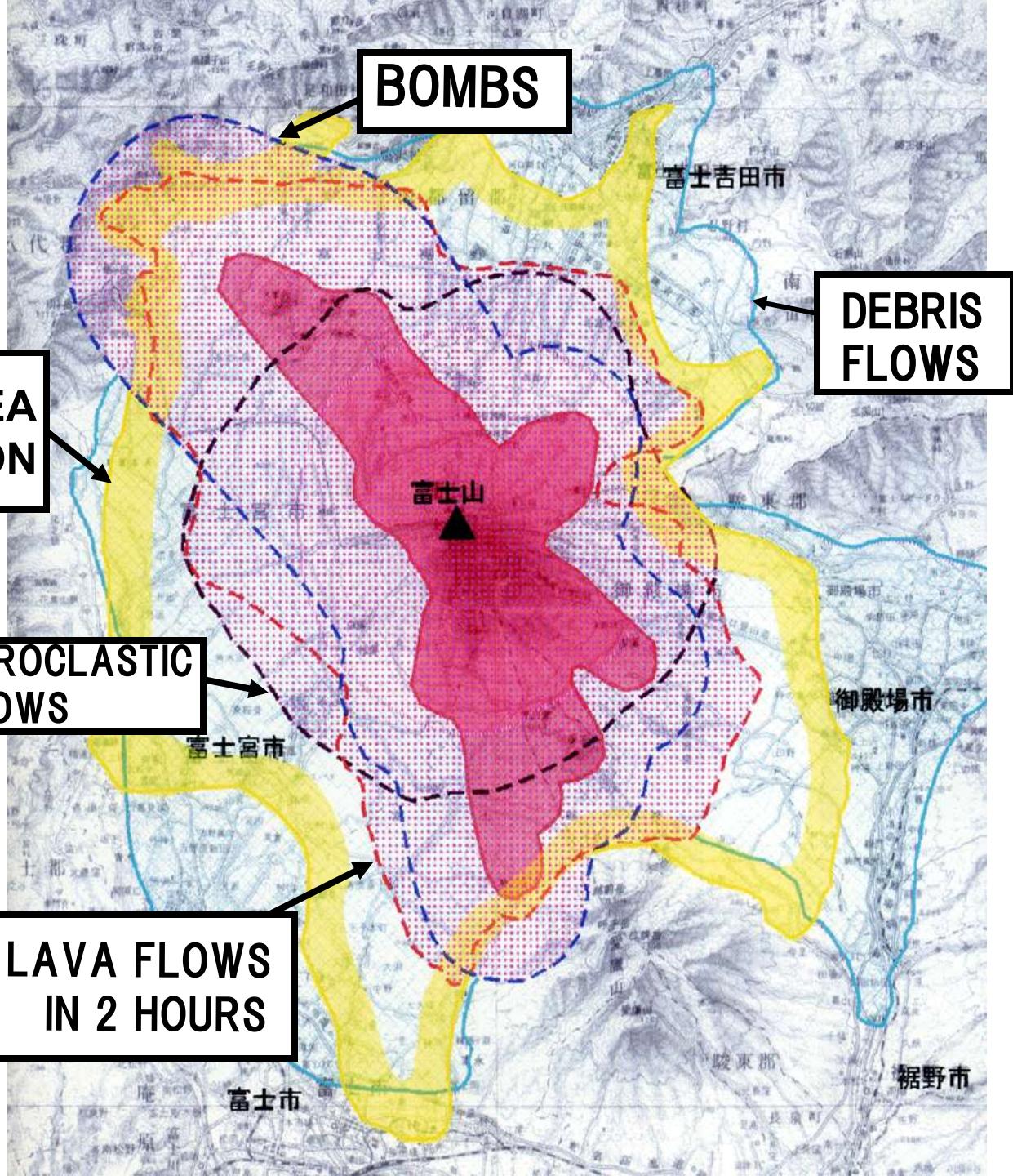


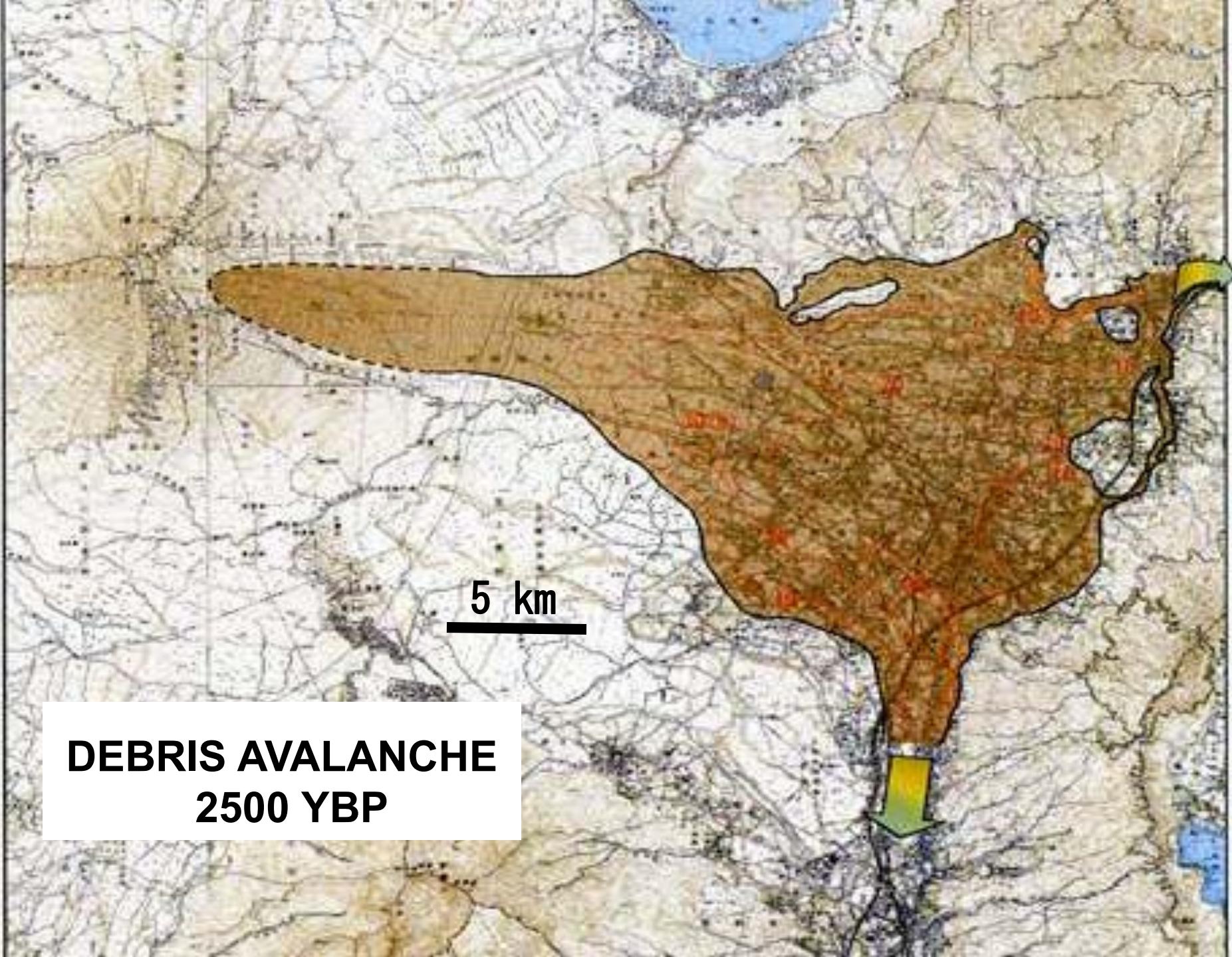
沿石流（火）ハザードマップ

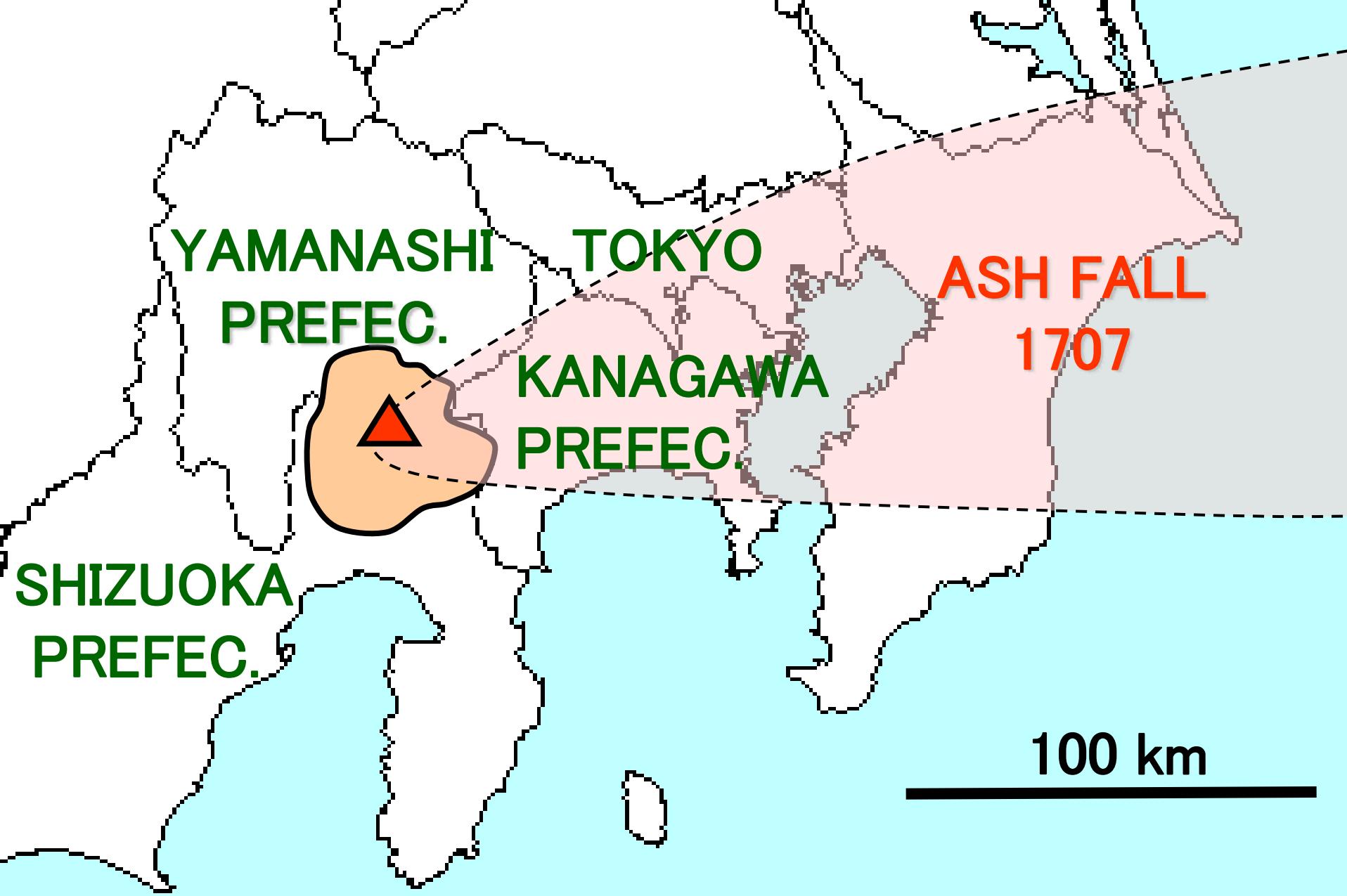




LIMITS OF HAZARDS







CRATER 1

CRATER 2

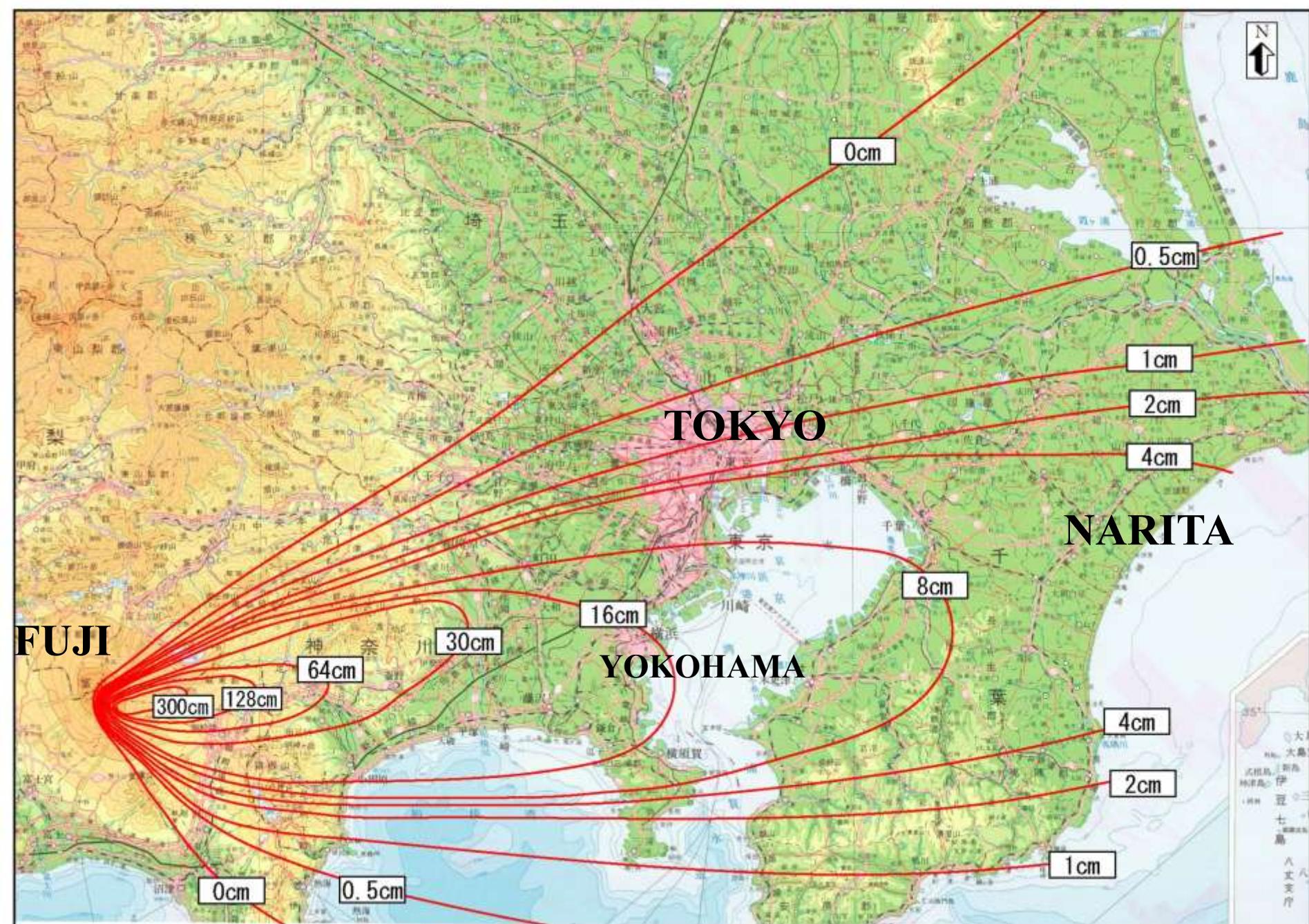
富士宝永火口鳥 **HOEI-SAN**

CRATER 3



1707 VENTS

ISOPACHS OF AIR-FALL PYROCLASTICS, 1707 ERUPTION



DAMAGE ESTIMATES HOEI-EQUIVALENT ERUPTION

CASUALTY ··· NO DEATHS ··· HEALTH HAZARDS ···

EVACUATION

BUILDINGS ··· 280-700 WOODEN HOUSES CRUSHED

TRANSPORTATION ··· ROAD CLOSED 3700-14600 km ···

RAILWAY 1800 km ···

AIR 515 FLIGHTS 220 K PERSON/DAY

LIFELINES ··· ELECTRICITY · GAS · WATER SUPPLY ·
SEWER · COMMUNICATIONS · BROADCASTING

AGRICULTURE · FORESTRY · FISHERY

MANUFACTURING

TOURISM

FLOOD · MUD FLOWS

Total Loss
20 Billion US\$
(in Rainy Seasons)

HAZARDOUS VOLCANIC PHENOMENA

- **BALLISTICS**
- **PYROCLASTIC FALL**
- **LAVA FLOW**
- **PYROCLASTIC FLOW, SURGE**
- **MUD, DEBIRS FLOW**
- GROUND DEFORMATION
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