WebGIS System Development II-1c

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WebGIS System Development II

SQL and Web Processing Service Formulation (WPS)

WebGIS System Development II

I. SQL and Web Processing Service Formulation

II. Spatial Query Results Handling and Visualization

III. OpenLayers and WMS

IV. GetFeatureInfo Implementation

TASKS

WPS: Single Mineral Query
- **phpPgAdmin**
- **PHP Script**
- **Form**
- **Converting Query Results to KML and Shapefile**

WPS: Compound Mineral Query
- **phpPgAdmin**
- **PHP Script**
- **Form**
- **Converting Query Results to KML and Shapefile**

WPS: Spatial Query
- **phpPgAdmin**
- **PHP Script**
- **Form**
- **Converting Query Results to KML, Shapefile and WMS**

WPS: Single Mineral Query

Using Myanmar Data (myanmar_minerals_table)

```
select mineral_co, ST_ASText(the_geom) from myanmar_minerals_table
where mineral_co='Gold';
```

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WPS: Single Mineral Query

Executing the SQL using Form and PHP script

PHP Fragment

```
<?php
$which_mineral=$_GET['the_mineral'];
$dbname =$_GET['database'];
$dbtable =$_GET['table'];
$query_table=$_GET['query_result'];
$kml_file=$_GET['kml_file'];
$mineral_column=$_GET['mineral_column'];

$connect=pg_connect("host=localhost port=5432 dbname=$dbname  user=postgres
password=joelbandibas");
$sql="select $mineral_column, ST_ASText(ST_Transform(the_geom,4326)) from  $dbtable
where $mineral_column='$which_mineral'";
$result=pg_query($connect,$sql);

$sql1="CREATE TABLE $query_table (gid SERIAL PRIMARY KEY, $mineral_column VARCHAR)";
$new_result=pg_query($connect,$sql1);
$sql2="SELECT AddGeometryColumn('$query_table','the_geom',4326,'POINT',2)";
$new_result=pg_query($connect,$sql2);
$number_of_records=pg_numrows($result);
```

WPS: Single Mineral Query

Sample result after executing the SQL using phpPgAdmin

Query Results

mineral_co	st_astext
Gold	POINT(96.399568 24.93756)
Gold	POINT(97.504942 27.423347)
Gold	POINT(97.162159 24.492124)
Gold	POINT(97.139658 24.329399)
Gold	POINT(97.113801 24.425053)
Gold	POINT(97.12166 24.555421)
Gold	POINT(97.075152 24.232523)
Gold	POINT(96.975181 24.052168)
Gold	POINT(96.936801 24.027592)
Gold	POINT(97.004986 24.00786)
Gold	POINT(97.068669 24.214644)
Gold	POINT(96.954003 24.366326)
Gold	POINT(97.578083 25.504461)
Gold	POINT(96.975422 23.964453)
Gold	POINT(96.963607 23.99152)
Gold	POINT(96.993313 23.870901)
Gold	POINT(97.035831 23.814172)
Gold	POINT(97.005283 23.753655)
Gold	POINT(97.000232 23.805199)
Gold	POINT(96.399568 24.93756)
Gold	POINT(96.399568 24.93756)

WPS: Single Mineral Query

Executing the SQL using PHP script

PHP Fragment

```
$sql1="CREATE TABLE $query_table (gid SERIAL PRIMARY KEY, $mineral_column VARCHAR)";
$new_result=pg_query($connect,$sql1);
$sql2="SELECT AddGeometryColumn('$query_table','the_geom',4326,'POINT',2)";
$new_result=pg_query($connect,$sql2);
$number_of_records=pg_numrows($result);

for ($i=0;$i<$number_of_records;$i++)
      {
         $values=pg_fetch_row($result,$i);
         $sql3="INSERT INTO $query_table ($mineral_column,the_geom) VALUES
('$values[0]',ST_GeomFromText('$values[1]',4326))";
         $new_result=pg_query($connect,$sql3);
      }
```

WPS: Single Mineral Query

Executing the SQL using PHP script

```
$script_fname=$shape_fname."_script";

$sh=fopen($script_fname,"w");
fwrite($sh,"#!/bin/sh¥n¥n");
fwrite($sh,"exec /usr/local/pgsql/bin/pgsql2shp -f $shape_fname -h localhost -p 5432 -u
postgres -P joelbandibas $dbname $query_table¥n");
fclose($sh);
exec("chmod +x $script_fname");
$jout=shell_exec($script_fname);

$files_to_zip=$shape_fname.".*";
$final_output_shape_file=$shape_fname.".zip";
exec("zip $final_output_shape_file $files_to_zip");
echo $jout;
```

PHP Fragment
(Query Results Converted to Shapefile)

WPS: Single Mineral Query

Executing the SQL using Form and PHP script

Exercise

1. **Edit the html document *training_one_mineral_kml_shape.html* in your PC.**
2. **Open it using a browser, fill up the form and submit.**
3. **Check the results using WinSCP and phpPgAdmin**

WPS: Single Mineral Query

Executing the SQL using Form and PHP script

HTML Form: ***training_one_mineral_kml_shape.html***
PHP Script: ***training_query_one_mineral_kml_shape.php***

WPS: Compound Mineral Query

Using Myanmar Table

select mineral_co, ST_ASText(the_geom) from myanmar_minerals_table where mineral_co='Gold' or mineral_col='Iron';

WPS: Compound Mineral Query

Executing the SQL using Form and PHP script

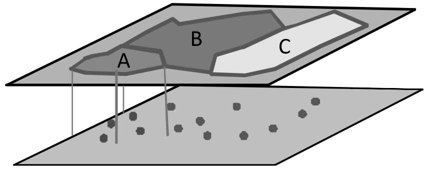
PHP Fragment

```
<?php
$which_mineral1=$_GET['the_mineral1'];
$which_mineral2=$_GET['the_mineral2'];
$dbname =$_GET['database'];
$dbtable =$_GET['table'];
$query_table=$_GET['query_result'];
$kml_file=$_GET['kml_file'];
$mineral_column=$_GET['mineral'];

$connect=pg_connect("host=localhost port=5432 dbname=$dbname  user=postgres
password=joelbandibas");
$sql="select $mineral_column, ST_ASText(ST_Transform(the_geom,4326)) from  $dbtable
where $mineral_column='$which_mineral1'  or $mineral_column='$which_mineral2' ";
$result=pg_query($connect,$sql);

$sql1="CREATE TABLE $query_table (gid SERIAL PRIMARY KEY, $mineral_column VARCHAR)";
$new_result=pg_query($connect,$sql1);
$sql2="SELECT AddGeometryColumn('$query_table','the_geom',4326,'POINT',2)";
$new_result=pg_query($connect,$sql2);
$number_of_records=pg_numrows($result);
```

WPS: Spatial Query

ST_Within: Returns true if the geometry A is completely inside geometry B

BOOLEAN ST_Within(geometry A, geometry B)



Map_A

Map_B

Sample Query: Get points of Map_B if they are inside polygon A of Map_A

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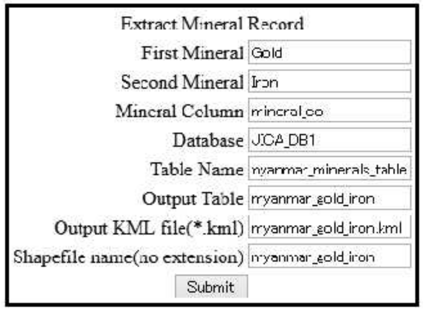
Compound Mineral Query

Executing the SQL using Form and PHP script



Extract Mineral Record

First Mineral	Gold
Second Mineral	Iron
Mineral Column	mineral_co
Database	JICA_DB1
Table Name	myanmar_minerals_table
Output Table	myanmar_gold_iron
Output KML file(*.kml)	myanmar_gold_iron.kml
Shapefile name(no extension)	myanmar_gold_iron

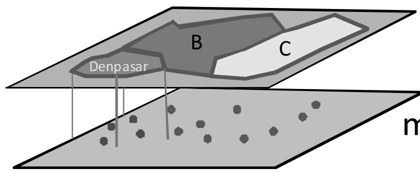
Submit

HTML Form: ***training_one_compound_kml_shape.html***
PHP Script: ***training_query_compound_mineral_kml_shape.php***

WPS: Spatial Query

Exercise

ST_Within Using Actual Data in phpPgAdmin



east_asia_geology_table

myanmar_minerals_table

Sample Query: Get mineral data covering Denpasar province

The Corresponding SQL

select myanmar_minerals_table.mineral_co, myanmar_minerals_table.the_geom from myanmar_minerals_table,east_asia_geology_table where ST_Within(myanmar_minerals_table.the_geom, east_asia_geology_table.the_geom) and east_asia_geology_table.geo_des ='Q_S: Sedimentary Rocks, Quaternary';

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WPS: Spatial Query

ST_Within Using Actual Data in phpPgAdmin

The Corresponding SQL

```
select myanmar_minerals_table.mineral_co,
myanmar_minerals_table.the_geom
from
myanmar_minerals_table,east_asia_geology_table
where
ST_Within(myanmar_minerals_table.the_geom,
east_asia_geology_table.the_geom)
and
east_asia_geology_table.geo_des ='Q_S: Sedimentary Rocks,
Quaternary';
```


WPS: Spatial Query

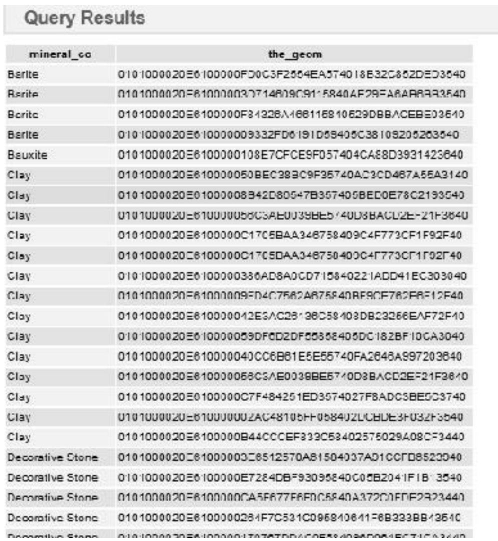
Executing the ST_Within SQL using Form and PHP script

```
$sql="select $final_mineral_column, ST_ASText(ST_Transform($final_mineral_the_geom,4326)) from $mineral_dbtable2, $polygon_dbtable1 where  ST_Within($final_mineral_the_geom, $final_polygon_the_geom) and $final_polygon_column='$which_polygon';";

$result=pg_query($connect,$sql);

$sql1="CREATE TABLE $query_table (gid SERIAL PRIMARY KEY, $table2_mineral_column VARCHAR)";
$new_result=pg_query($connect,$sql1);
$sql2="SELECT AddGeometryColumn('$query_table','the_geom',4326,'POINT',2)";
$new_result=pg_query($connect,$sql2);
$number_of_records=0;
$number_of_records=pg_numrows($result);
```

PHP Fragment

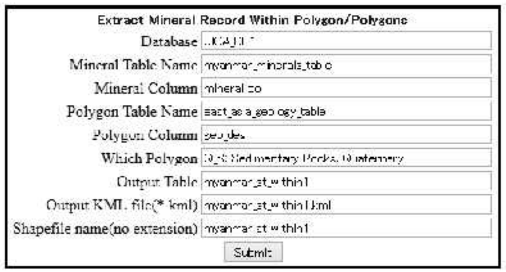
WPS: Spatial Query

ST_Within Using Actual Query Result



WPS: Spatial Query

Executing the ST_Within SQL using Form and PHP script



HTML Form: *training_st_within_kml_shape.html*
PHP Script: *training_query_st_within_kml_shape.php*

WPS: Spatial Query

Executing the ST_Within SQL using Form and PHP script

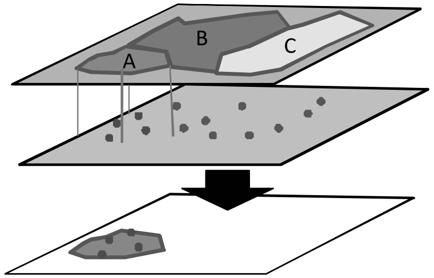
Exercise

1. **Edit the html document *training_st_within_kml_shape.html* in your PC.**
2. **Open it using a browser, fill up the form and submit.**
3. **Check the results using WinSCP and phpPgAdmin**

WPS: Spatial Query

ST_Intersects *is a function that takes two geometries and returns true if any part of those geometries is shared between the two.*

BOOLEAN ST_Intersects(geometry *geomA* , geometry *geomB*)



Sample Query: Get points of Map_B that intersect polygon A of Map_A

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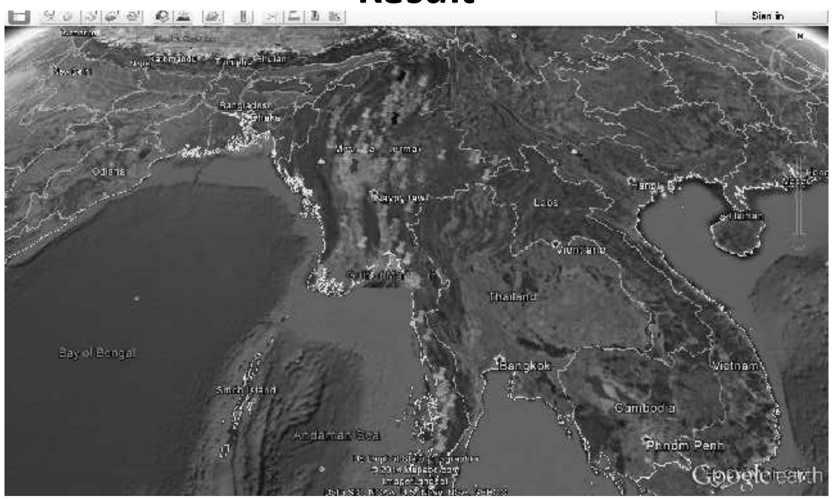
WPS: Spatial Query

Executing the ST_Within SQL using Form and PHP script

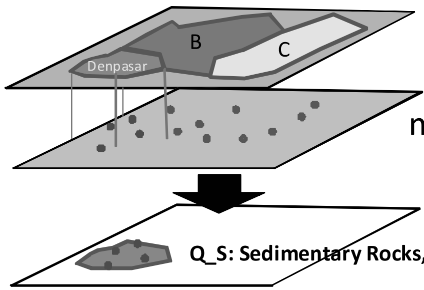
Result



WPS: Spatial Query

Exercise

ST_Intersects Using Actual Data in phpPgAdmin



Sample Query: Get mineral data covering polygon 'Q_S: Sedimentary Rocks, Quaternary';

The Corresponding SQL

select myanmar_minerals_table.mineral_co, myanmar_minerals_table.the_geom from myanmar_minerals_table INNER JOIN east_asia_geology_table ON ST_Intersects (myanmar_minerals_table.the_geom, east_asia_geology_table.the_geom) and east_asia_geology_table.geo_des='**Q_S: Sedimentary Rocks, Quaternary**';

WPS: Spatial Query

ST_Intersects

The SQL

```
select myanmar_minerals_table.mineral_co,
myanmar_minerals_table.the_geom
from
myanmar_minerals_table INNER  JOIN
east_asia_geology_table ON ST_Intersects
(myanmar_minerals_table.the_geom,
east_asia_geology_table.the_geom)
and
east_asia_geology_table.geo_des='Q_S: Sedimentary Rocks,
Quaternary';
```

WPS: Spatial Query

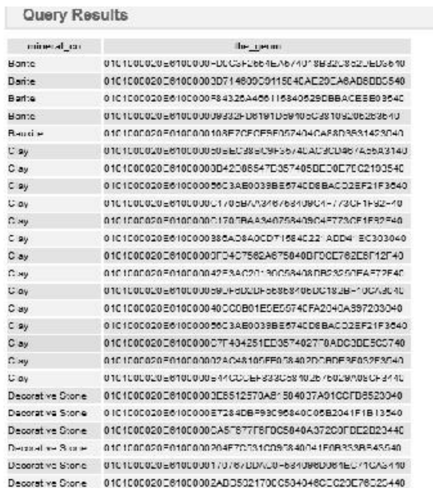
Executing the ST_Intersects SQL using Form and PHP script

```
$sql="select $final_mineral_column, ST_ASText(ST_Transform($final_mineral_the_geom,4326))
from $mineral_dbtable2 INNER JOIN $polygon_dbtable1 ON
ST_Intersects($final_mineral_the_geom,$final_polygon_the_geom) and
$final_polygon_column='$which_polygon';";

$result=pg_query($connect,$sql);

$sql1="CREATE TABLE $query_table (gid SERIAL PRIMARY KEY, $table2_mineral_column VARCHAR)";
$new_result=pg_query($connect,$sql1);
$sql2="SELECT AddGeometryColumn('$query_table','the_geom',4326,'POINT',2)";
$new_result=pg_query($connect,$sql2);
$number_of_records=0;
$number_of_records=pg_numrows($result);
```

PHP Fragment

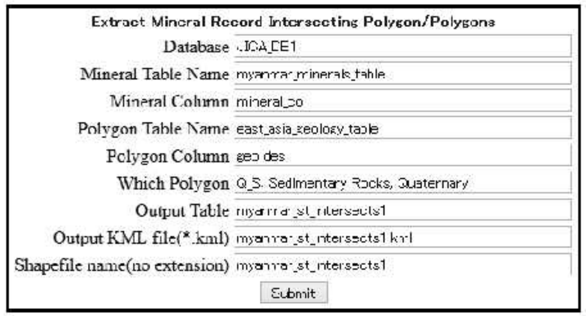
WPS: Spatial Query

ST_Intersects Using Actual Query Result



WPS: Spatial Query

Executing the ST_Intersects SQL using Form and PHP script



HTML Form: *training_st_intersects_kml_shape.html*
PHP Script: *training_query_st_intersects_kml_shape.php*

WPS: Spatial Query

Executing the ST_Intersects SQL using Form and PHP script

Exercise

1. **Edit the html document *training_st_within_kml_shape.html* in your PC.**
2. **Open it using a browser, fill up the form and submit.**
3. **Check the results using WinSCP and phpPgAdmin**

WPS: Spatial Query

Executing the ST_Intersects SQL using Form and PHP script and Converting Query Results to WMS

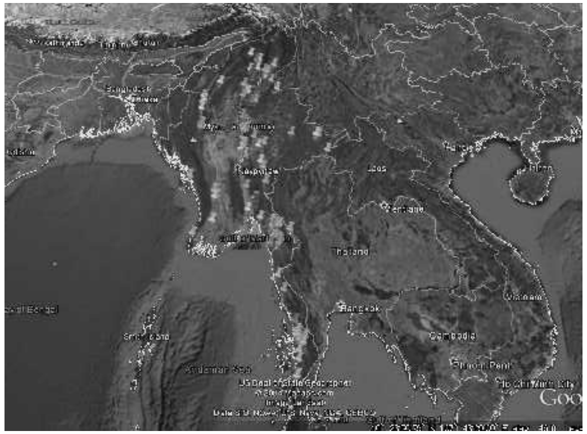
PHP Fragment

```
################################################## start writing mapfile
$fh=fopen($mapfile_output,"w");
fwrite($fh,"$map_comment¥n");
fwrite($fh,"MAP¥n");
fwrite($fh," NAME $map_ogc_name¥n");
fwrite($fh," STATUS ON¥n");
fwrite($fh," SIZE 256 256¥n");
fwrite($fh," EXTENT $map_extent¥n");
fwrite($fh," UNITS dd¥n");
##fwrite($fh,' SHAPEPATH "data"');fwrite($fh,"¥n");
fwrite($fh," IMAGECOLOR  255 255 255¥n");
fwrite($fh," IMAGETYPE gif¥n");
fwrite($fh," PROJECTION¥n");
fwrite($fh,"  ¥"init=epsg:$map_srid¥"¥n");
fwrite($fh," END¥n¥n");

fwrite($fh,"OUTPUTFORMAT¥n");
fwrite($fh,"  NAME gif¥n");
fwrite($fh,'  DRIVER "GD/GIF"');fwrite($fh,"¥n");
fwrite($fh,'  MIMETYPE "image/gif"');fwrite($fh,"¥n");
fwrite($fh,'  EXTENSION "gif"');fwrite($fh,"¥n");
fwrite($fh,"  TRANSPARENT ON¥n");
fwrite($fh," END¥n¥n");
```

WPS: Spatial Query

Executing the ST_Intersects SQL using Form and PHP script

Result



WPS: Spatial Query

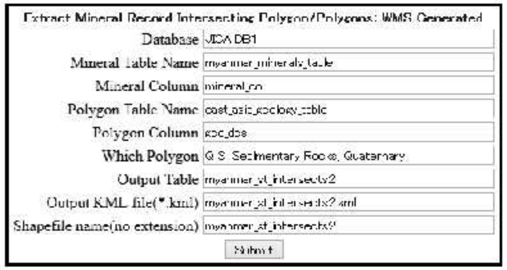
Executing the ST_Intersects SQL using Form and PHP script and Converting Query Results to WMS

PHP Fragment

```
fwrite($fh," LAYER¥n");
fwrite($fh,"    NAME $layer_name¥n");
fwrite($fh,"    METADATA¥n");
fwrite($fh,"      WMS_TITLE ¥"$wms_layer_title¥"¥n");
fwrite($fh,"      WMS_ABSTRACT ¥"$wms_layer_abstract¥"¥n");
fwrite($fh,"      WMS_SRS ¥"EPSG:$map_srid ESRI:54004 EPSG:4326 EPSG:4612 EPSG:4301 EPSG:900913¥"¥n");
fwrite($fh,"    END¥n¥n");
fwrite($fh,"      connectiontype postgis¥n");
fwrite($fh,"      connection ¥"user=$dbuser password=$dbpassword dbname=$dbname host=$host port=$port¥"¥n");
fwrite($fh,"      data ¥"the_geom from $dbtable using unique gid¥"¥n");
fwrite($fh,"    TYPE POINT¥n");
fwrite($fh,"    STATUS ON¥n");
fwrite($fh,"    PROJECTION¥n");
fwrite($fh,"      ¥"init=epsg:$map_srid¥"¥n");
fwrite($fh,"    END¥n¥n");

fwrite($fh,"    CLASSITEM ¥"$column_class_item¥"¥n¥n");

############################ layer legend definition
$sql="SELECT DISTINCT ON ($column_class_item) $column_class_item from $dbtable";
$result=pg_query($connect,$sql) or die("coud not get bla bla bla");
$counter=0;
$number_of_rows=pg_numrows($result);
```

WPS: Spatial Query

Executing the ST_Intersects SQL using Form and PHP script and Converting Query Results to WMS


Extract Mineral Record Intersecting Polygon/Polygons: WMS Generated

Database	JICA DB1
Mineral Table Name	myanmar_minerals_table
Mineral Column	mineral_co
Polygon Table Name	cost_asia_geology_table
Polygon Column	soc_dss
Which Polygon	Q S Sedimentary Rocks, Quaternary
Output Table	myanmar_st_intersects2
Output KML file(*.kml)	myanmar_st_intersects2.kml
Shapefile name(no extension)	myanmar_st_intersects2

Submit

HTML Form: *training_st_intersects_kml_shape_wms.html*
PHP Script: *training_query_st_intersects_kml_shape_wms.php*

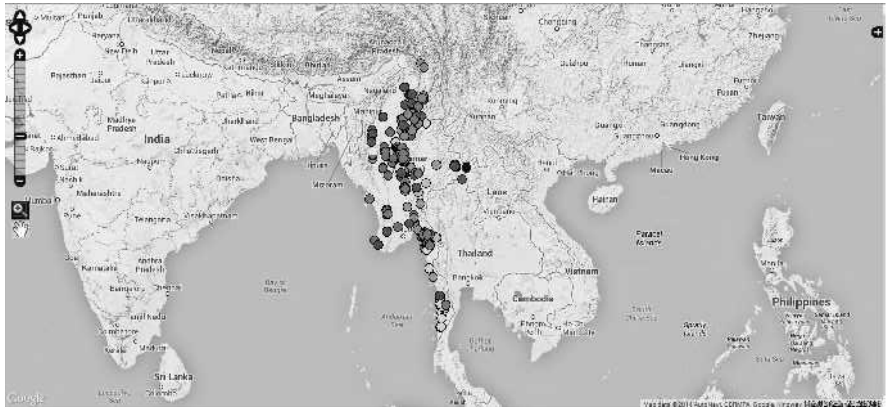
Mapfile Output At: /var/www/training_mapfiles/
WMS Script Ouput At: /var/www/cgi-bin/training_wms/

Important:
Mapfile and WMS script file names are the same as your Output Table name.

WPS: Spatial Query

Executing the ST_Intersects SQL using Form and PHP script and Converting Query Results to WMS

Resulting WMS



WPS: Spatial Query

Executing the ST_Intersects SQL using Form and PHP script

Exercise

1. **Edit the html document** ***training_st_within_kml_shape_wms.html*** **in your PC.**
2. **Open it using a browser, fill up the form and submit.**
3. **Check the results using WinSCP and phpPgAdmin**

Appendix 7

Geohazard

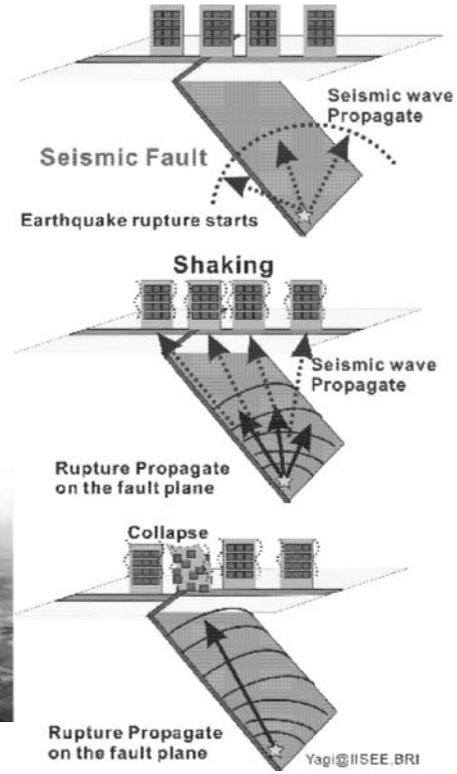
Subduction-type large earthquakes: Their tectonic and diversity mechanisms scope for future prediction

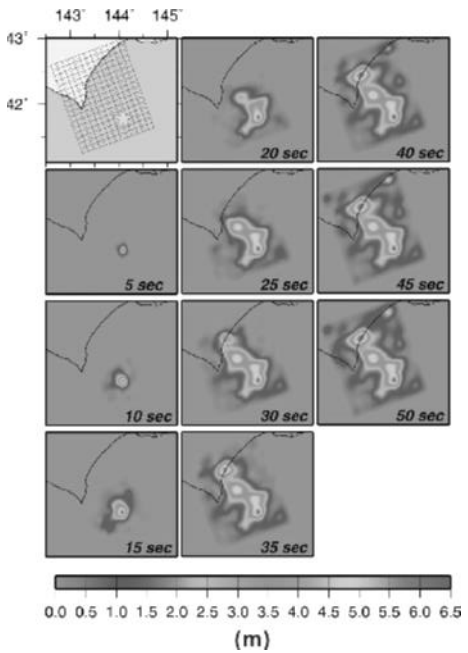
Yuji Yagi (University of Tsukuba)

Earthquake Process

Earthquake is a term used to describe both failure process along a fault zone, and the resulting ground shaking and radiated seismic energy caused by the slip, or by volcanic or magmatic activity, or other sudden stress changes in the earth.

Surface rupture (Taken by Prof. Abe, the University of Tokyo)



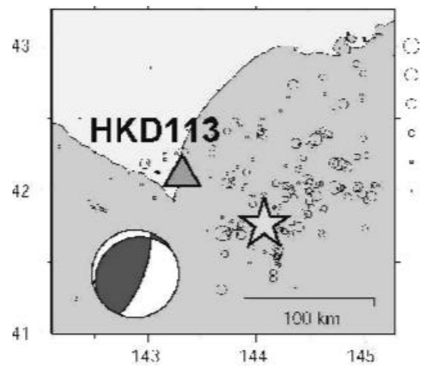


2003 Tokachi-oki, Japan earthquake

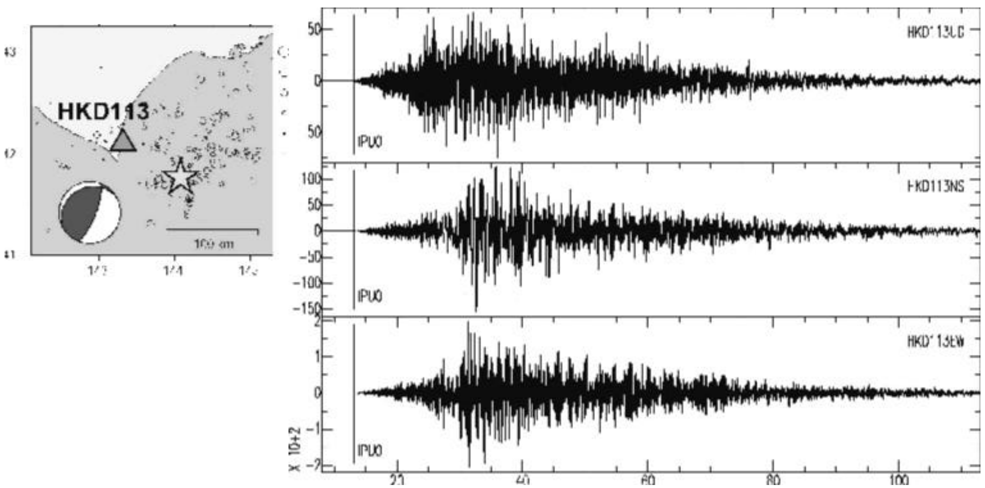
Rupture Process of Large Earthquake

Ground Motion

When an earthquake occurs, the ground shakes. The motion of ground is given by displacement ***u(t),*** velocity ***v(t),*** acceleration ***a(t),*** as a function of time, t, in 3 directions, usually, **UD**, **NS**, and **EW**.



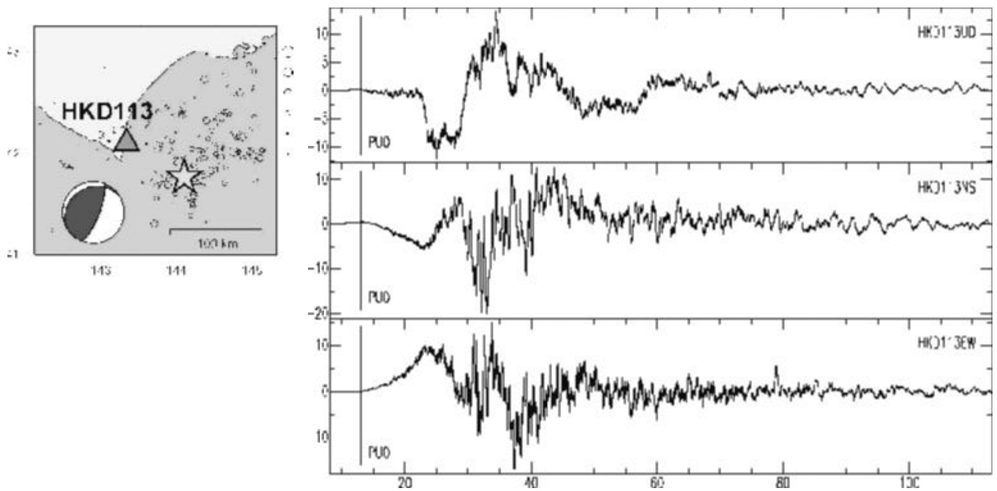
Acceleration



(unit: gal = cm/s/s)

2003 Tokachi-oki, Japan earthquake
station HKD113 (K-net)

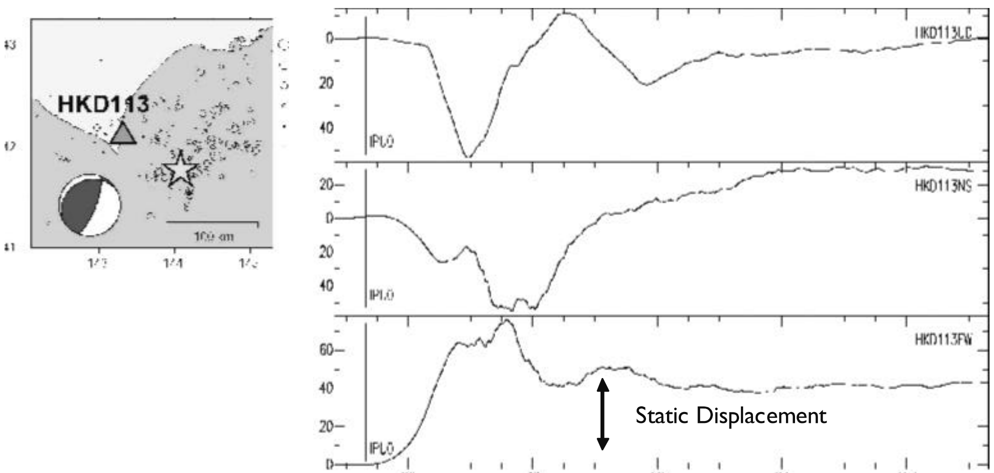
Velocity



(unit: cm/s)

2003 Tokachi-oki, Japan earthquake
station HKD113 (K-net)

Displacement

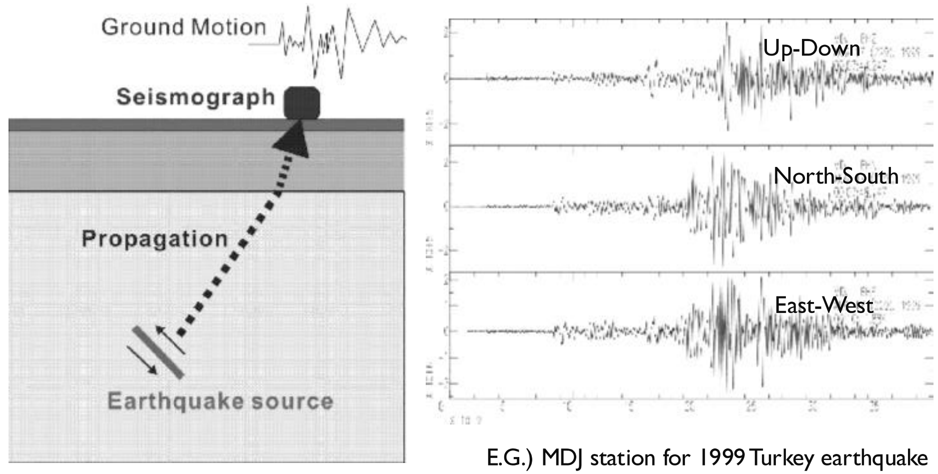


(unit: cm)

2003 Tokachi-oki, Japan earthquake
station HKD113 (K-net)

Seismology

Seismology is the study of earthquakes and the Earth using seismic waves.



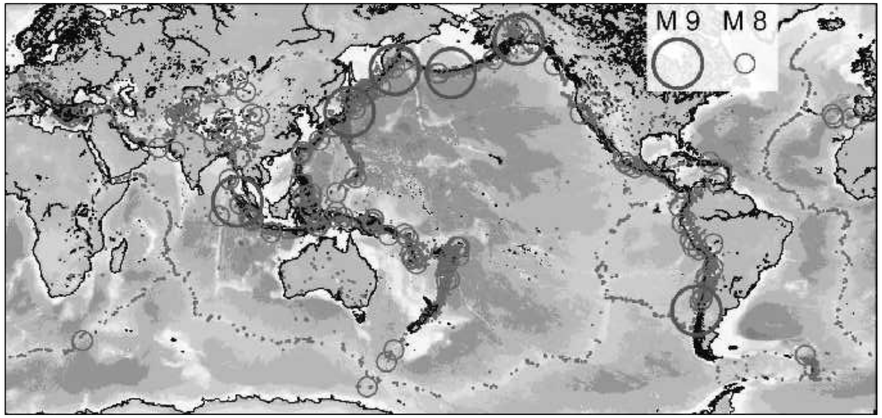
E.G.) MDJ station for 1999 Turkey earthquake

Seismology for source

From recordings of earthquake-generated waves, information about the earthquake source may be derived, including its magnitude, location, time of occurrence, its orientation, and movement on the fault.

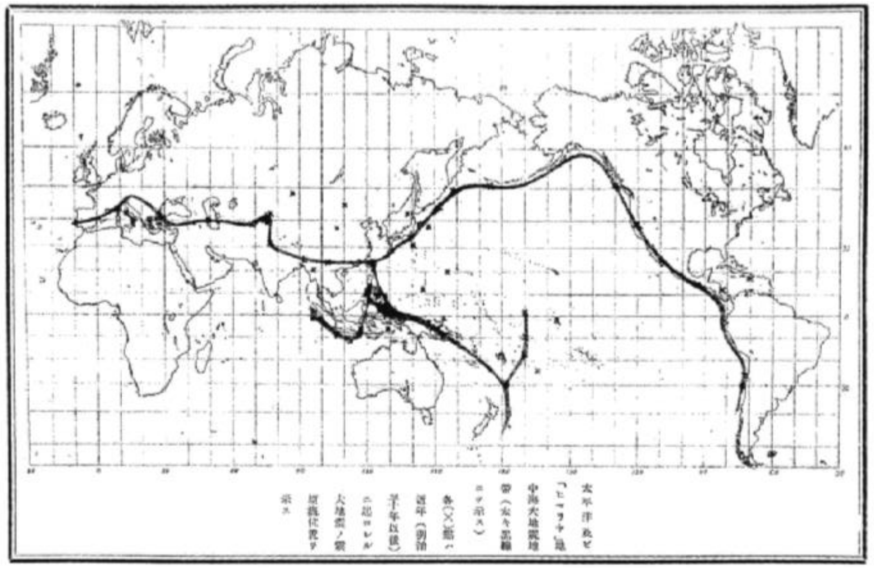
Surface rupture in 1999 Taiwan, Chi-Chi earthquake (Taken by Prof. Abe, the University of Tokyo)

Seismicity Map



Epicenter determined by USGS

Seismicity Map



Omori（1921）

OMORI Fusakichi (大森房吉)

Wkipedia

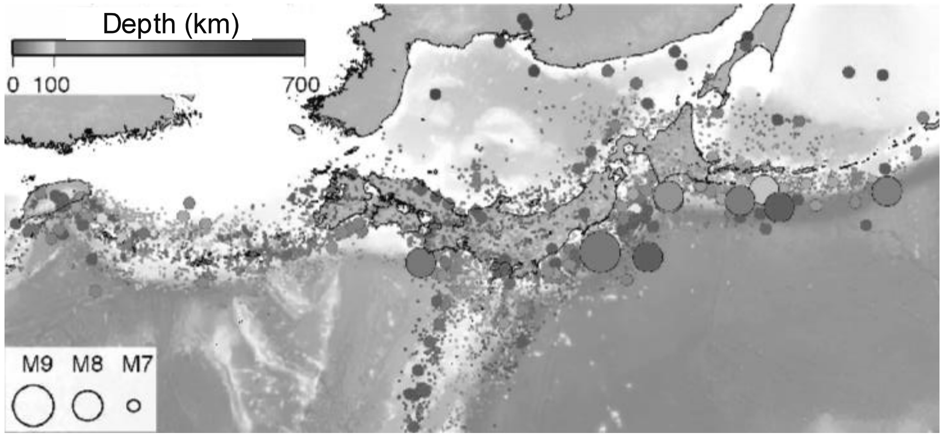
Omori's Law： declining aftershock rate

$$n(t)=\frac{K}{(t+c)^p}$$

Omori's formula: Relationship between distance from observation to hypocenter and [Ts - Tp].

$$d=k(Ts-Tp)$$

Seismicity map of Japan



Hypocenter determined by JMA

"Namazu-e" (Pictures of the gigantic catfish)

"Namazu-e" (Pictures of the gigantic catfish

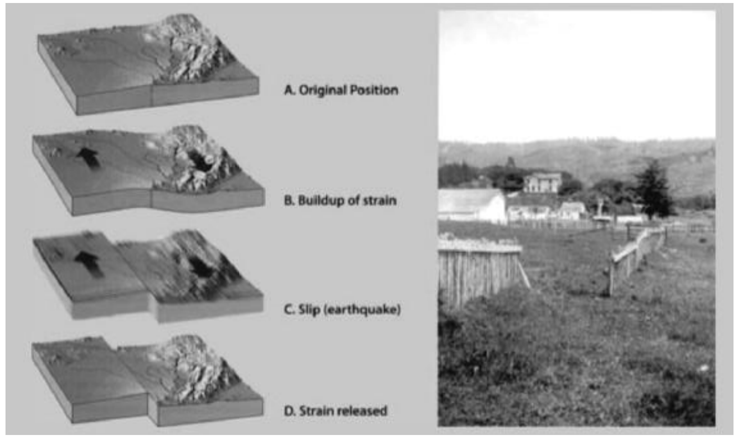
not only Destructive phenomena
but also Reconstruction & Revitalize event

"Namazu-e" (Pictures of the gigantic catfish)

Seismic wave radiated from fault dislocation

1891 Nobi , central Japan, earthquake

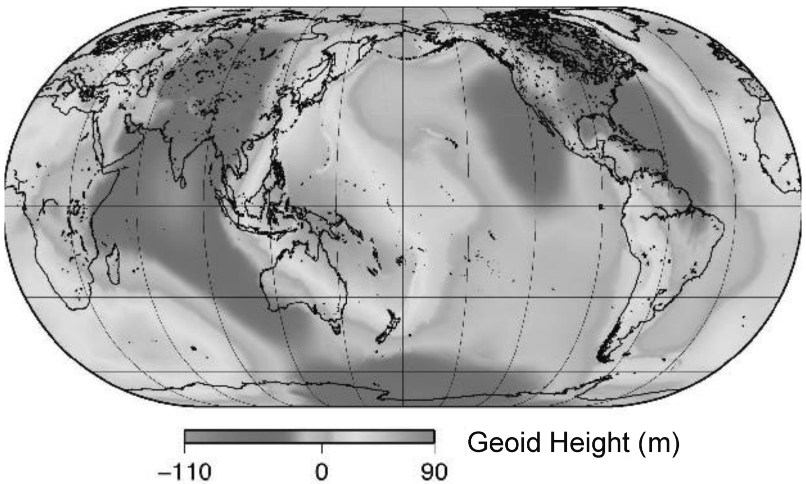
Elastic rebound theory



From Stanford University and the 1906 Earthquake

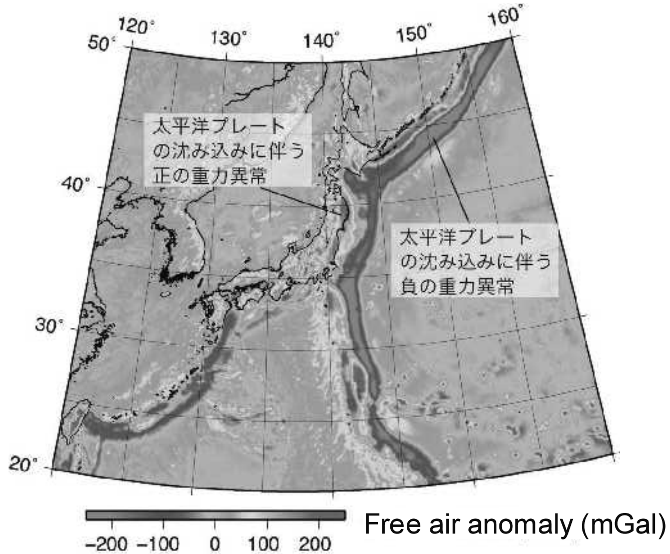
[Earthquake] = [Rapid dislocation along fault, releasing accumulated elastic strain] (by H. F. Reid)

Geoid Height (heterogeneity structure)



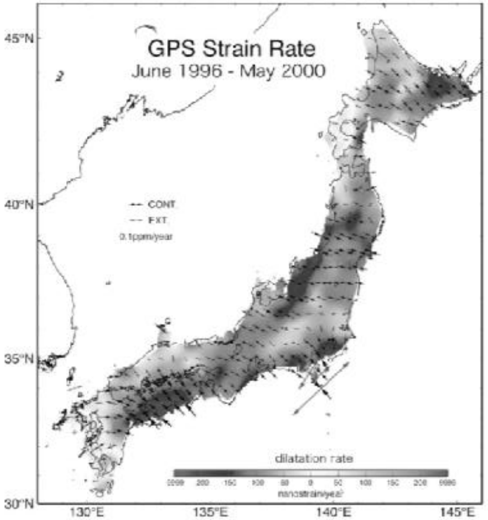
Data source：EGM2008

Free air anomaly



Data source：NOAA

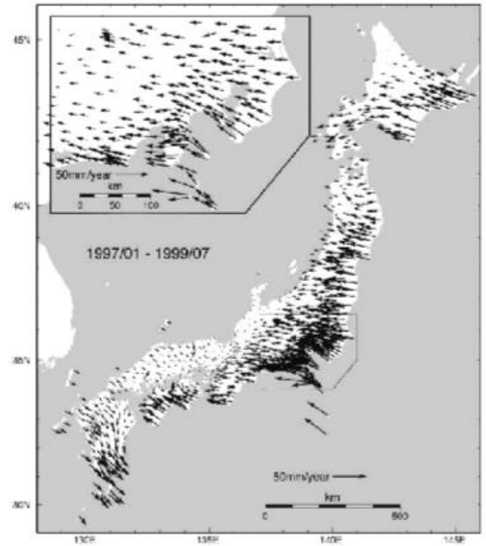
Dilatational strain



Heterogeneous distribution:
Why?
- Earthquake (pre & after)
- Volcanic activity
- Heterogeneous distribution of crustal strength.

Sagiya 2004

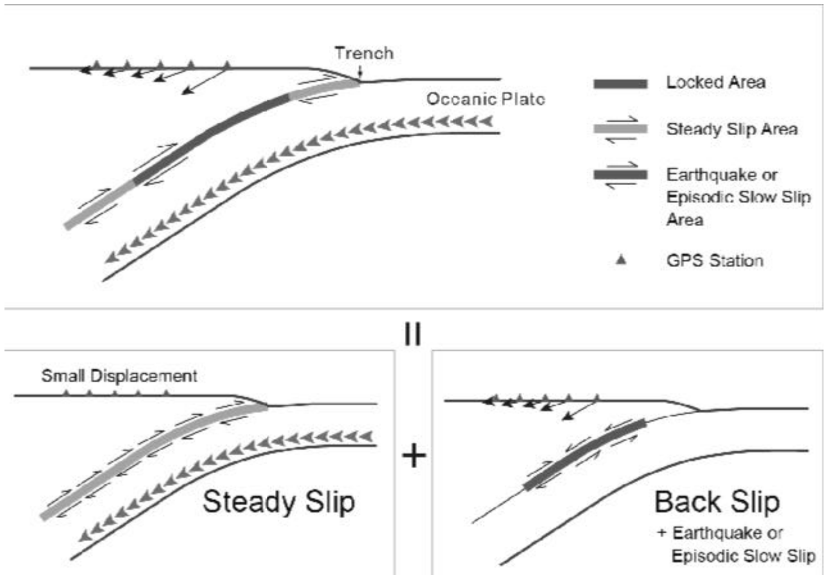
Crustal deformation of Japan



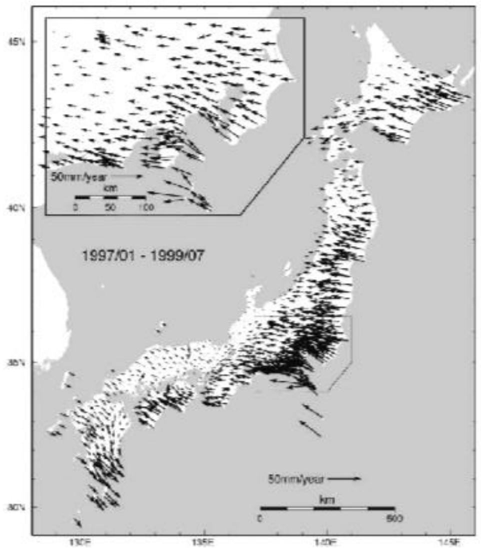
Heterogeneous distribution:
Why?
- Earthquake (pre & after)
- Volcanic activity
- Heterogeneous distribution of crustal strength.

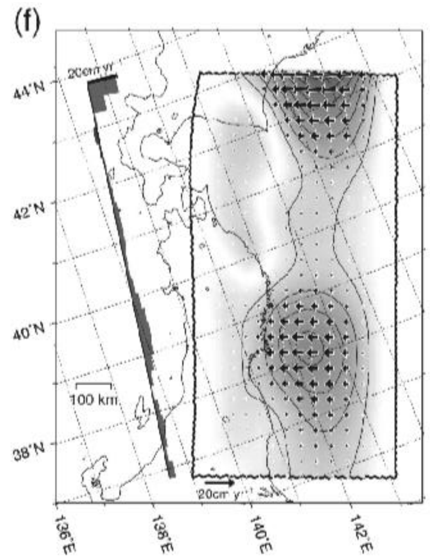
Sagiya 2004

Displacement field and strain accumulation



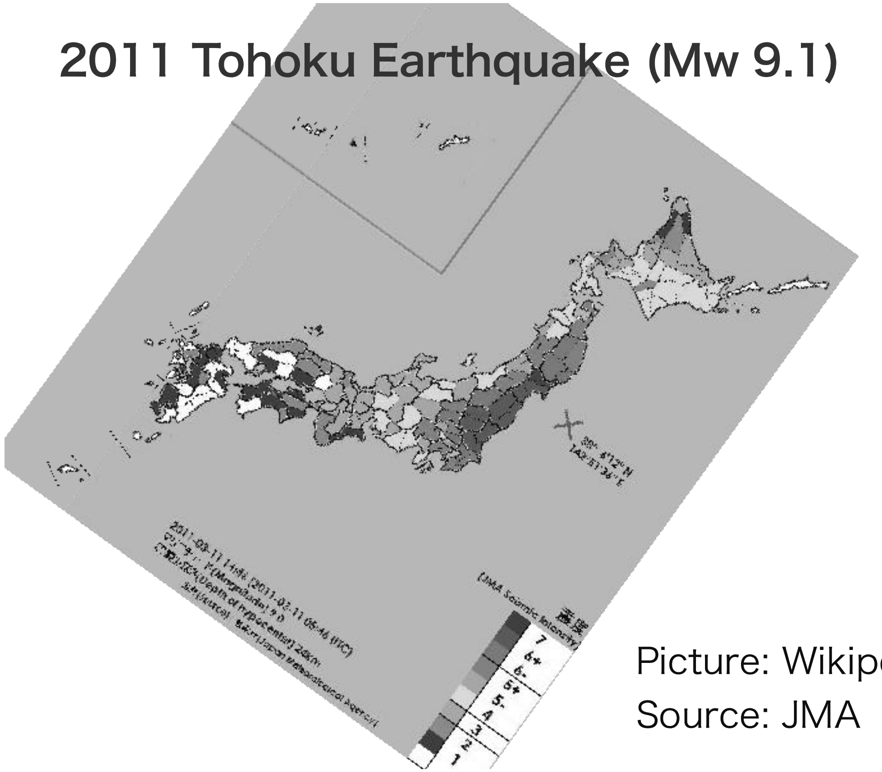
Slip deficit distribution





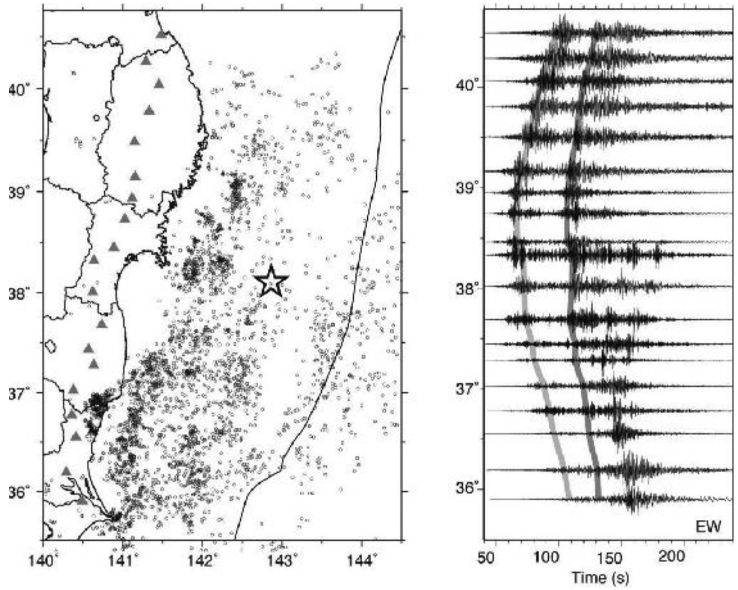
Nishimura et al., (2004)

2011 Tohoku Earthquake (Mw 9.1)



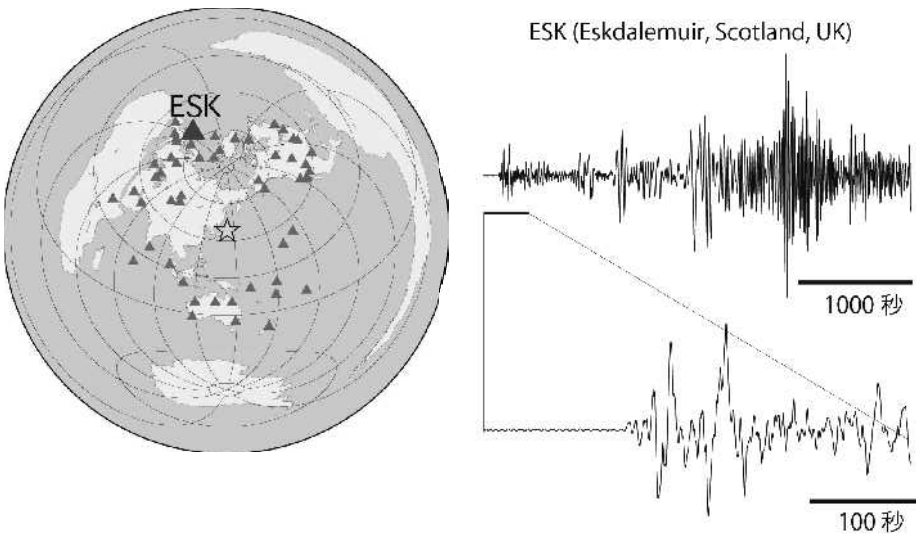
Picture: Wikipedia
Source: JMA

2011 Tohoku Earthquake (Mw 9.1)



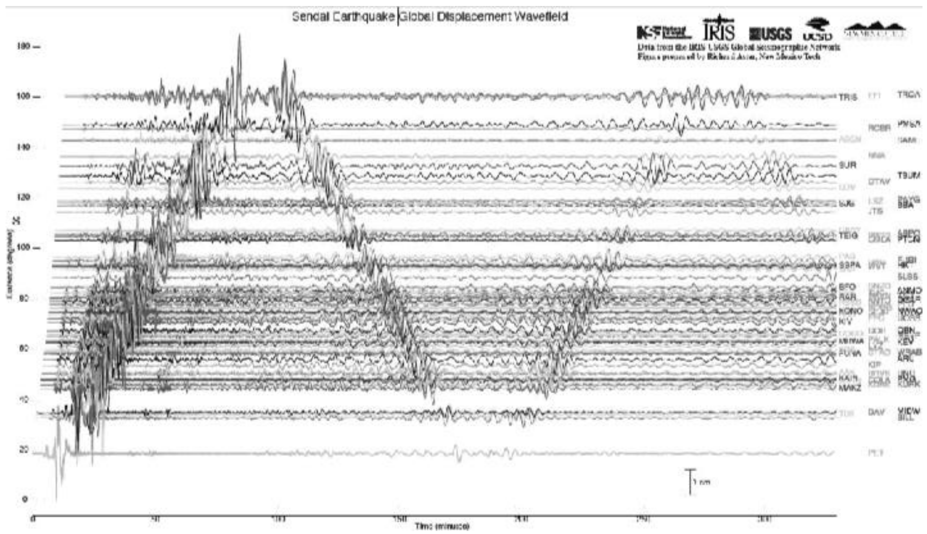
Data Source: K-NET, NIED

2011 Tohoku Earthquake (Mw 9.1)



Data source: IRIS-DMC

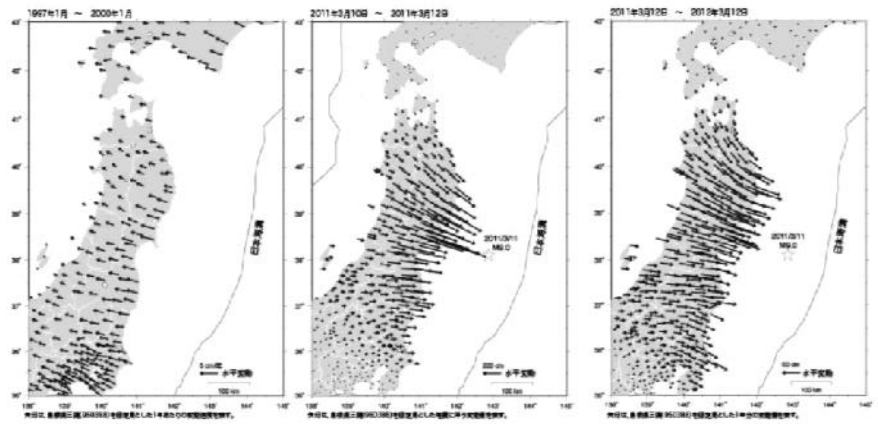
2011 Tohoku Earthquake (Mw 9.1)



Data source: IRIS-DMC

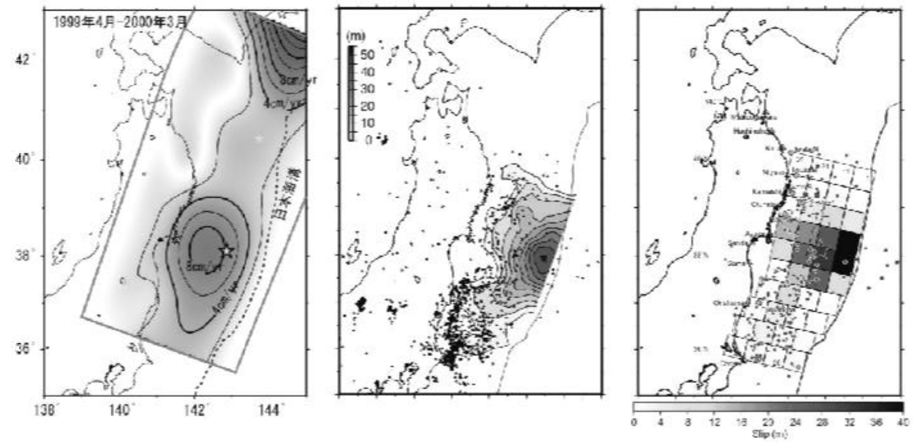
Crustal deformation related to mega-quake

Pre-earthquake | Earthquake | After-earthquake



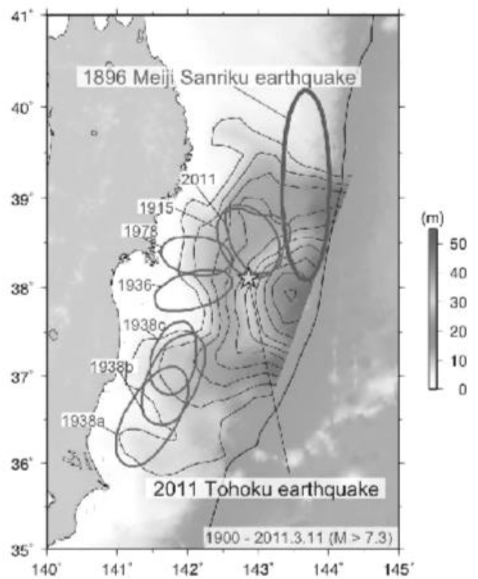
Slip deficit & stress release (2011 Tohoku EQ.)

Slip deficit | Co-seismic slip distribution



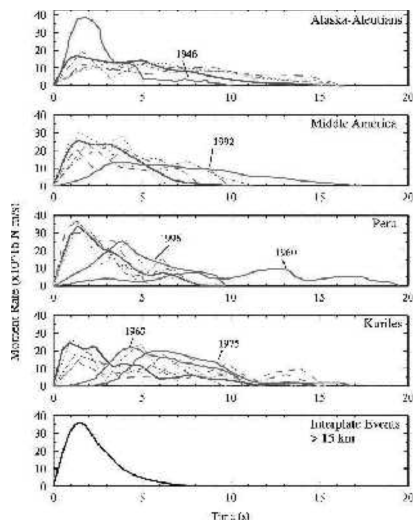
Nishimura et al., (2004) | Yagi & Fukahata (2011) | Fuji et al. (2011)

Mega-thrust & Tsunami EQ.



At least part of the source region of the 1896 tsunami earthquake overlapped with the extremely large slip area of the 2011 Tohoku-oki earthquake

Tsunami earthquake

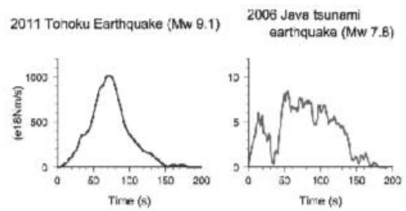


Bilek and Lay (2002)

Low-rate of seismic wave radiation

= Slow slip on fault

→ long source duration



Yagi and Fukahata (2011)

Mega-thrust and Slow Tsunami EQ

Tohoku megathrust EQ

- Huge release of strain energy

(1) Super strong patch
(e.g., Kato and Yoshida)
(2) Very large patch
(e.g., Hori and Miyazaki)

(3) Dynamic frictional weakening process to release large part of absolute stress
(e.g. Mitsui et al., 2011; Shibazaki et al., 2011)

Slow Tsunami EQ

- Larger tsunami than expected from seismic wave

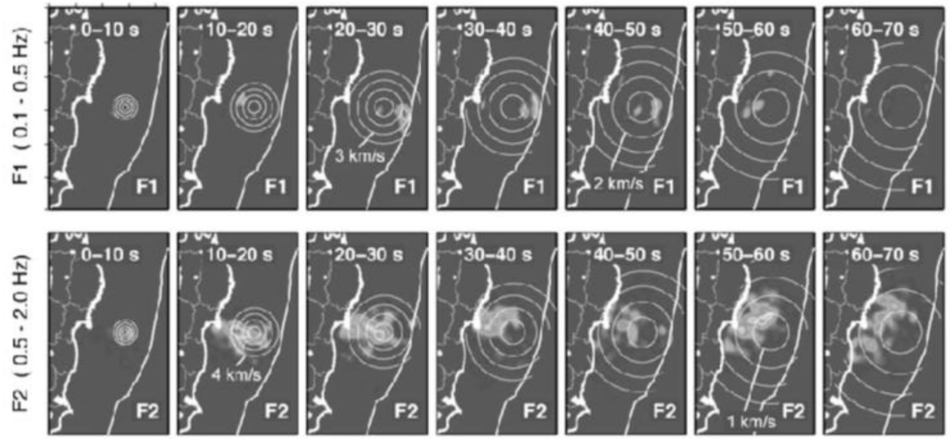
- Low stress drop
- Slow slip near trench

- Fault branching ?
- Seafloor landslide ?
- Sediment deformation ?

Different slip behavior in the shallow part of the subducting plate

Seismic radiation

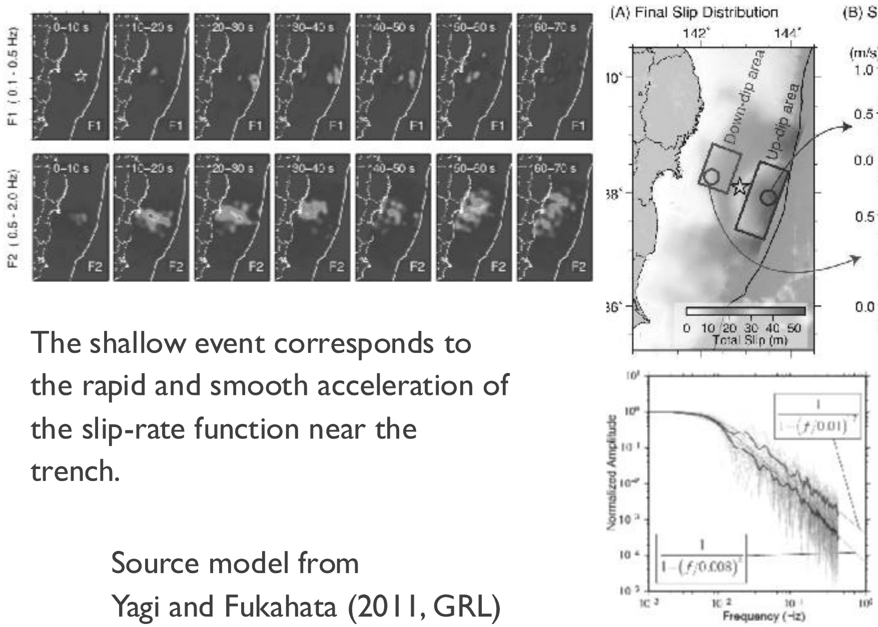
Yagi; Nakao; Kasahara (2012, EPSL)



The large slip-rate on the shallow part of the fault along the Japan Trench was evident only for the Low frequency dataset.

HBP and Inversion

Yagi; Nakao; Kasahara (2012, EPSL)



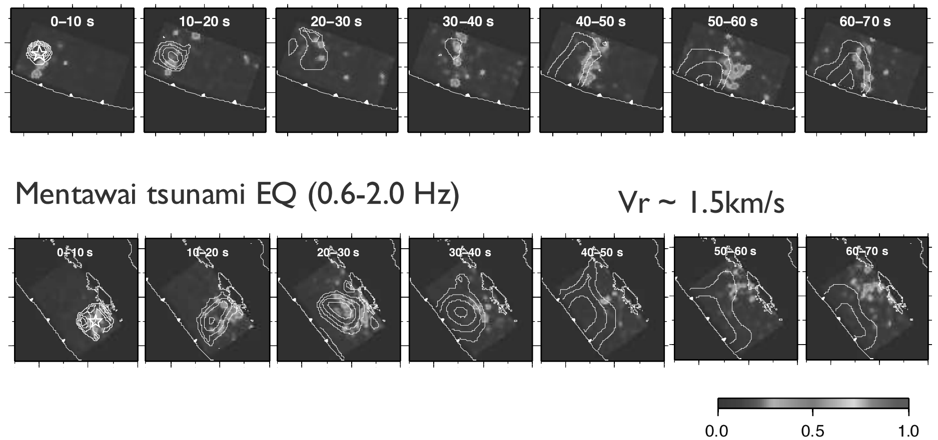
The shallow event corresponds to the rapid and smooth acceleration of the slip-rate function near the trench.

Source model from
Yagi and Fukahata (2011, GRL)

Application to Two Tsunami EQ.

Java tsunami EQ (0.5-2.0 Hz) Vr ~ 1.25km/s

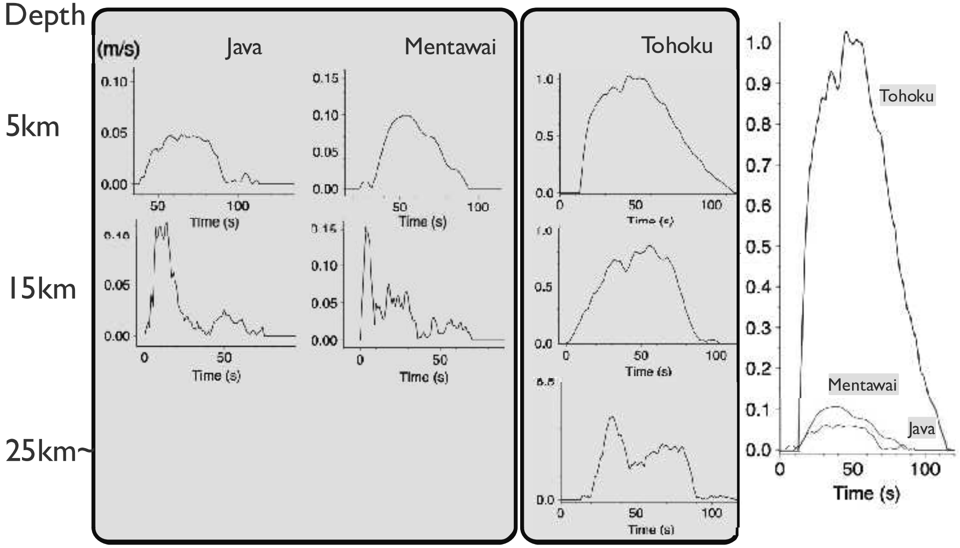
Mentawai tsunami EQ (0.6-2.0 Hz) Vr ~ 1.5km/s



Slow and smooth slip near trench seems to be triggered by deep rupture.

We have never found the rapid and smooth slip near trench.

Slip-rate function for mega-thrust EQ and slow tsunami EQ



Acceleration of Slip near trench is high only for the Tohoku EQ !

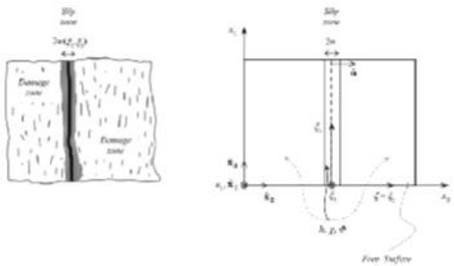
Megathrust EQ and Slow Tsunami EQ

Mitsui & Yagi (2013, GRL)

Tohoku megathrust EQ	Slow Tsunami EQ
• Huge release of strain energy	• Low stress drop
• Rapid and smooth slip near trench detected by waveform inversion and HBP. Dynamic frictional weakening (**strong contribution**) near trench triggered by deep rupture?	• smooth slip near trench seems to be triggered by deep rupture. Dynamic frictional weakening (**weak contribution**) near trench triggered by deep rupture?

Dynamic weakening mechanism of thermal pressurization (TP)

Mitsui & Yagi (2013, GRL)



Material Parameter — Shear Stress — Hydraulic Diffusivity (m^2/s)

$$p(t) = p_0 + \frac{A}{w}\int_0^t \mu(t')\left[\sigma - p(t')\right] v(t') F(t,t',w,\chi,\varpi)\,dt'$$

0.05 m — Slip Velocity (m/s) — Temperature Diffusivity (m^2/s)

$$F(t,t',w,\chi,\varpi) = \left[-\frac{\chi}{\varpi-\chi}\operatorname{erf}\left(\frac{w}{4\sqrt{\chi(t-t')}}\right) + \frac{\varpi}{\varpi-\chi}\operatorname{erf}\left(\frac{w}{4\sqrt{\varpi(t-t')}}\right)\right]$$

Bizzarri and Cocco (2006, JGR)

Elastodynamic rupture simulation:

Solving the evolution of stress and slip, assuming evolution laws of frictional strength

Mitsui & Yagi (2013, GRL)

・Method: Boundary element method in frequency domain

(Geubelle and Rice [1995], Day et al. [2005])

・Friction: Velocity and state-dependent law (Ampuero and Ben-Zion, 2008)

$$\mu = \mu_0 + \alpha\frac{v}{v+v_c} - \beta\frac{\theta}{\theta+v_c}$$

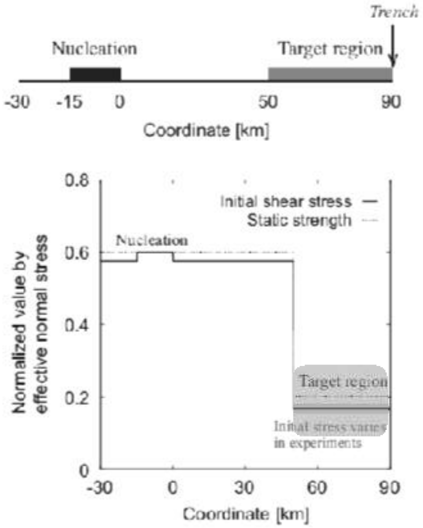
$$\frac{d\theta}{dt} = \frac{v-\theta}{t_c}$$

and nonlinear weakening with thermal fluid pressurization due to shear heating 『TP』 (Bizzarri and Cocco [2006])

Elastodynamic rupture simulation:

Solving the evolution of stress and slip, assuming evolution laws of frictional strength

Mitsui & Yagi (2013, GRL)



・Boundary condition:

free end (mirroring) for the trench, and fixed end for the other extremity

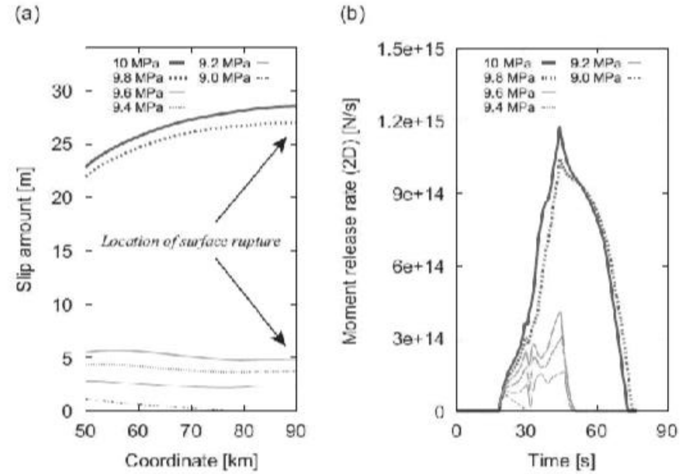
・Initial condition:

seismic rupture starts from the nucleation area

Performing experiments by varying the initial stress in the target shallow region, to check the fault behavior

Results

Mitsui & Yagi (2013, GRL)



Megathrust EQ: Huge slip near trench and triangular source time function

Slow tsunami EQ: Large slip near trench and trapezoidal source time function

Ordinary EQ: No slip near trench and triangular source time function

Megathrust EQ and Slow Tsunami EQ

Observation of Megathrust EQ and Slow Tsunami EQ

✳ Dynamic frictional weakening near trench seems to be triggered by deep rupture;

✳ Smooth and rapid slip event is detected only for the Tohoku megathrust Eq.

Simulation of Megathrust EQ and Slow Tsunami EQ

✳ The sensitive dependence on the initial stress conditions of the earthquakes growth.

Megaquakes with huge slip near trench.

⬍ Slow Tsunami earthquake as a transient phenomenon

Ordinary earthquake without surface rupture

JICA-GSJ/AIST Asia Region Data Collection Survey on Geological Mapping and Mineral Information System in ASEAN

G-EVER volcanic hazard assessment assist system and Asia-Pacific region earthquake and volcanic hazard mapping project

Shinji Takarada
G-EVER Promotion Team
Geological Survey of Japan, AIST

Recent Volcanic Eruption and Earthquake


Kirishima-Shinmoedake Eruption, Jan. 27, 2011

Photo: Mainichi Newspaper

Photo: taken by Toshio Kono

The 2011 off the Pacific coast of Tohoku Earthquake, March 11, 2011

Contents

1. G-EVER Activities
2. G-EVER Volcanic Hazard Assessment Assist System
   - ·Eruption History, Volcano Database, and Simulation
     - ·Quaternary volcanoes in the world (ca. 3300) (Energy Cone and Titan2D, ASTER G-DEM)
3. Asia-Pacific Region Earthquake and Volcanic Hazards Mapping Project
   - ・Eastern Asia Earthquake and Volcanic Hazards Map
   - ·G-EVER Asia-Pacific Region Earthquake and Volcanic Hazards Information System
4. Demonstrations and Trials

G-EVER1

The 1st Workshop of Asia-Pacific Region Global Earthquake and Volcanic Eruption Risk Management

Date: Feb. 22 (Wed) – 24 (Fri), 2012
Venue: Auditorium, AIST Tsukuba Central, Tsukuba, Japan

152 participants from 12 nations and regions and 56 institutes

G-EVER1

Background

As shown by the 2011 off the Pacific coast of Tohoku Earthquake, Asia-Pacific Region is an area with high risk of catastrophic natural disasters such as earthquakes and volcanic eruptions. Once a disaster occurs, in today's highly globalized economy, it can create unpredictable turmoil all over the world, not just in the affected area. Countermeasures against these large-scale disasters are crucial for the sustainable development of the global economy to ensure human security. Now is the time to establish an effective international framework where we collaborate and develop a system to gather information on disaster mitigation in Asia-Pacific Region, including Japan.

Purpose

・Enhance collaboration among geological institutes within the Asia-Pacific Region and rearrange existing information about the future risk for global earthquakes and volcanic disasters.
・Build international and national networks, set up a website, and establish a consortium so that we can share and provide the information.
・Create the environment to promote cooperative research, including personnel training, in the area with little information, especially in developing countries.
・Evaluate the risk of business activities in the Asia-Pacific region and seek to develop new business opportunities to provide information on the risk of catastrophic natural disasters.

The G-EVER1 Accord

The first Workshop of Asia-Pacific Region Global Earthquake and Volcanic Eruption Risk Management (G-EVER 1) was held in Tsukuba, 22-24 February 2012, to discuss how to reduce the risks of national and international disasters due to natural geohazard events like earthquakes, tsunamis, and volcanoes. One hundred fifty two participants came from twelve nations and regions and fifty-six national and international institutes. Participants are deeply saddened by recent disasters, from Sumatra to Christchurch to Tohoku, but also encouraged by cases of successful mitigation and progress on a variety of local and global risk reduction efforts. We believe that increased international collaboration between geohazard institutes and organizations in the Asia-Pacific can advance the science of natural hazards and contribute to reduction of disaster risks from earthquakes, tsunamis, and volcanic eruptions.

We, the participants, agreed unanimously on several recommendations that we call the G-EVER1 Accord.

RECOMMENDATIONS

We agreed that the following 10 recommendations should be communicated to Asia-Pacific research institutes and relevant organizations, and encourage all participating institutes, and also those Asia-Pacific research institutes and organizations not represented in Tsukuba, to embrace these recommendations:

•Establish a consortium of Asia-Pacific geohazard research institutes, with the goal of enhancing collaboration, sharing resources, and making information about risk from earthquakes and volcanic eruptions freely available and understandable.
•Promote the use of hazard information in decision-making by citizens, governments, and businesses, so our science supports mitigation actions.

G-EVER1

Program contents:

1. Recent Earthquakes and Volcanic Eruptions
   2011 off the Pacific coast of Tohoku Earthquake
   2008 Wenchuan Earthquake
   2004 Sumatora-Andaman Earthquake
   2010 Iceland Eruption
   1991 Pinatubo Eruption, etc
2. Report of Asia Pacific Region
   Indonesia, Philippine, Singapore, Korea, Vietnam, Taiwan, USA, and Japan, etc
3. [illegible]
   VHub, GEO Grid, PAGER, GEM, and GVM, etc

The G-EVER1 Accord

- Develop a website hub for the consortium in English and major Asian languages, which would link to websites of allied global efforts, such as VHub, GEM Nexus, and the International Seismological Centre (ISC).
- Establish or endorse data interchange standards and standardized analytical methods for geohazard institutes of the world to promote data sharing and comparative analyses.
- Actively participate in related global risk reduction efforts, such as Integrated Research on Disaster Risk (IRDR) Program, Global Earthquake Model (GEM), Global Volcanic Model (GVM) and their component databases like World Organization of Volcano Observatories Database (WOVOdat) and GEM Faulted Earth.
- Promote "the borderless world of science" with trans-border hazard maps built using common data sets, and more uniform and advanced methods and software than has been possible in the past.
- Promote exchange visits among researchers of the consortium, and encourage opportunities for graduate study in geohazards.
- Encourage the formation of working groups for broad, multi-disciplinary, unifying themes.
- Promote best practice training on interaction with the media, on outreach to citizens and school children on hazard preparedness, and on interaction between volcano scientists and Volcanic Ash Advisory Centres in the region.
- Convene a G-EVER workshop every 2 years in Asia-Pacific countries in conjunction with major regional events (such as AOGS, WPGM and AGU meetings).

This accord was produced and unanimously endorsed by participants at the G-EVER1 Workshop in Tsukuba, Japan, 24 February 2012.

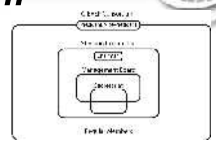
G-EVER Activities Plan

1. G-EVER Working Groups
   eg. Risk Assessment WG, International Standard WG, Database WG, Hazard and Risk Map WG
   Collaboration with existing groups
   (eg. GEM, GVM, VHub, VOGRIPA, and WOVOdat)
2. G-EVER Hub site (English and local language versions)
   http://g-ever.org
3. Meetings, Symposium, Short Courses, and Session Proposals
   AGU G-EVER Session, G-EVER International Symposium
   Exchange knowledge and promote international standard
4. G-EVER Conference in every 2 years (G-EVER2, 3…)
5. Disseminations at major Meetings (IAVCEI, IASPEI, AGU..)
6. Collaborations with international organizations
   such as IUGG, IUGS, UNESCO, CCOP, IASPEI and IAVCEI

Recent G-EVER Activities

1. Workshop and Symposium
   - G-EVER1 Workshop (Tsukuba, Feb. 22-24, 2012)
   - 1st G-EVER Symposium (Tsukuba, March 11, 2013)
   - 2nd G-EVER Symposium (Sendai, Oct. 19-20, 2013)
2. G-EVER Session （including future plan）
   - 2012 AGU Fall Meeting, 2013 AGU Fall Meeting
   - 2013 JpGU Meeting, 2014 JpGU Meeting
   - 2014 AOGS Meeting, 2014 COV8 Meeting
3. Collaborations
   - GNS Science, Massy Univ. and Canterbury Univ. (March 2013)
   - Earth Observatory of Singapore (EOS) (March 2013)
   - INGV (Pisa, Bologna, Nov. 2013) >>> MOU (2014)
   - CVGHM (Bandung, March 2014), PHIVOLCS (Manila, Ma
4. Meetings
   - C O V 7 (Colima, Nov. 2012), IUGG GRC (Orange, Dec. 2012) SCA 2013 (Bangkok, May 2013), IAVCEI 2013 (Kagoshima, July 2013), CCOP2013 (Sendai, Oct. 2013), VOBP2 (Erice, Nov. 2013)

G-EVER Consortium



President：Eikichi Tsukuda (GSJ)

Vice President ：John Eichelberger (Univ. Alaska)

Management Board :
John Eichelberger (Univ. Alaska), Greg Valentine (State Univ. of New York), Renato Solidum (PHIVOLCS), Paolo Papale (INGV), Augusto Neri (INGV), Surono (CVGHM), Xiaojun Li (China Earthquake Administration), Cheng-Horng Lin (Academia Sinica), Nguyen-Hong Phuong (VAST), Oleg Melnik (Moscow State Univ.), Shinji Takarada (GSJ) and Yuzo Ishikawa (GSJ)

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G-EVER Promotion Team :
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Regular Member : Please Join Us!! (mailing list membership)

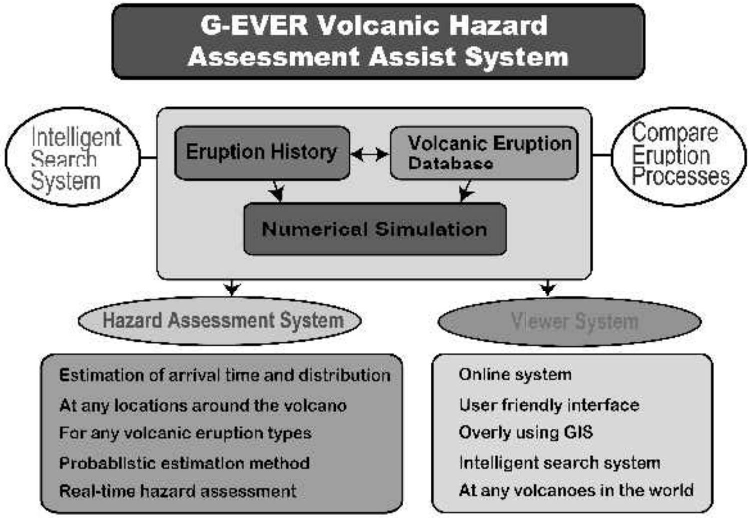
Sendai Agreement

- Improve the quantity and quality of data on past events (paleo), recent events (modern analogues), including that from monitoring, and other precursors of future events, including better understanding and modeling of what controls occurrence and magnitude of events.
- Promote better translations from hazard to risk – including damage curves, values at risk, etc.
- Improve outreach mechanisms, including visualizations, to enhance communication with end users. Develop multidisciplinary teams and communicate uncertainty to end-users.
- Improve methods for communicating authoritative information to underpin decision-making. Offer training public officials and local people to reduce geo-risks.
- Promote the optimum use of geoscientific information by public officials and other decision makers. Lessons-learned and best practices are the most useful types of warning information. Gather feedback from public officials and engage in dialogue about what decisions they need to make and what information they need to make those decisions.
- Develop creative new options for mitigating impacts, based on scientific, technical and socio-economic expertise, and develop effective means to have advice used in policies/decisions. Engineers, social scientists and economists should be involved.
- Play international leadership, coordination, and best practices through ICSU.
- Participate in related global risk reduction efforts, such as Integrated Research on Disaster Risk (IRDR) Program, Future Earth, Global Earthquake Model (GEM), and Global Volcanic Model (GVM).

The G-EVER Hub site

http://g-ever.org

Hazard Assessment System



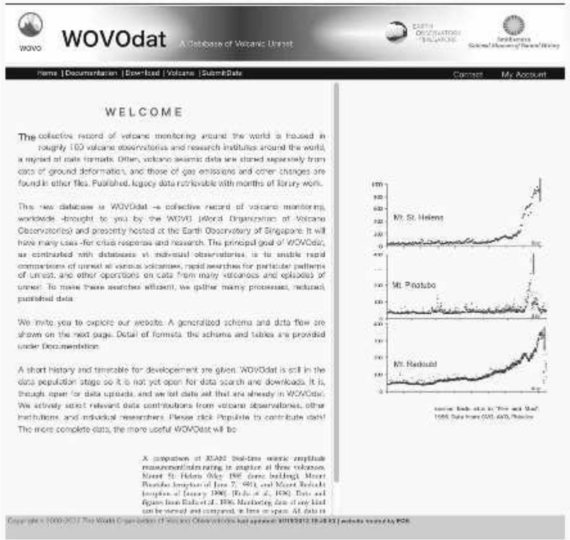
Current G-EVER Working Groups

A. **Risk Assessment of Large-scale Earthquakes WG, 2012-2016 (Ishikawa**
1. Evaluation of super large-scale earthquake
2. Comparison between normal and super cycles
3. Hypocenter DB, unify calendars and reevaluation

B. **Risk Assessment of Large-scale Volcanic Eruptions WG, 2012-2015 (Takada)**
1. Super eruptions in Indonesia (1883, 1815 and 13c)
   Preparation process, precursors, effects, and recovery
2. Risk assessment (potential assessment and risk management)

C. **Volcanic Hazard Assessment Assist System WG, 2012-2016 (Takarada)**
1. Eruption History
2. Volcanic eruption database
3. Numerical simulation
4. Next-generation volcanic hazard assessment system

Eruption History



http://www.wovodat.org/

Since 2000

Open to public from 2013

Earth Observatory of Singapore (EOS, Chris Newhall) Initiative

Database of precursor phenomena

Collaboration with volcano observatories

Eruption Database

10ka eruption event database in GSJ

Compile eruption events of Japanese volcanoes in detail

Volume and References

Still under construction (eg. Fuji, Unzen, Kirishima, Sakurajima)

Without distribution maps of each eruption products

Eruption Database

Spatial distribution database of volcanic eruption products

1 . Tephra fall distribution

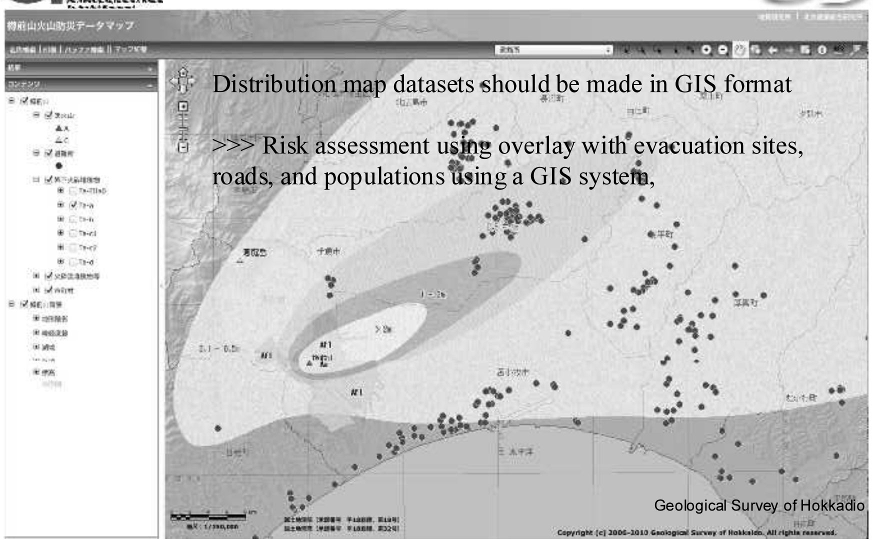
2. Pyroclastic flow deposits distribution

3. Debris avalanche deposits distribution

4. Lava flow distribution

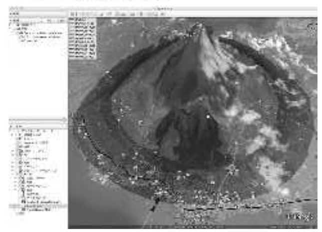
Using GIS system
Start from major volcanoes in Southeastern Asia

Eruption Database

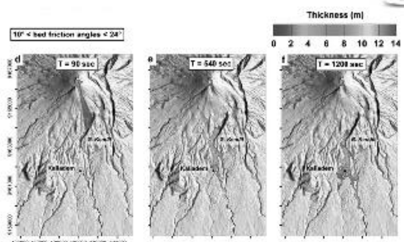


Ash fall distribution database at Tarumae Volcano

Hazard Assessment System

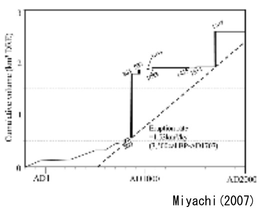


Energy cone Online Simulation



Titan2D Online Simulation

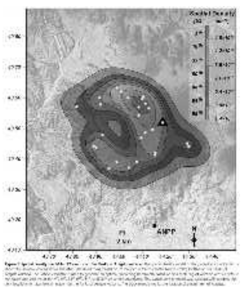
Charbonnier and Gertisser (2009)



Miyachi (2007)

Assessment using Volume-Time diagram

Link to major volcano databases



Probabilistic Analysis Connor et al. (2012)

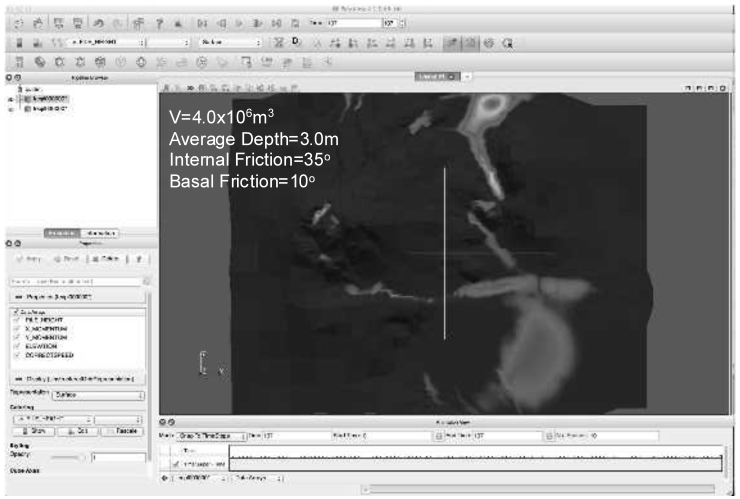
Hazard Assessment System

G-EVER volcanic hazard assessment assist system

1. **Integrate eruption history, database, and simulation**
2. **Intelligent search system (easy to compare eruption styles, patterns, and spatial distributions on the assessment system)**
3. **Active volcanoes in the world** (understanding eruption processes, display distribution of each eruption products)
4. **Estimate affected area and arrival time from eruptions using numerical simulations** (evaluations should be done before the major eruptions)
5. **Probabilistic estimation method** (potential risk assessment)
6. **Real-time volcanic hazard assessment system** (Real-time risk assessment, Online, any volcanoes in the world)

Volcanic Hazard Assessment System

G-EVER Volcanic Hazard Assessment Assist System (Titan2D)



Titan2D numerical simulation (State Univ. New York Buffalo)

ASTER Global DEM 10m DEM (GSI) in Japan area

Cover Quaternary volcanoes in the world (ca. 3300)

Use 3D viewer (Paraview, free)

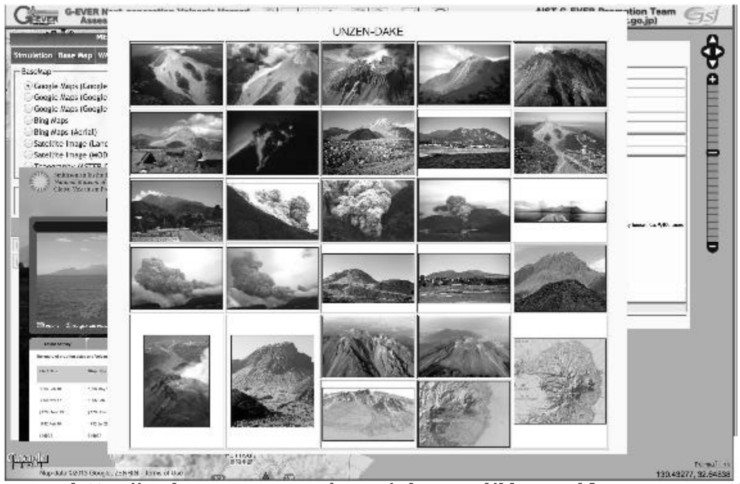
Google Maps and Bing Maps can be used as reference maps

Evaluate Arrival Time, Speed, Volume Effects and Affected Area

Demonstration

Hazard Assessment System

G-EVER Volcanic Hazard Assessment Assist System (Energy Cone)



Developed based on previous GEO Grid volcano gravity flow simulation system

ASTER Global DEM

Cover Quaternary volcanoes in the world (ca. 3300)

Google Maps and Bing Maps can be used as reference maps

Link to major volcanic databases, such as Smithsonian, Quaternary volcano, and VOGRIPA.

http://volcano.g-ever1.org/vhazard/HazardAssessment/ **Demonstration**

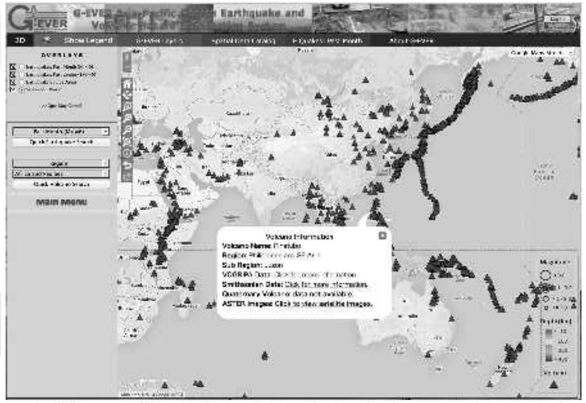
Asia-Pacific Region Earthquake and Volcanic Hazards Mapping Project

Eastern Asia Earthquake and Volcanic Hazards Map

1. Geohazards Map (will be published as a CGMW map) scale 1:7,500,000
2. Cooperation with CCOP member countries and G-EVER Consortium members
3. Planning to be published until March 2016

G-EVER Asia-Pacific Region Earthquake and Volcanic Hazard Information System

1. Hazards records and hazard affected areas from earthquake, tsunami and volcanic eruptions in Asia Pacific region on the intelligent hazards online system
2. Detailed earthquake and volcano database



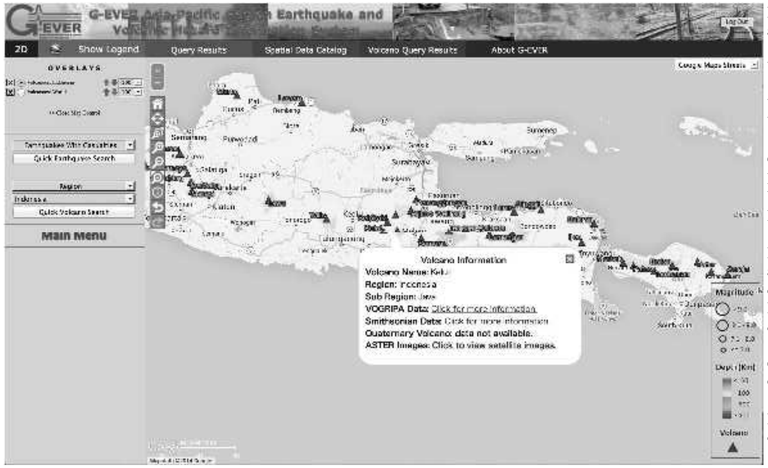
Effects of this project

・Essential hazard and risk information for the future risk assessment of earthquake, tsunami and volcanic eruption (eg. Overlay on population, roads and facility maps)

・ Improving the database for hazard risk information and assist international economic activities in formulating their BCP

Asia-Pacific Region Earthquake and Volcanic Hazards Mapping Project

G-EVER Asia-Pacific Region Earthquake and Volcanic Hazards Information System (Preliminary Version) since July 2014



Earthquakes: USGS Earthquake Hazards Program and ISC

Volcanoes: Smithsonian GVP, Volcanoes of Japan, VOGRIPA (GVM)

Query of Earthquakes and Volcanoes in Asia Pacific Region

Distribution of affected area by earthquakes, tsunami, Pyroclastic flow deposit, Ash fall

OneGeology Geological Maps

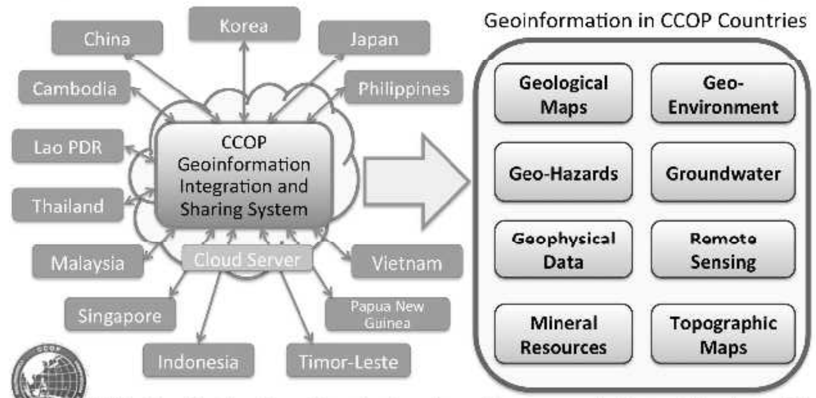
Detailed information of past geohazards

http://ccop-geoinfo.org/G-EVER

Demonstration

Geoinformation Sharing Infrastructure for East and Southeast Asia

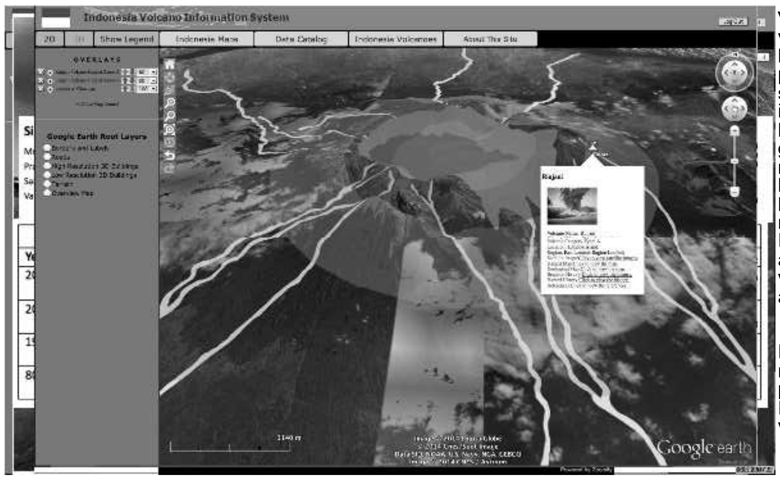
Develop a new geoinformation integration and sharing system using international standards and free and open-source software among CCOP countries



CCOP= Coordinating Committee for Geoscience Programmes in East and Southeast Asia

Indonesia Volcano Information System

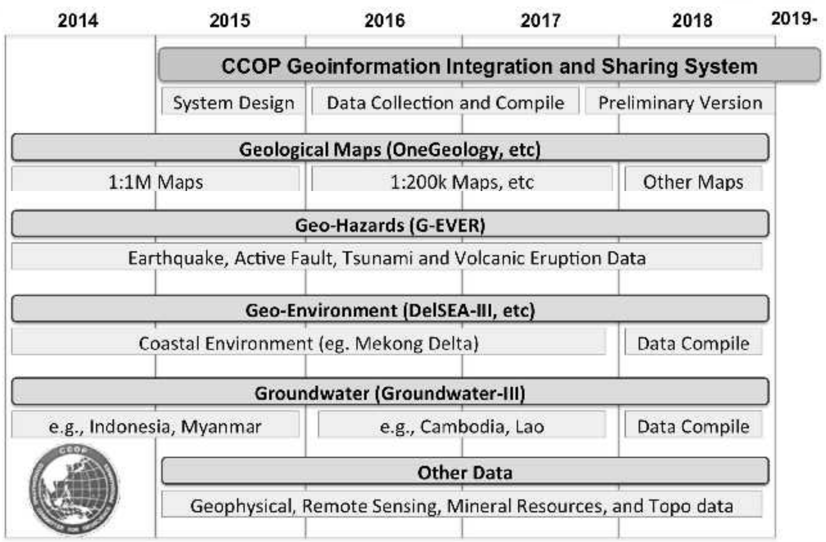
Collaborative project with CVGHM (Indonesia)



Volcano name, volcano type, location, pictures, satellite images, hazard map, geological map, eruption history, hazard history and references of Indonesian active volcanoes are available.

Based on recent publication in Indonesian version.

Geoinformation Sharing Infrastructure for East and Southeast Asia

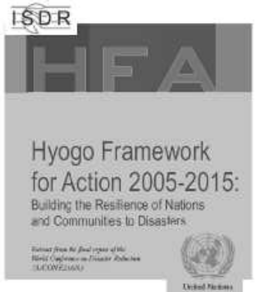


Earthquake and Volcanic Hazards Workshop during the UN World Conference on Disaster Reduction, Sendai, Tohoku, Japan on March 2015

- ❖ **United Nations International Strategy for Disaster Reduction (UNISDR)**
  - Established by UN's general assembly on 2000
  - Targeting various natural disasters
  - Hyogo Framework for Action (HFA) defines the action plan for 2005-2015
- ❖ **The World Conference on Disaster Reduction**
  - General Assembly specified in disaster reduction
  - 14-18 March 2015 in Sendai, Japan
  - Review progress of HFA and establish Post-HFA for next ten years
  - Associated with side-events including public forums to support the conference
- ❖ **Taking this opportunity…**

  GSJ, together with CCOP, will organize a workshop on Geohazards (Earthquake, Tsunami and Volcanic Eruption)

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



Summary

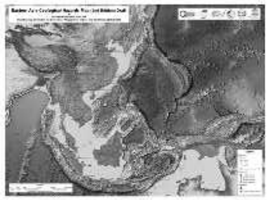
1. G-EVER Activities
   ·G-EVER1 Accord, Sendai Agreement, Working Groups
2. G-EVER Volcanic Hazard Assessment Assist System
   ·Eruption History, Volcano Database, and Simulation
   ·Online hazard Assessment System using energy Cone and Titan2D
3. Asia-Pacific Region Earthquake and Volcanic Hazards Mapping Project
   · Eastern Asia Earthquake and Volcanic Hazards Map (CGMW)
   ·G-EVER Asia-Pacific Region Earthquake and Volcanic

Earthquake and Volcanic Hazards Workshop during the UN World Conference on Disaster Reduction, Sendai, Tohoku, Japan on March 2015

Purpose:

Discuss the strategy and work plan of the G-EVER & CCOP Earthquake and Volcanic Hazards Mapping Project

Points of Discussion:
1. Contributions from CCOP member countries: Possible submission of original domestic data
2. Contents of the Eastern Asia Earthquake and Volcanic Hazards Map (CGMW)
3. Contents of the G-EVER Asia-Pacific Region Earthquake and Volcanic Hazards Information online system
4. Database of earthquakes, active faults and volcanic eruptions
5. Work Plan of the Hazards Mapping Project



Anybody who is interested in this project is welcome to join this WS!

Demonstrations and Trials

1. G-EVER Hub *http://g-ever.org*
2. G-EVER Volcanic Hazard Assessment Assist System

   http://volcano.g-ever1.org/vhazard/HazardAssessment
3. Asia-Pacific Region Earthquake and Volcanic Hazards Mapping Project

   G-EVER Asia-Pacific Region Earthquake and Volcanic Hazards Information System

   http://ccop-geoinfo.org/G-EVER

   Indonesia Volcano Information System (under construction)

   http://jcbwebgis.com/indonesia_maps/index.php

Demonstrations and Trials

Useful Links

OneGeology ***http://www.onegeology.org/***

GSJ database portal

https://www.gsj.jp/en/database/db-portal/index.html

Geomap Navi

https://gbank.gsj.jp/geonavi/?lang=en

Seamless Digital Geological Map of Japan

https://gbank.gsj.jp/seamless/index_en.html

QuiQuake

https://gbank.gsj.jp/QuiQuake/index.en.html

Active Fault

https://gbank.gsj.jp/activefault/index_e_gmap.html

Volcanoes of Japan

https://gbank.gsj.jp/volcano/index_e.htm

Vhub

https://vhub.org/