

卷末資料

本邦招聘ワークショップ  
講義資料



## 卷末資料 1

### リモートセンシング解析



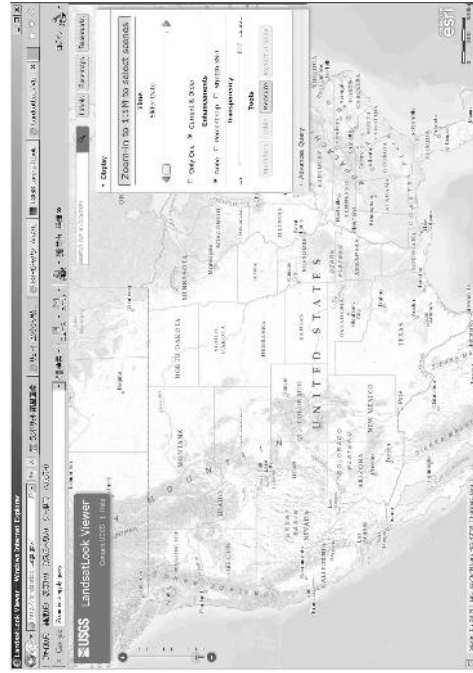
# How to download LANDSAT data



SUMIKO Resources Exploration & Development Co., Ltd

## How to get LANDSAT data

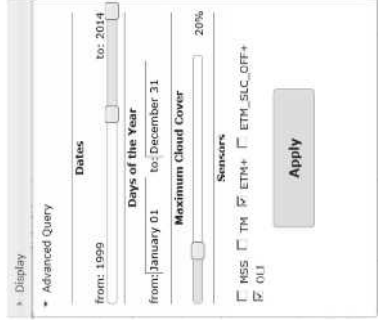
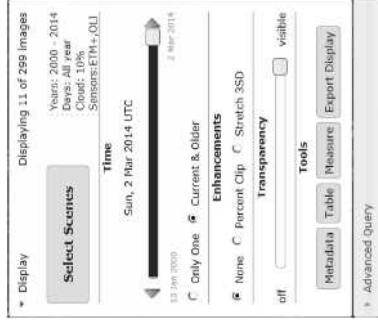
-Go to the following, <http://landsatlook.usgs.gov/>  
The USGS LandsatLook Viewer allows comprehensive searching and downloading of full-resolution LandsatLook images.



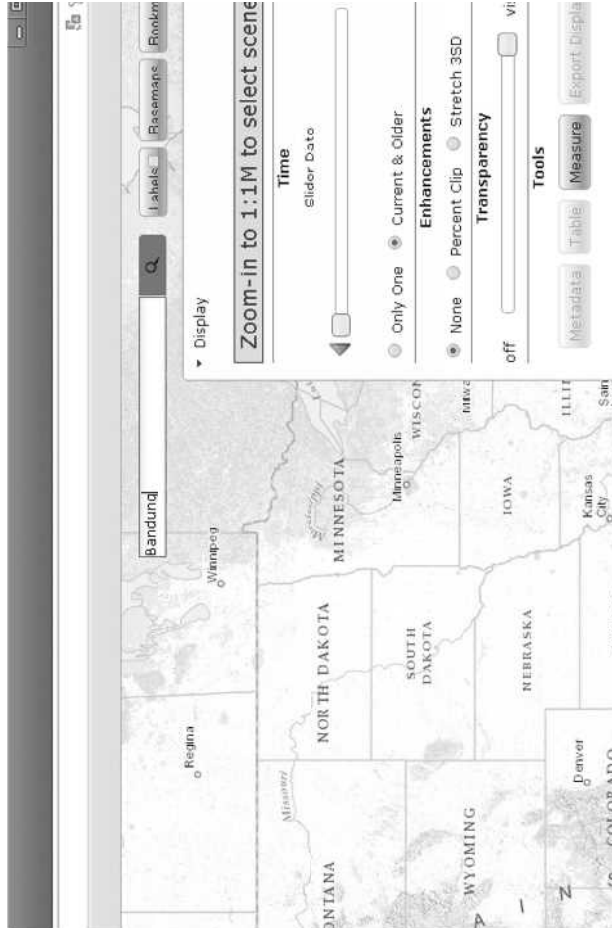
## LANDSAT

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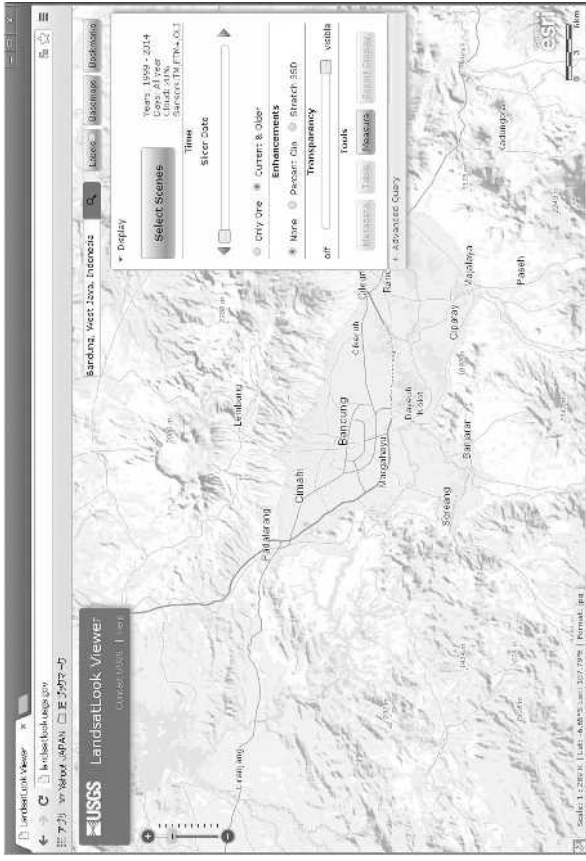
Yo an nd yo a a o nt t by t Yo an od yt d a l t a a t  
t xt ba d a tool nt t ya o o a l o d o an and  
o by ann n and zoo n a o nd t n o l t o n n Ad an d Q y  
lob window



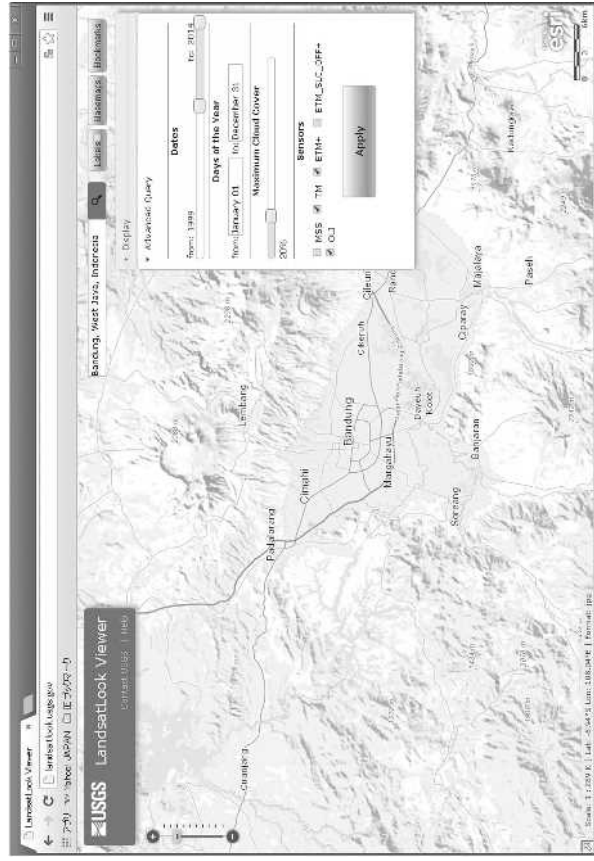
-You can find your area of interest by the text-based search tool in the upper right or by panning and zooming around the globe.



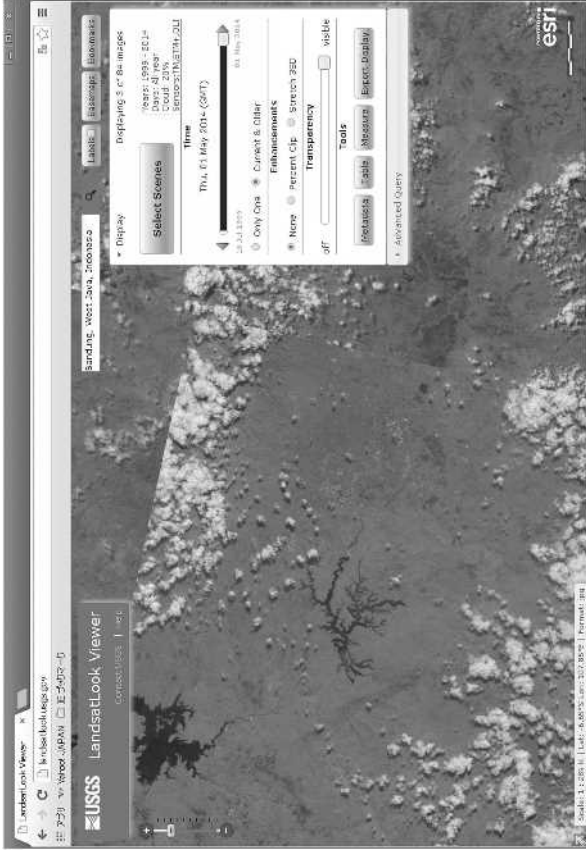
-You can find your area of interest by the text-based search tool in the upper right or by panning and zooming around the globe.



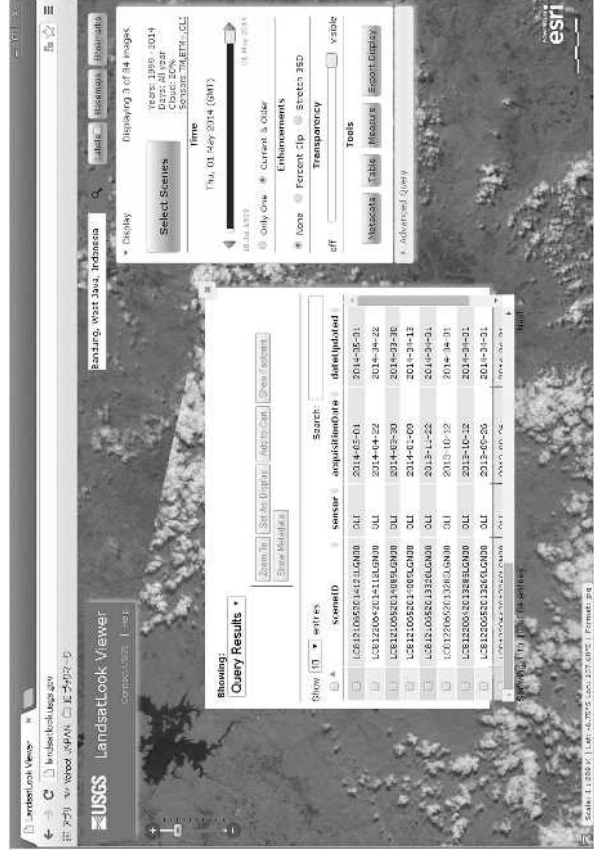
-You can find your area of interest by the text-based search tool in the upper right or by panning and zooming around the globe.



-This is result of search.



-This is result of search.



-Click "Table" in "Display" window, the table of images is shown.

sceneID	sensor	acquisitionDate	dateUpdated
LC8120652014089LGN00	OLI	2014-03-30	2014-03-30
LC8120652014091LGN00	OLI	2014-01-09	2014-04-13
LC8120652013286LGN00	OLI	2013-11-22	2014-04-01
LC8120652013285LGN00	OLI	2013-10-12	2014-04-01
LC8120652013283LGN00	OLI	2013-10-12	2014-04-01
LC8120652013289LGN00	OLI	2013-09-26	2014-04-01
LC8120652013289LGN00	OLI	2013-09-28	2014-04-01
LC8120652013285LGN00	OLI	2013-09-10	2014-04-01

-Click "Metadata" in "Display" window, the browse image is shown. You can check images one by one.

Showing: **Query Results**

1 of 3

Show Footprint Zoom To Add To Cart View Cart

sceneID: LC81210652014121LGN00  
 sensor: OLI  
 acquisitionDate: 01 May 2014  
 dateUpdated: 01 May 2014  
 path: 45  
 row: 21  
 cloudCover: 11  
 sunElevation: 54.99965  
 sunAzimuth: 50.54667  
 receivingStation: LON  
 sceneStartTime: 01 May 2014 02:53:46 GMT  
 year: 2014

-Select data to be downloaded in "Query Results" window, and then click "Add to Cart".

sceneID	sensor	acquisitionDate	dateUpdated
LC8120652014089LGN00	OLI	2014-03-30	2014-03-30
LC8120652014091LGN00	OLI	2014-01-09	2014-04-13
LC8120652013286LGN00	OLI	2013-11-22	2014-04-01
LC8120652013285LGN00	OLI	2013-10-12	2014-04-01
LC8120652013283LGN00	OLI	2013-10-12	2014-04-01
LC8120652013289LGN00	OLI	2013-09-26	2014-04-01
LC8120652013289LGN00	OLI	2013-09-28	2014-04-01
LC8120652013285LGN00	OLI	2013-09-10	2014-04-01

-Select data to be downloaded in "Cart" window, and then click "Get Landsat Data".

Showing: **Cart**

1 of 1 entries

Remove from Cart Layer Properties Get Landsat Data Image Start Download Data

sceneID	sensor	acquisitionDate	dateUpdated
LC8120652013285LGN00	OLI	2013-09-10	2014-04-01

-To check the area of the scene, click "Show Footprint".

Showing: **Query Results**

Zoom To Set As Display Add To Cart Show Footprint Show Metadata

sceneID	sensor	acquisitionDate	dateUpdated
LC8120652014089LGN00	OLI	2014-03-30	2014-03-30
LC8120652014091LGN00	OLI	2014-01-09	2014-04-13
LC8120652013286LGN00	OLI	2013-11-22	2014-04-01
LC8120652013285LGN00	OLI	2013-10-12	2014-04-01
LC8120652013283LGN00	OLI	2013-10-12	2014-04-01
LC8120652013289LGN00	OLI	2013-09-26	2014-04-01
LC8120652013289LGN00	OLI	2013-09-28	2014-04-01
LC8120652013285LGN00	OLI	2013-09-10	2014-04-01

Showing 1 to 10 of 84 entries

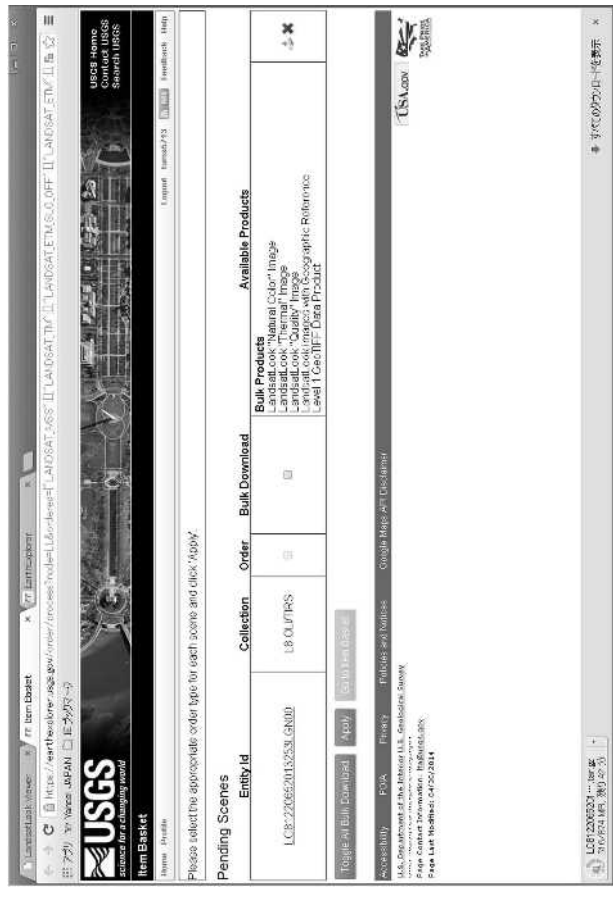
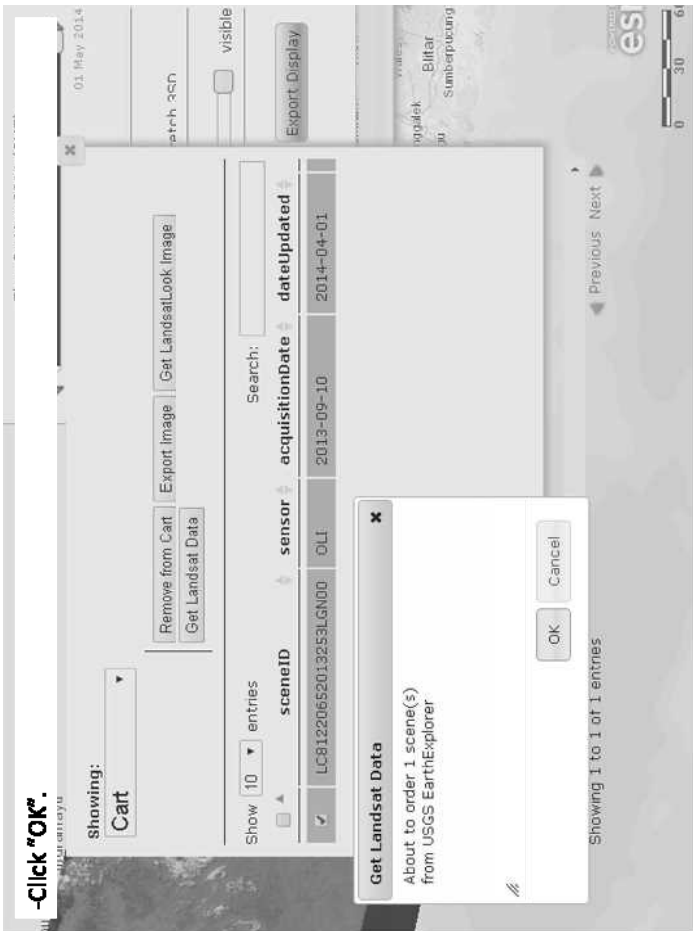
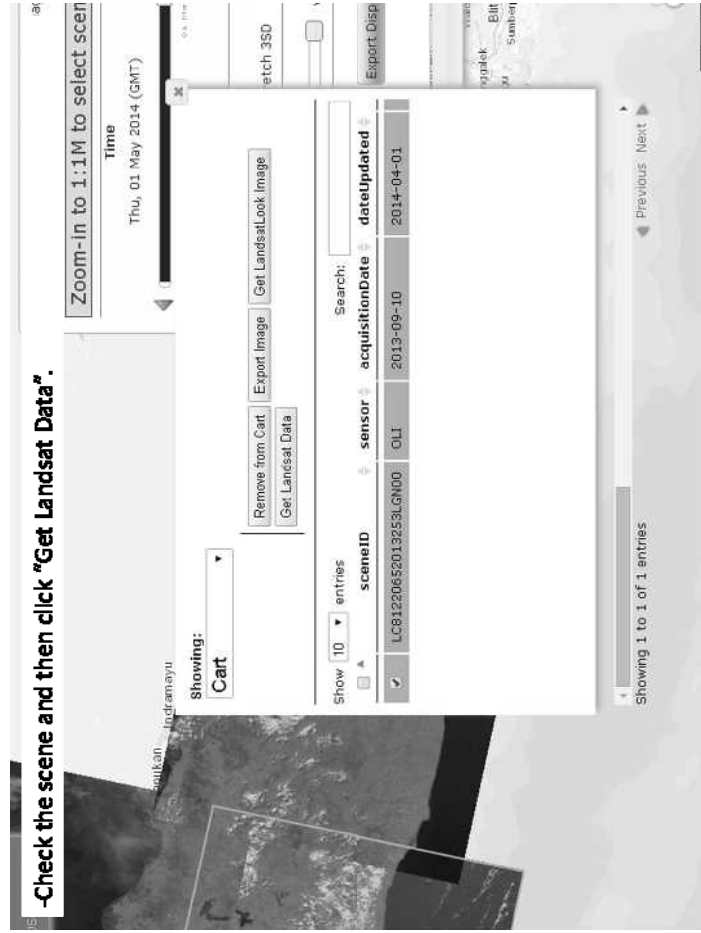
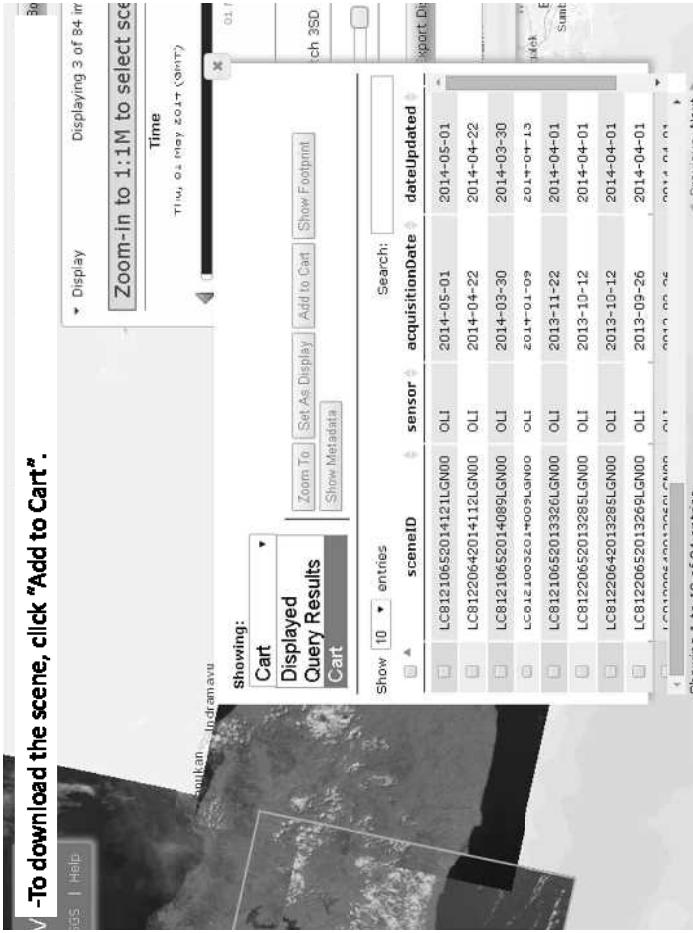
-To download the scene, click "Add to Cart".

Showing: **Query Results**

Zoom To Set As Display Add To Cart Show Footprint Show Metadata

sceneID	sensor	acquisitionDate	dateUpdated
LC8120652014089LGN00	OLI	2014-03-30	2014-03-30
LC8120652014091LGN00	OLI	2014-01-09	2014-04-13
LC8120652013286LGN00	OLI	2013-11-22	2014-04-01
LC8120652013285LGN00	OLI	2013-10-12	2014-04-01
LC8120652013283LGN00	OLI	2013-10-12	2014-04-01

Showing 1 to 10 of 84 images





-Select the image you want and click "Download".

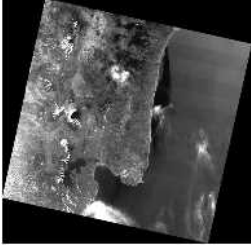
The screenshot shows the EarthExplorer interface with a list of download options:

- LandsatLook "Natural Color" Image (4.0 MB)
- LandsatLook "Thermal" Image (1.3 MB)
- LandsatLook "Quality" Image (460.8 KB)
- LandsatLook images with Geographic Reference (6.0 MB)
- Level 1 GeoTIFF Data Product (874.2 MB)

Each option has a "Download" button. The page footer includes: "USGS science for a changing world", "EarthExplorer", "U.S. Department of the Interior U.S. Geological Survey", "URL: http://earthexplorer.usgs.gov", "Page Contact Information: lal@usgs.gov", and "Page Last Modified: 04/30/2014".

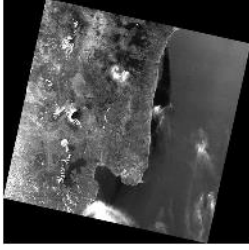
## Creation of Pansharpened image

True color image (low resolution)

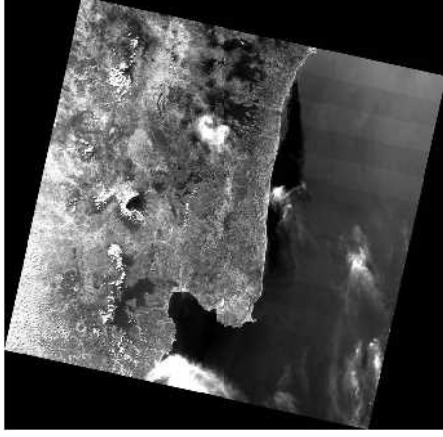


+

Panchromatic image (high resolution)



Pansharpened Image (high resolution)

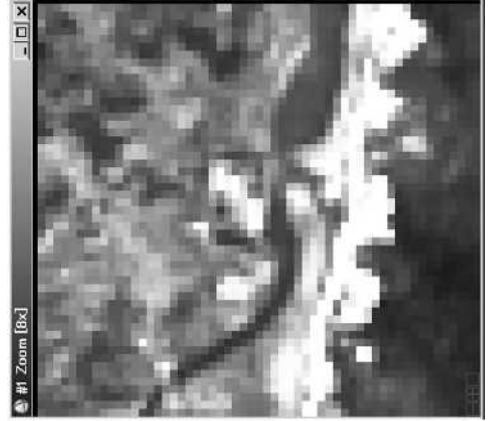


-Get Landsat Data - Download the Full Scenes. Clicking the Get Landsat Data will direct you to the USGS Registration Service, you, which will require login credentials, in order to download the Level 1 Product.

The screenshot shows the USGS Registration Service login page. It includes a "Sign in using your USGS registered username and password" section with fields for "Username:" and "Password:", and a "Remember Me?" checkbox. There are "Cancel" and "Sign In" buttons. Below this is a "Forgot your password?" link. At the top right, there is a "Register" link. A red arrow points from the text "Click 'Register' to do registration." to the "Register" link. The page footer includes: "USGS science for a changing world", "EarthExplorer", "U.S. Department of the Interior U.S. Geological Survey", "URL: http://earthexplorer.usgs.gov", "Page Contact Information: lal@usgs.gov", and "Page Last Modified: 04/30/2014".

## Resolution of each band

True Color image (RGB=B4,B3,B2)  
Resolution: 30m

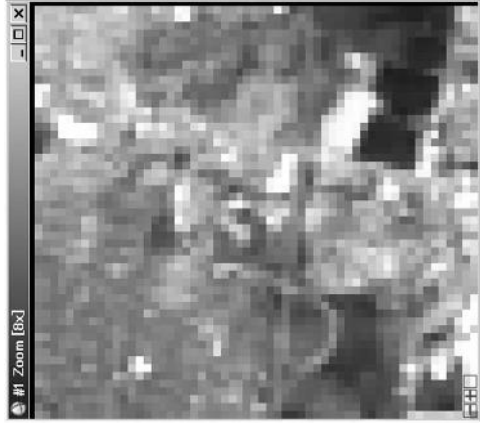


Panchromatic Image (B8)  
Resolution: 15m



## Resolution of each band

True Color image (RGB=B4,B3,B2)  
Resolution: 30m



Panchromatic Image (B8)  
Resolution: 15m



## Result of Pansharpen

True Color image (RGB=B4,B3,B2)  
Resolution: 30m

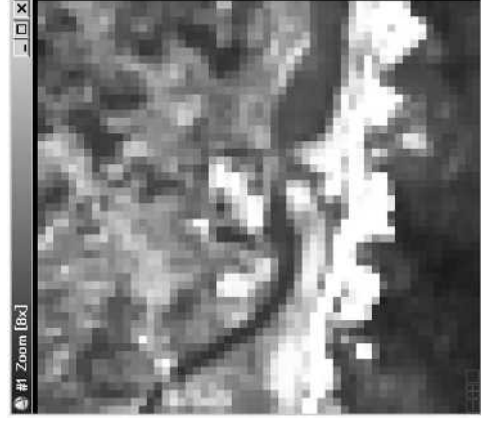


Pansharpened Image  
(RGB=B4,B3,B2)  
Resolution: 15m

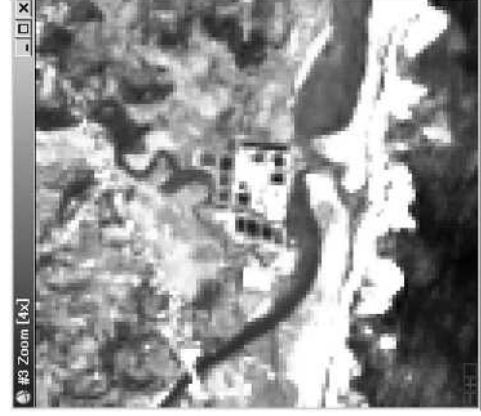


## Result of Pansharpen

True Color image (RGB=B4,B3,B2)  
Resolution: 30m



Pansharpened Image  
(RGB=B4,B3,B2)  
Resolution: 15m



## Appendix

# LANDSAT 8

The Landsat Data Continuity Mission (named Landsat 8 after on-orbit initialization and verification) launched from Vandenberg Air Force Base in California on February 11, 2013, atop an Atlas V rocket. As with previous partnerships, this collaboration between the U.S. Geological Survey (USGS) and National Aeronautics and Space Administration (NASA) continues the mission to acquire high-quality data that meet both USGS and NASA scientific and operational requirements for observing land use and land cover change.

from USGS WEB site

Processing parameters for Landsat 8 standard data products

**Product Type:** Level 1T (terrain corrected)

**Data type:** 16-bit unsigned integer

**Output format:** GeoTiff

**Pixel size:** 15 meters/30 meters/100 meters (panchromatic/multispectral/thermal)

**Map projection:** UTM (Polar Stereographic for Antarctica)

**Datum:** WGS 84

**Orientation:** North-up (map)

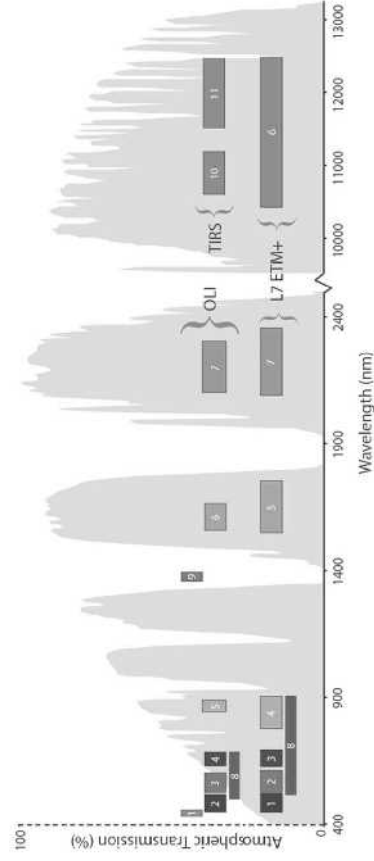
**Resampling:** Cubic convolution

**Accuracy:** OL : 12 meters circular error, 90 percent confidence

**T RS:** 41 meters circular error, 90 percent confidence

from USGS WEB site

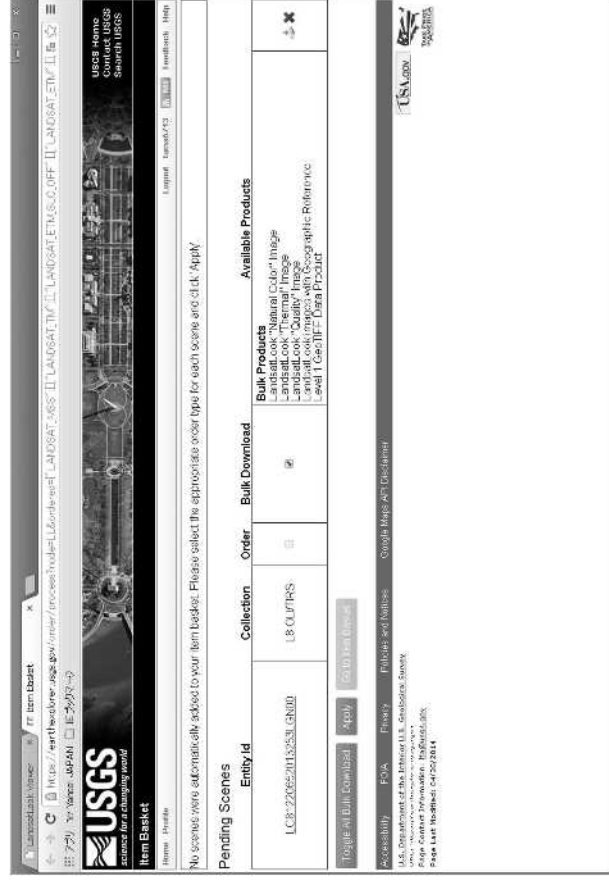
## Comparison of Band Location between LANDSAT 7 and LANDSAT 8



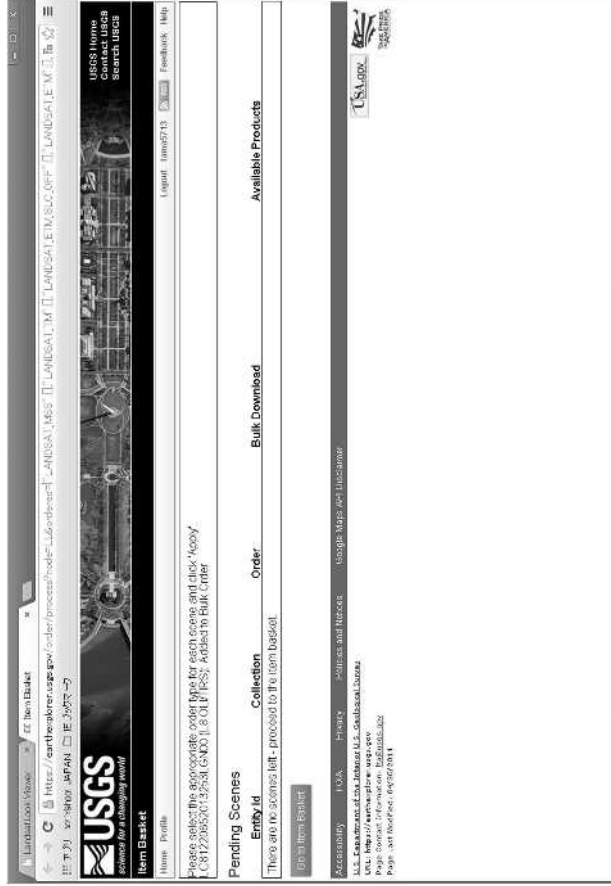
from USGS WEB site

Band passes of the Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) instruments

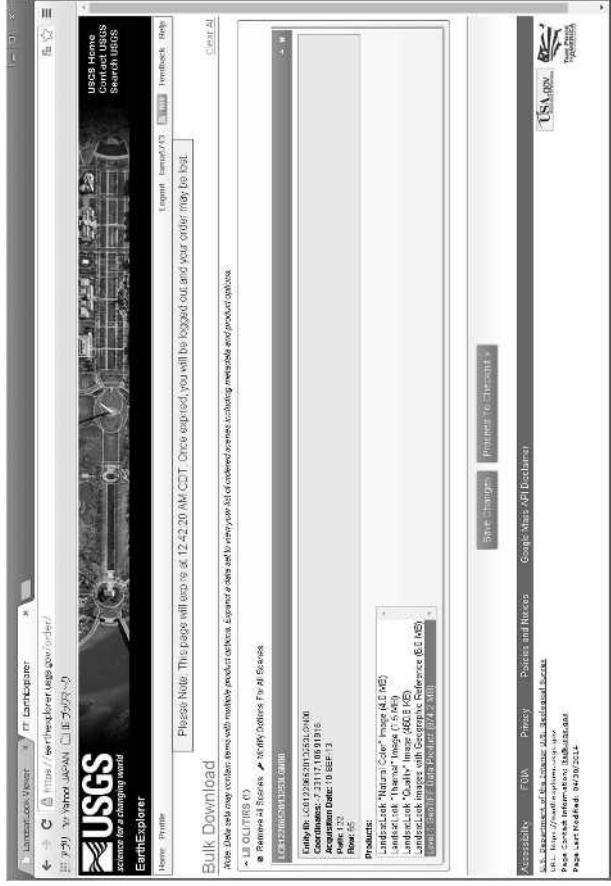
-Check "Bulk Download" and then click "Apply".



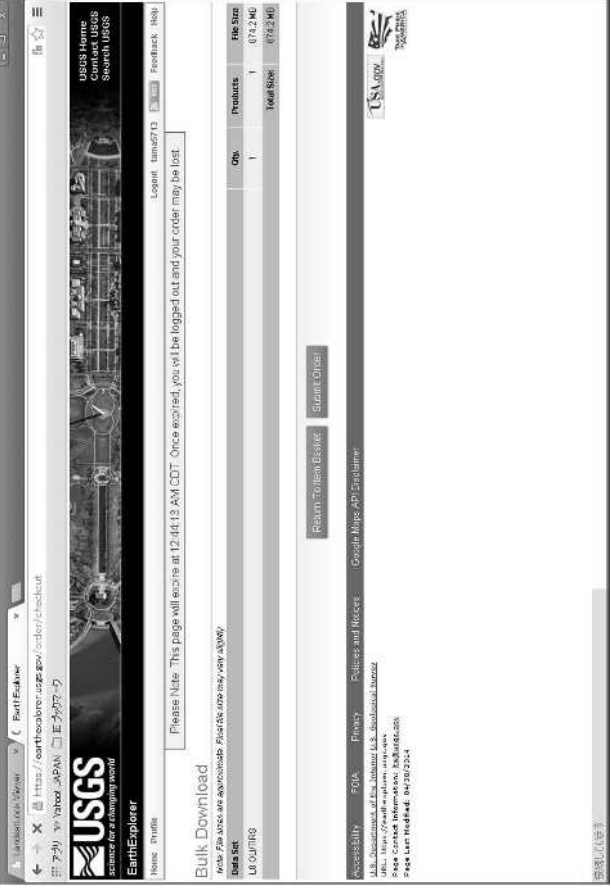
-Check "Bulk Download" and then click "Apply".



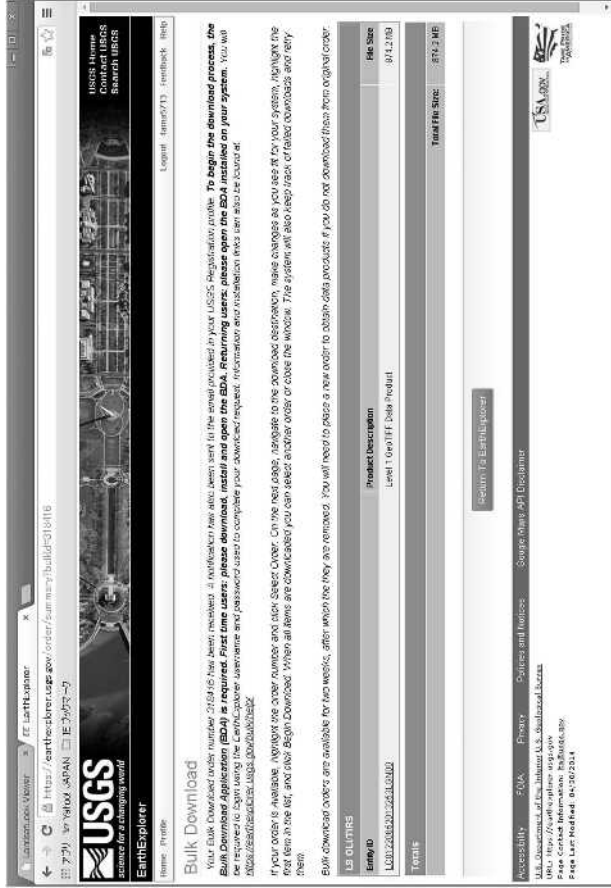
-Check "Bulk Download" and then click "Apply".



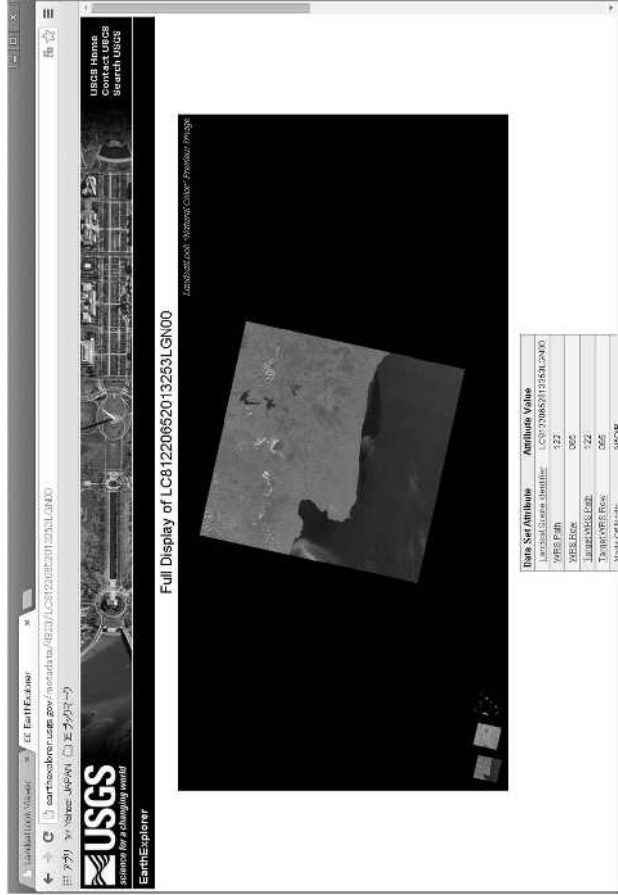
-Check "Bulk Download" and then click "Apply".



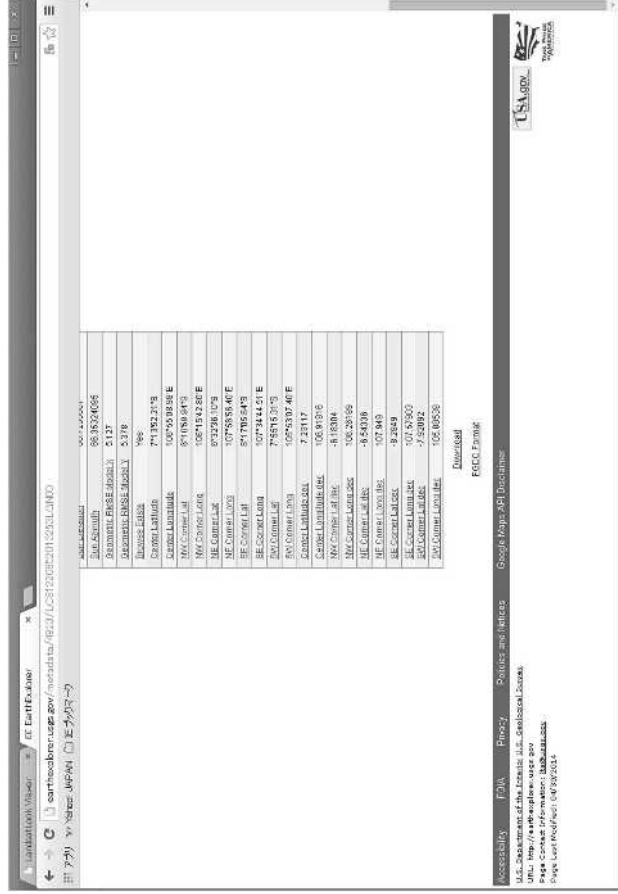
-Check "Bulk Download" and then click "Apply".



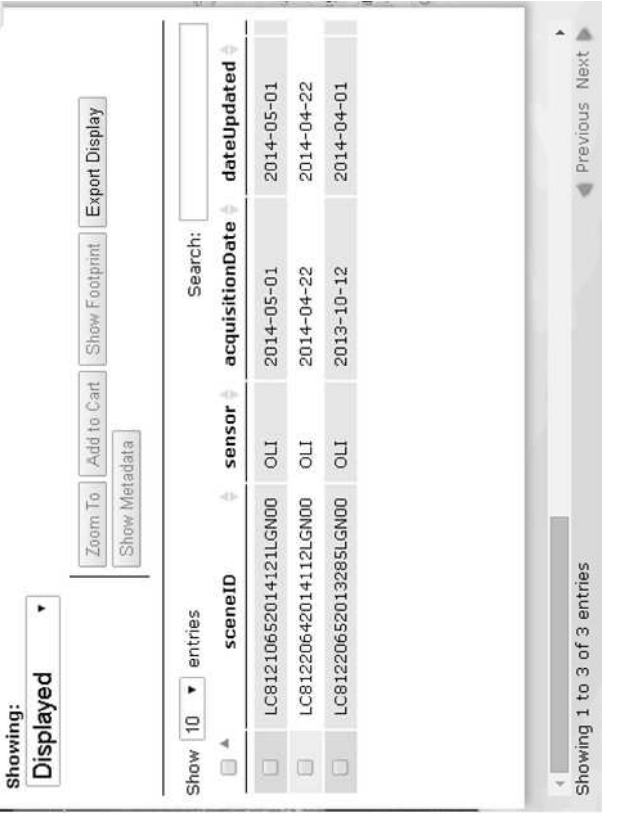
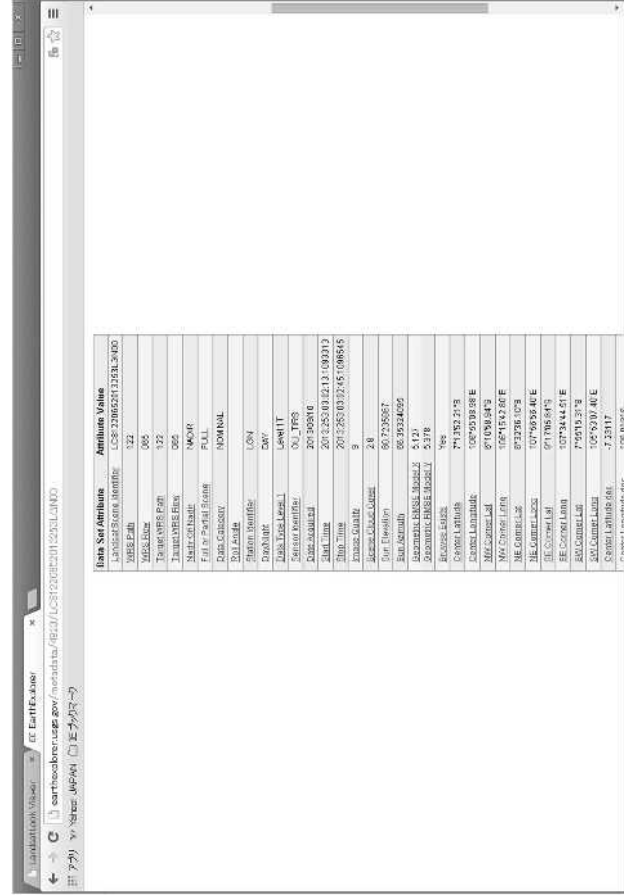
-Full display of the scene.

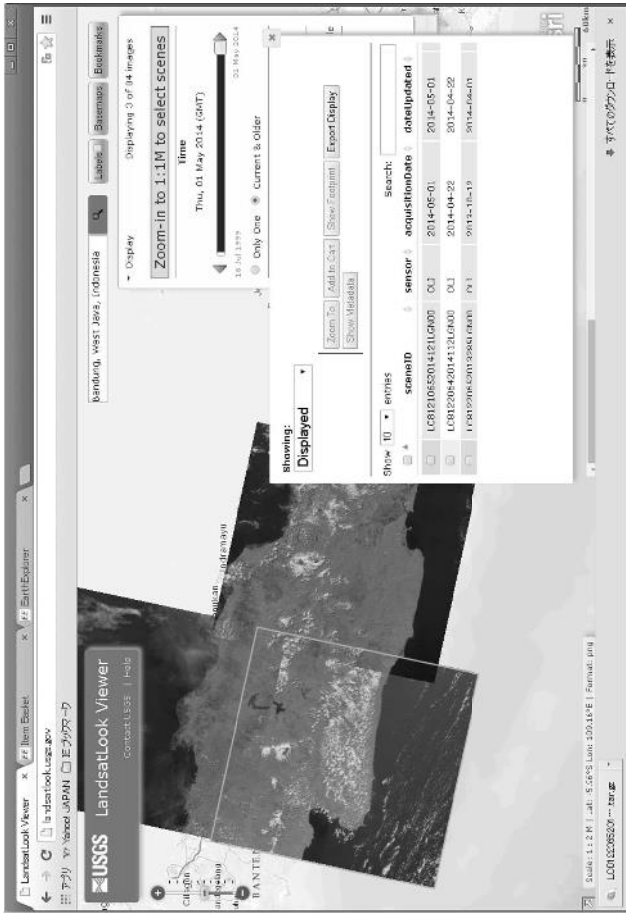


-The specification of the scene.



-The specification of the scene.





# How to use MultiSpec



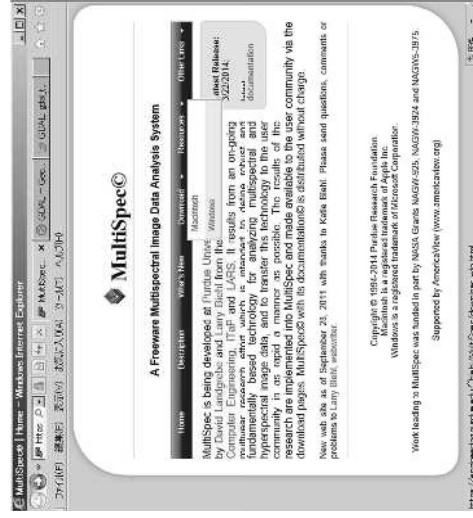
SUMIKO Resources Exploration & Development Co., Ltd

# Contents of this program

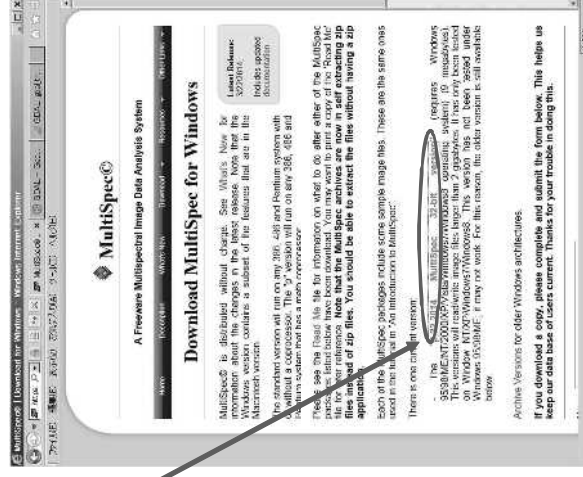
1. Installation of MultiSpec
2. Creation of Band composite image
3. File Format Change of ASTER HDF to GeoTIFF Format

## Installation of MultiSpec

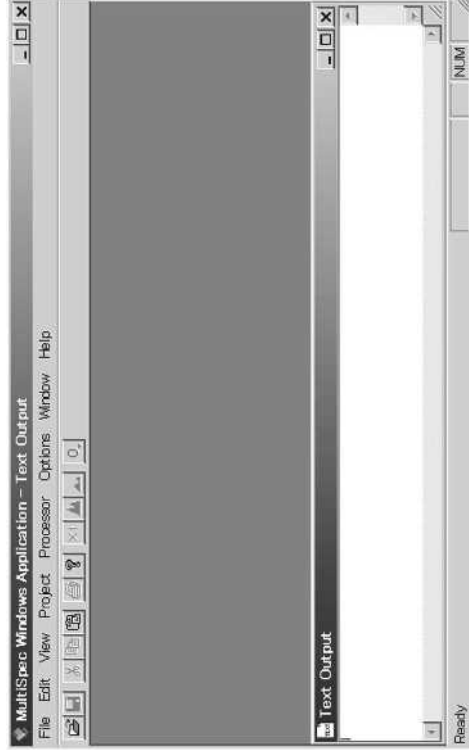
Download software from the following website.  
<https://engineering.purdue.edu/~biehl/MultiSpec/>



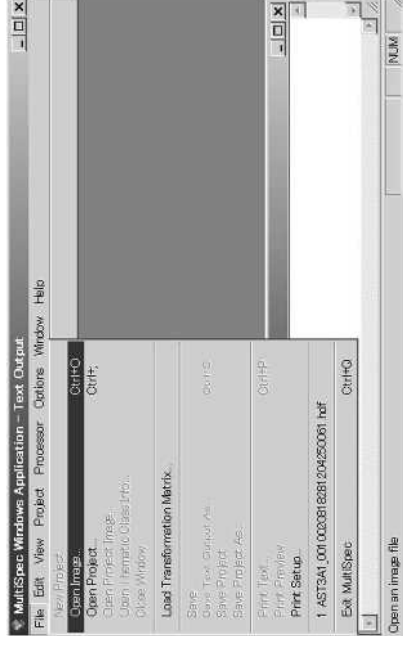
- Click here
- Download MultiSpecWin32z.exe.
- Specify a directory where you unzip the downloaded file and unzip.
- MultiSpecWin32 folder created in the directory you specified.



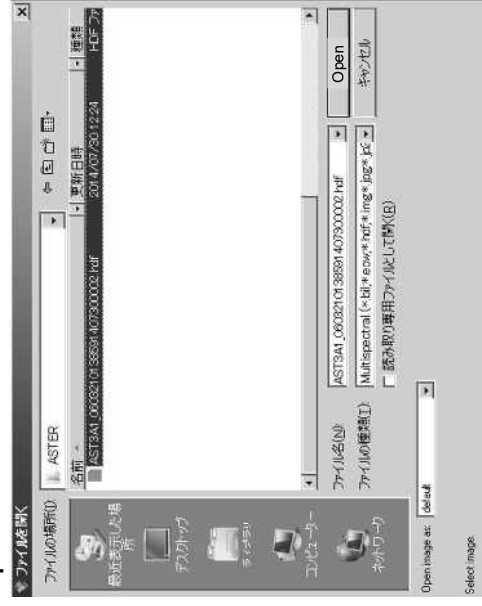
- Click MultiSpecW32.exe in the folder to run.
- Main window appears.



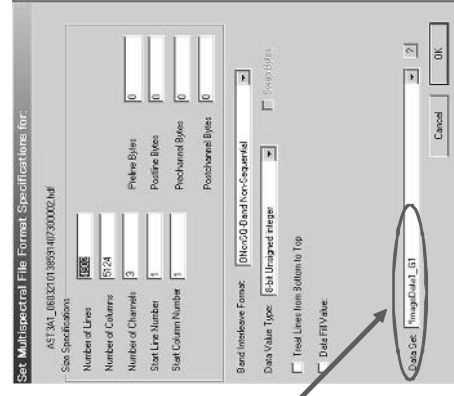
- Creation of Band composite image
- Select and Click "File-Open Image" in main menu.



- "Open File" window appears.
- Select a ASTER HDF file.  
e.g.: AST3A1\_0603210138591407300002.hdf
- Click "Open"



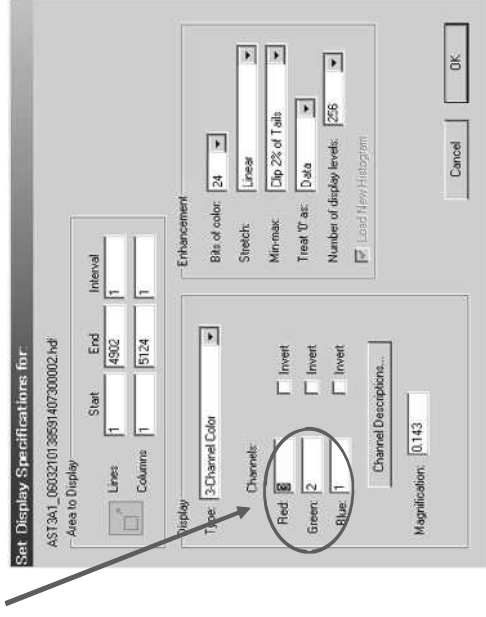
- Set "Multispectral File Format Specification" window appears.
- Enter or select proper parameters in inquiry boxes.
- Almost parameters are set with default automatically.



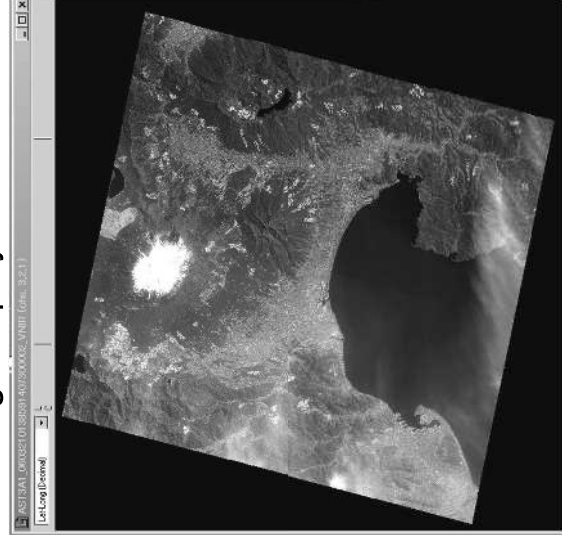
- Select \*ImageData1\_G1 as the first channel (This is Band1 data of ASTER) and click "OK"



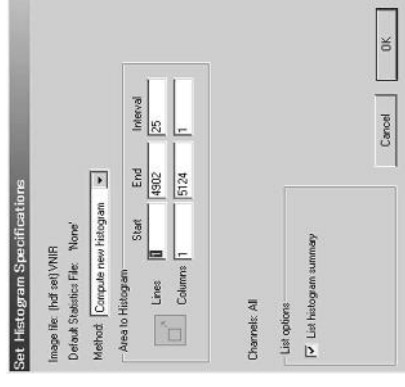
- Set Display Specifications for” window appears.
- The parameters needed for image display are set automatically, click “OK” to proceed.



- ASTER false color image (RGB=Band3,2,1) appears in the created image display.



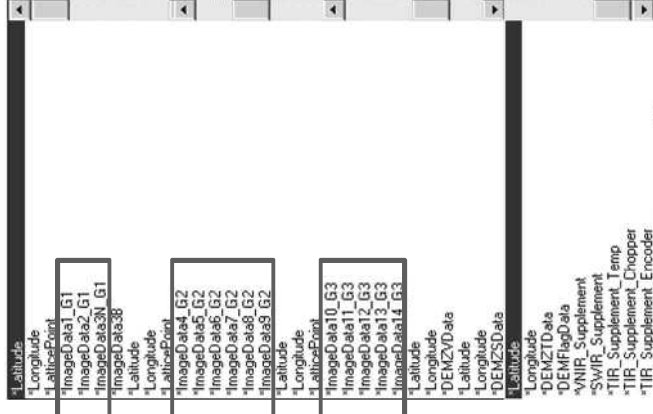
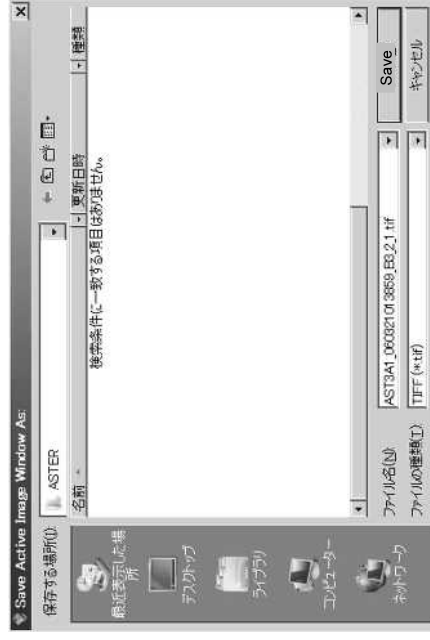
- Set Histogram Specifications” window appears.
- The parameters needed for image display are set automatically.
- Click “OK” to proceed.



- To save the image, Select and click “File-Save Image To GeoTIFF As” in main menu.



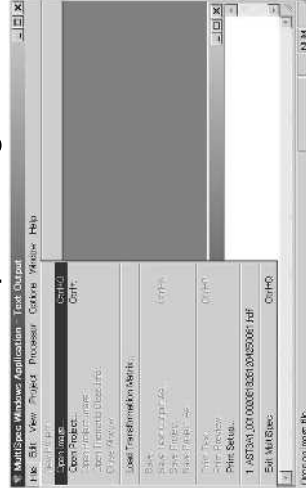
- Select the folder where you save the image and enter the filename of the image in filename box.  
e.g.: AST3A1\_060321013859\_B3\_2\_1.tif
- Click "Save".



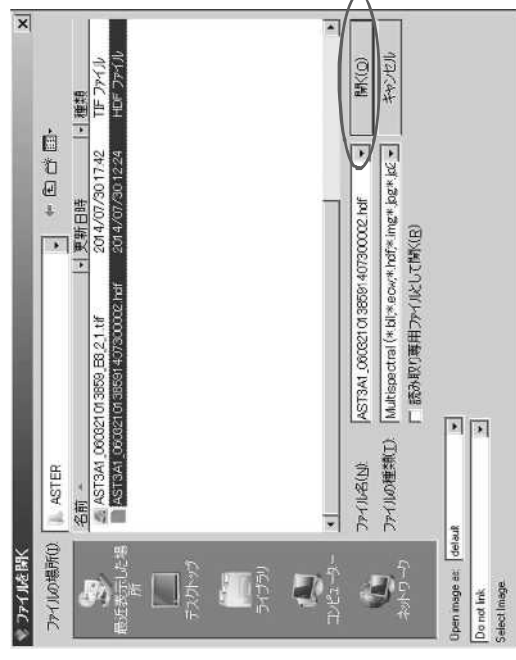
- ATTENTION:
- Click ▾ in "Data Set" box.
- The list of components in the HDF file appears
- From \*ImageData1\_G1 to \*ImageData3N\_G1 is VNIR data of Band1, 2, 3.
- From \*ImageData4\_G2 to \*ImageData9\_G2 is SWIR data of Band4, 5, 6, 7, 8, 9.
- From \*ImageData10\_G3 to \*ImageData14\_G3 is TIR data of Band10, 11, 12, 13, 14.

## File Format Change of ASTER HDF to GeoTIFF Format

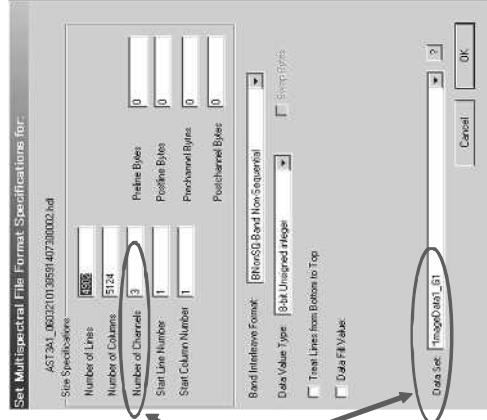
- QGIS is needed to perform an arithmetical operation of ASTER data like calculation of band ratio.
- To load ASTER data by QGIS, You need to change file formats from HDF to GeoTIFF in ASTER data, by using MultiSpec.
- Select and click "File-Open Image" in main menu.



- Select ASTER HDF file.  
e.g.: AST3A1\_0603210138591407300002.hdf
- Click "Open".

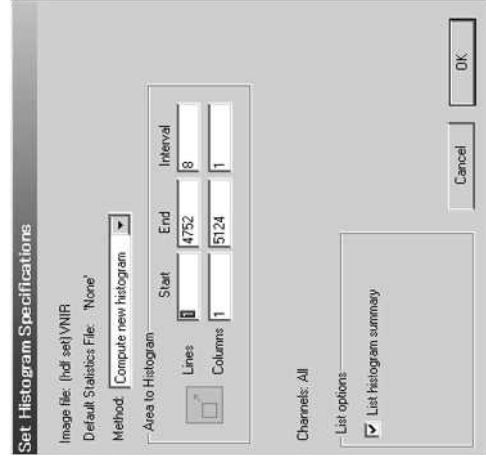


- Set "Multispectral File Format Specification" window appears.
- Select one group of data in "Data Set" box to save in GeoTIFF format.
- Click "OK".

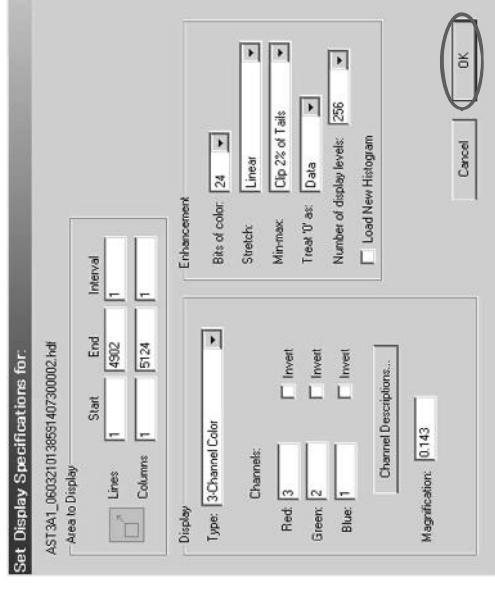


- If you select one group of data in "Data Set" box, the number of channels is entered in "Number of Channel" box automatically.
- The number of bands of VNIR is 3, SWIR is 6, TIR is 5.

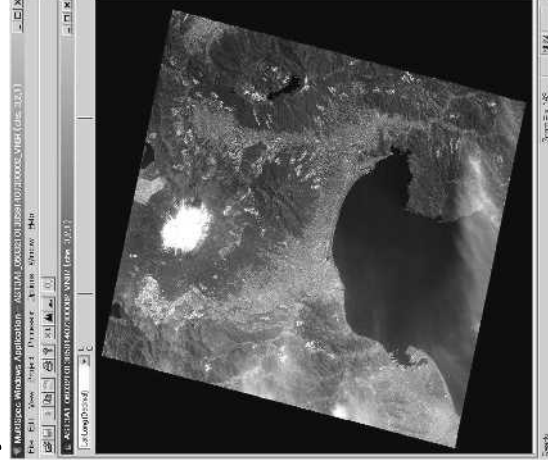
- If "Set Histogram Specifications" window appears, click "OK" to proceed.



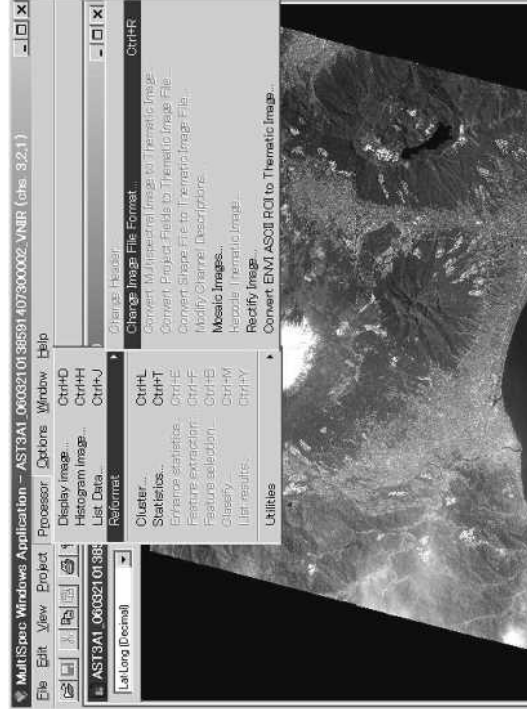
- Set Display Specifications for" window appears.
- Use default parameters in this window.
- Click "OK" to proceed.



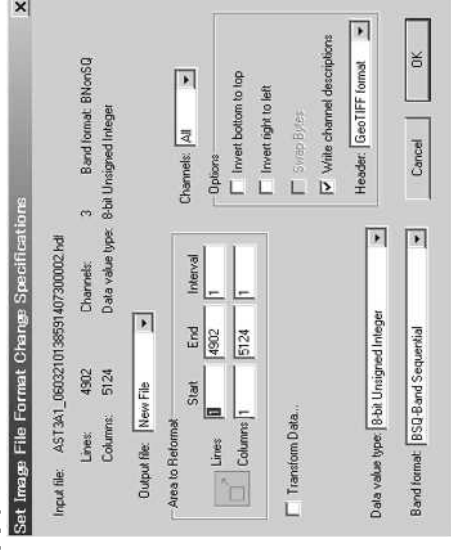
- The band composite image of ASTER appears in the image display.



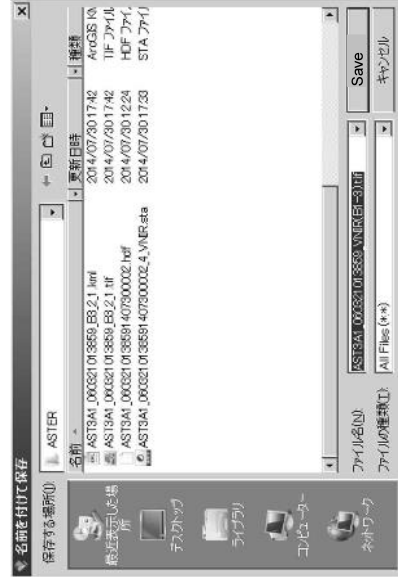
-To save the image in GeoTIFF format, Select and click “Processor-Reformat-Change Image File Format” in main menu.



-“Save Image File Format Change Specifications” window appears.  
 -Use default parameters.  
 -Confirm “GeoTIFF format” in “Header:” box.  
 -Click “OK”.



-Select the folder where you save the image and enter the filename of the image in filename box.  
 e.g.: AST3A1\_060321013859\_VNIR(B1-3).tif  
 -Click “Save” .  
 -VNIR band (3 bands) file in GeoTIFF format is created.  
 -Repeat above about SWIR and TIR band data.



## EXERCISE

•Create SWIR (6 bands) file and TIR (5 bands) file in same way of VNIR band (3 bands) file.

Example of Filename

-Input filename (HDF format)

e.g.: AST3A1\_06032101385914073000002.hdf  
includes 9 bands

-Output filename (GeoTIFF format)

e.g.: AST3A1\_060321013859\_VNIR(B1-3).tif  
VNIR includes 3 bands

e.g.: AST3A1\_060321013859\_SWIR(B4-9).tif  
SWIR includes 6 bands

e.g.: AST3A1\_060321013859\_TIR(B10-14).tif  
TIR includes 5 bands

END

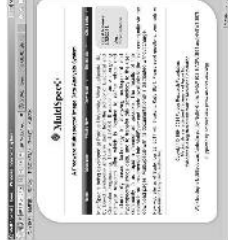


## URL of Open Software

-Geographic Information System(GIS) Free Software  
 QGIS:A Free and Open Source GIS  
<http://www.qgis.org/en/site/>

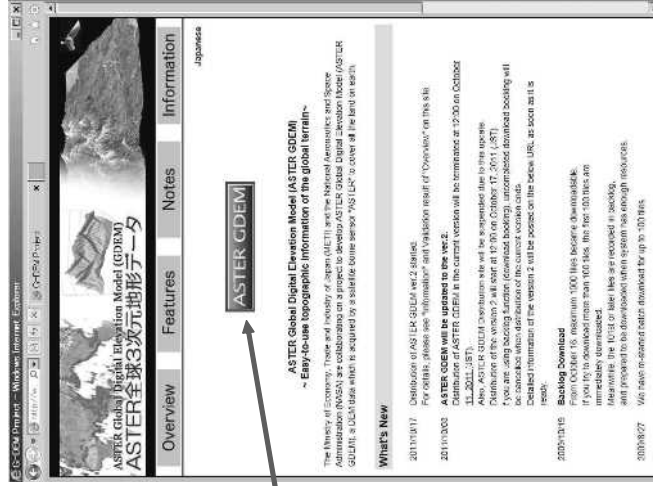


-Open ASTER HDF file and Convert format to GeoTIFF  
 MultiSpec:A Freeware Multispectral Image Data Analysis System  
<https://engineering.purdue.edu/~bieh/MultiSpec/>



## ASTER G-DEM

-Go to the following,  
<http://www.jspacsys.ms.or.jp/ersdac/GDEM/E/index.html>



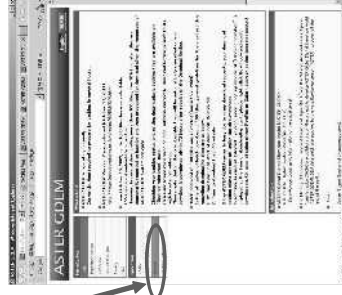
-Click ASTER GDEM

## URL of Open Data

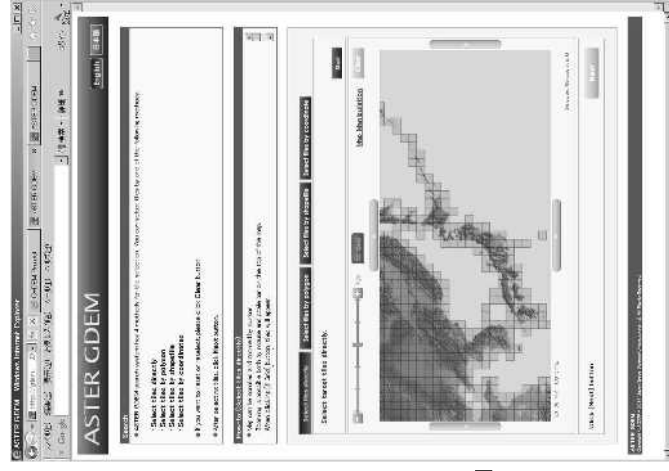
-ASTER GDEM data  
<http://www.jspacsys.ms.or.jp/ersdac/GDEM/E/index.html>  
 -LANDSAT  
<http://landsatlook.usgs.gov/>  
<http://glcfapp.glcf.umd.edu:8080/esdi/index.jsp>

- Basic Information of Countries  
 (border, city/town, road, railway, river, water area)  
<http://download.geofabrik.de/>  
<http://openstreetmapdata.com/data>  
<http://www.diva-gis.org/gdata>  
<http://earth-info.nga.mil/gns/html/namefiles.htm>  
<http://data.geocomm.com/catalog/index.html>

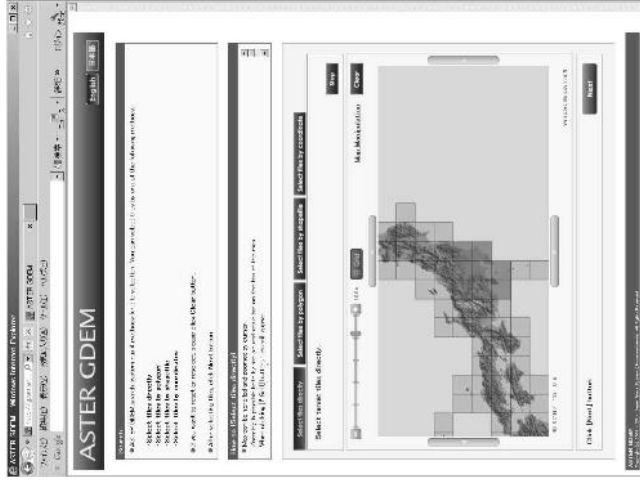
-Click Search



-New window is opened (right) .  
 By using the search window, search and select GDEM data you need.  
 Download them from this window.



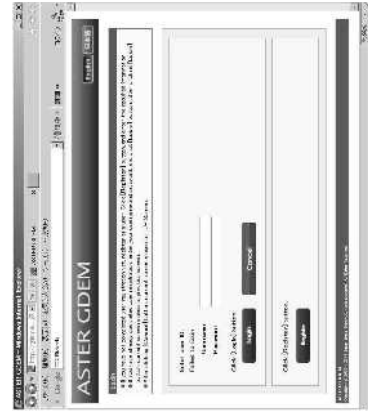
- Click Start button in the middle of windows to select GDEM data.
- Click tile on the map to select GDEM data to be downloaded.
- After finishing selection, click Stop button in the middle of windows to go to next step.



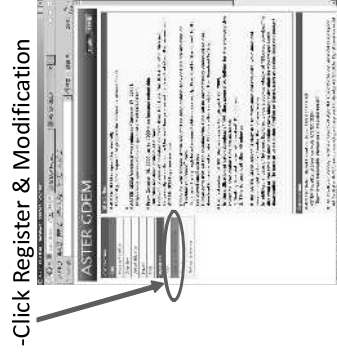
- Tile list appears. After checking the contents of the list, click Next button.



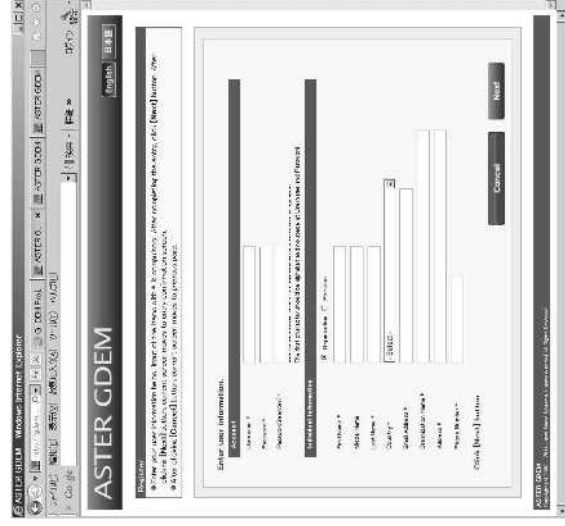
- Login windows appears.
- After entering Username and Password to login and then answering questions, you can download GDEM data.



- To download GDEM data from JSS site, registration is needed beforehand.



- New window is opened (right). Registration is done by filling the blanks.

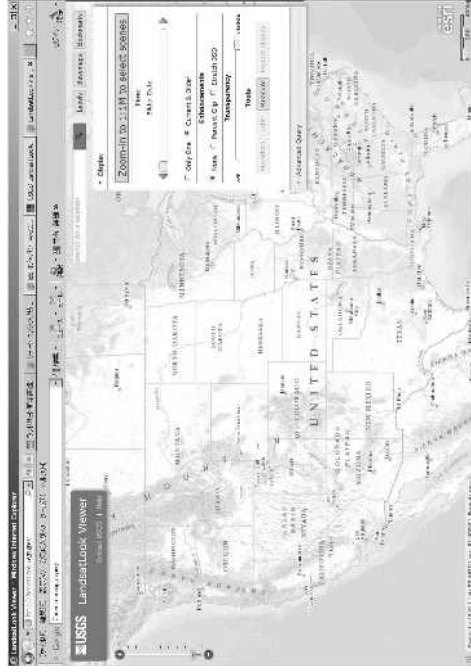




# LANDSAT

-Go to the following, <http://landsatlook.usgs.gov/>

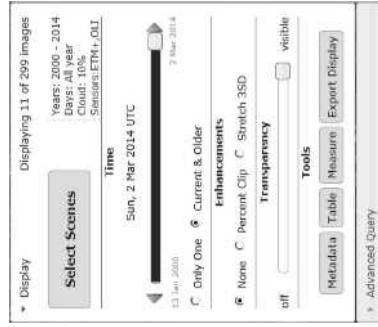
The USGS LandsatLook Viewer allows comprehensive searching and downloading of full-resolution LandsatLook images.



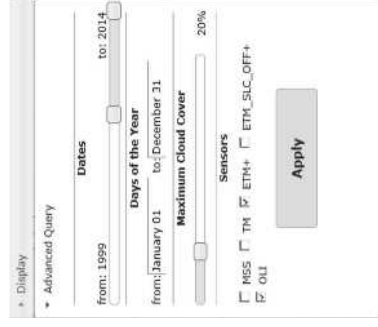
# LANDSAT

-Go to the following, <http://landsatlook.usgs.gov/>

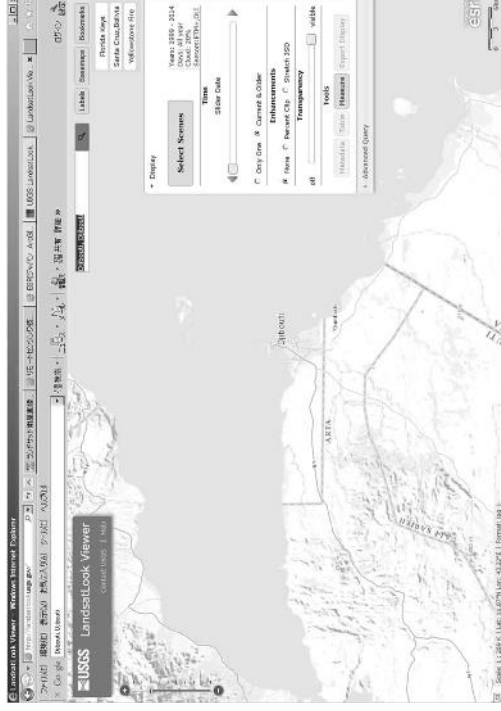
You can find your area of interest by the text-based search tool in the upper right or by panning and zooming around the globe.



You can modify the default parameters: years of coverage, cloud cover ranges, and sensor selection in Advanced Query window.



-You can find your area of interest by the text-based search tool in the upper right or by panning and zooming around the globe.



-After clicking Apply in Advanced Query window, then clicking Select Scenes, LANDSAT images are searched and showed.

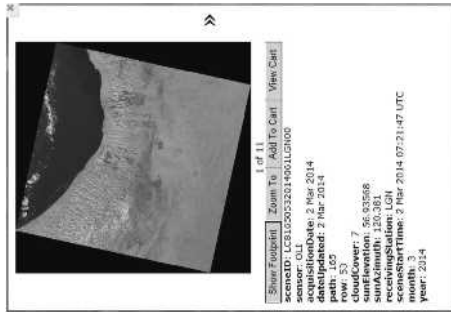


-Click Table in Display windows, the table of images is showed.

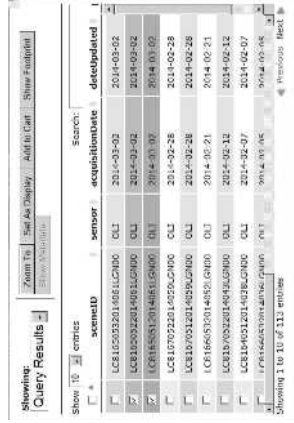
Showing: Query Results	Zoom To	Share Fullscreen	Show Metadata
entries	sensor	acquisitiondate	dateupdated
<input type="checkbox"/>	LC18160503014051LG000	OLI	2014-02-02
<input type="checkbox"/>	LC18160503014051LG000	OLI	2014-02-02
<input type="checkbox"/>	LC18160503014051LG000	OLI	2014-02-02
<input type="checkbox"/>	LC18160503014051LG000	OLI	2014-02-28
<input type="checkbox"/>	LC18160503014051LG000	OLI	2014-02-28
<input type="checkbox"/>	LC18160503014051LG000	OLI	2014-02-28
<input type="checkbox"/>	LC18160503014051LG000	OLI	2014-02-21
<input type="checkbox"/>	LC18160503014051LG000	OLI	2014-02-12
<input type="checkbox"/>	LC18160503014051LG000	OLI	2014-01-19

-Click Table in Display windows, the table of images is showed.

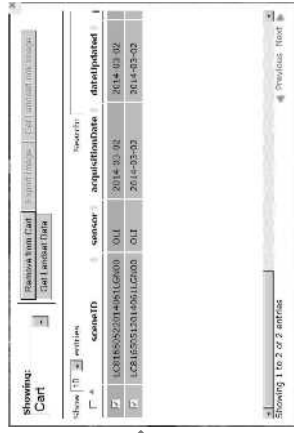
-Click Metadata in Display windows, the browse image windows is showed, you can check images one by one.



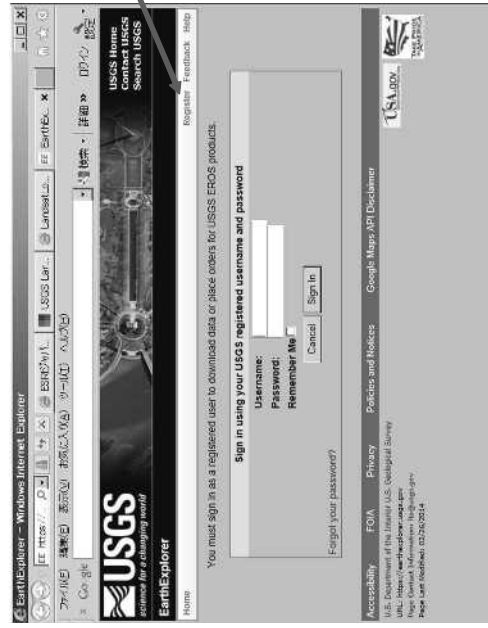
- Select data to be downloaded in Query Results windows, and then click Add to Cart.
- Select Cart in Showing: menu to go to Cart window.



-Select data to be downloaded in Cart windows, and then click Get Landsat Data.



-Get Landsat Data - Download the Full Scenes. Clicking the Get Landsat Data will direct you to the USGS Registration Service. You, which will require login credentials, in order to download the Level 1 Product.



Click Register to do registration.

### Basic Information

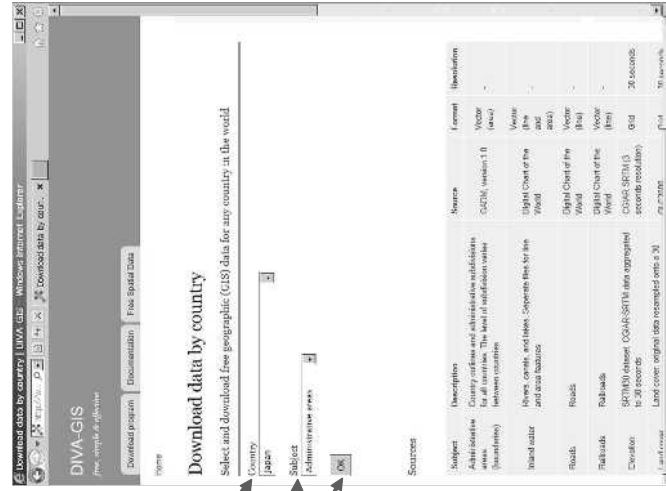
-Go to the following, <http://www.diva-gis.org/igdata>

-Select country in Country menu.

-Select subject in Subject menu and then click OK to go to next step.

-Click Download to begin the download.

-You can download data as shape files.



# Basic Information

-Go to the following,  
<http://earth-info.nga.mil/gns/html/namefiles.htm>

-Scroll windows and find your country of interest in the country list.  
-Click the country name to begin the download. You can download data as text file.

**Country Files (GNS)**

Complete Files of Geospatial Names for Geopolitical Areas from GNS (R50)DC  
Item#4 (Last update: LIF-3) (Compliant as of 18 July 2002)

**News**

- What's New? (23)
- What's Coming?

**GNS Search**

- GNS Views
- Page
- Text Based
- Page

**GNS Services**

- GNS Official Services

**Research & Reference**

- Download
- Country Files
- Country Codes
- Country Codes - Bolivia
- Country Codes - Micronesia
- Papers
- Country Policy
- Country Policy - Syria
- Symbols

**Indonesia Features**

- ADFP
- Administrative

Country Name	Country Code	File Name	Number of Records
AFGHANISTAN	AF	20141210	14217
ALBANIA	AL	20141210	2418
ALGERIA	DZ	20141210	2418
ARMENIA	AM	20141210	1790
AZERBAIJAN	AZ	20141210	1890
AUSTRALIA	AU	20141210	2418



# 1. Theory of Remote sensing and Spectrum



SUMIKO Resources Exploration & Development Co., Ltd

## Outline of Presentation

### Optical Sensor

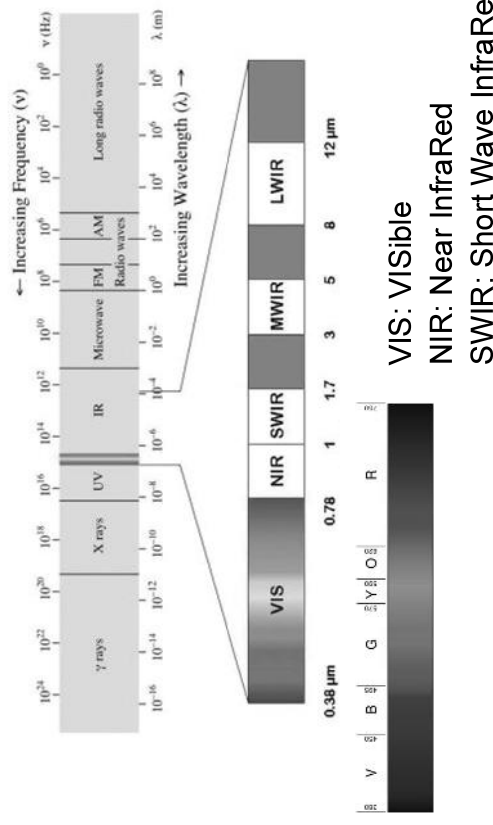
- Wavelength and spectra
- Spatial resolution
- Spectral resolution
- Mineral mapping theory

### Synthetic Aperture Radar

- Features
- Polarization
- Wavelength

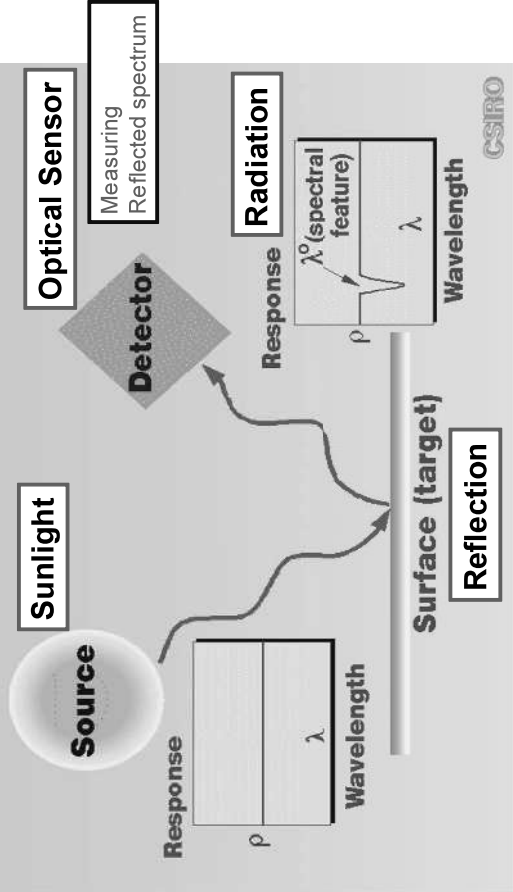
## Optical Sensor

### Wavelength



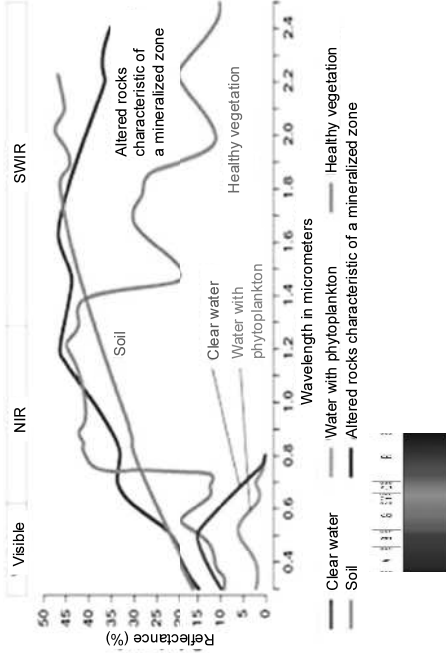
# Mineral Mapping Theory by Optical Sensor

## ENERGY - MATTER INTERACTIONS - PRINCIPLES

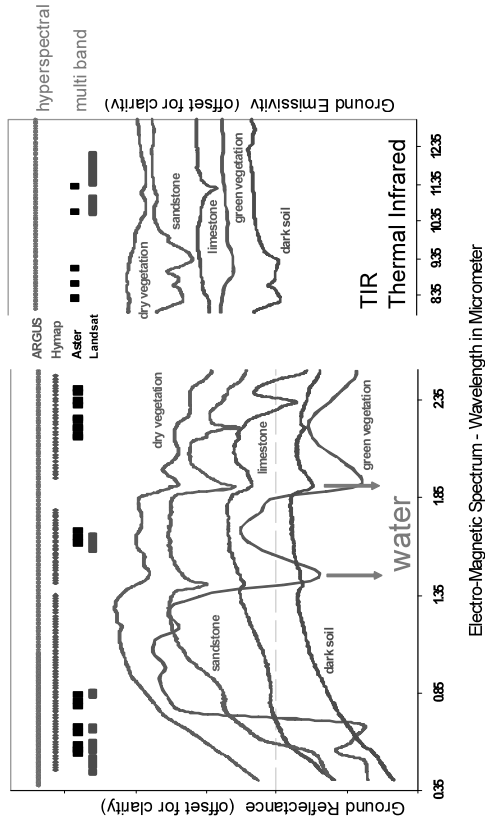


# Spectral pattern

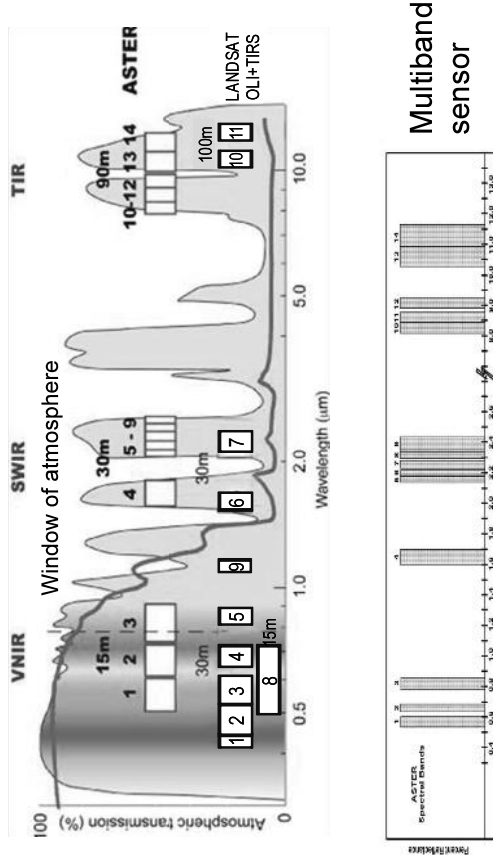
Generalized reflectance spectra of some earth surface materials



# Spectral patterns and bands location



# Band location of ASTER and LANDSAT



# Spatial Resolution and Spectral Resolution

## Spatial Resolution

Actual size per pixel

High spatial resolution : 0.4 - 4 m

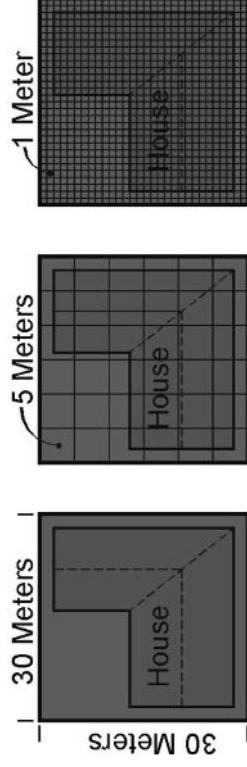
- » QuickBird
- » IKONOS/GeoEye
- » ALOS
- » SPOT-5
- » HyMap / 3 - 5m

Medium spatial resolution : 4 - 30 m

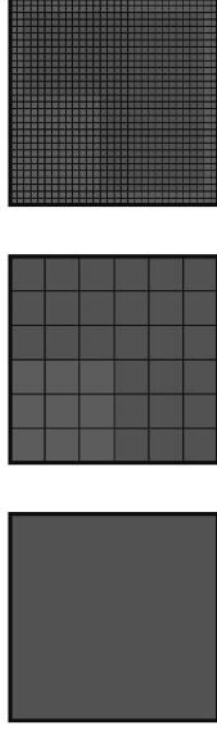
- » ASTER / 15m (Band1-3), 30m (Band 4-9)
- » LANDSAT 8 / 30m (Band1-7,9), 15m (Band8)
- » Hyperion / 30m
- » AVIRIS / 20m

HyMap and AVIRIS are hyperspectral airborne sensor

## Pixel Size (Spatial resolution)



## Pixel Output (Display)

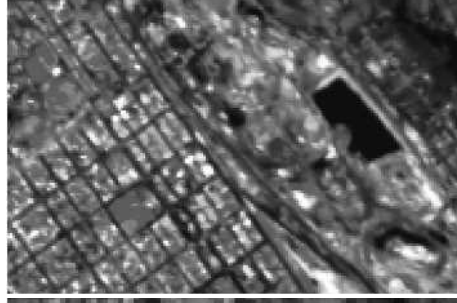


Vegetation is shown in red color.

LANDSAT  
RGB=B4, B3, B2  
30m



ASTER  
RGB=B3, B2, B1  
15m



HyMap  
RGB=B25, B16, B9  
3.3m



# Spectral Resolution

## Spectral resolution

High spectral resolution: 100- 230 bands

- » AVIRIS
- » HyMap
- » Hyperion



Hyperspectral sensor

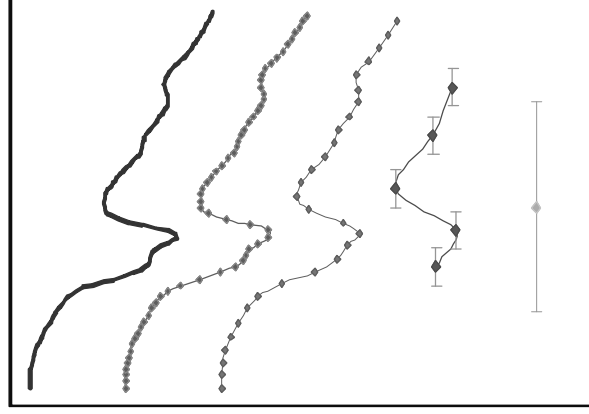
Medium spectral resolution: 5 - 15 bands

- » ASTER / 14bands
- » LANDSAT 8 / 11bands

Low spectral resolution:  $\leq 4$  bands

- » QuickBird
- » IKONOS/GeoEye
- » ALOS
- » SPOT-5

## Comparison of spectral patterns (spectral resolution)



Spectrometer

AVIRIS

HyMap

ASTER

LANDSAT

2.1 2.3 2.5 Wavelength (micrometer)

spatial resolution = geological identification  
spectral resolution = mineralogical identification

High resolution brings high accuracy.

It is necessary to select the kind of data according to the objectives and the cost.



## Comparison of typical data

	Name	# of Bands	Pixel size (m)	Data cost
Airborne	AVIRIS	224	20	Free (restricted)
Space-borne	HyMap	128	3-5	V. High
	Hyperion	210	30	Moderate
	ASTER	14	15/30/90	Low
	LANDSAT-8	11	15/30/100	(free)
	SPOT-5	4	2.5/10/20	High
	IKONOS	4	0.5/1	High
	QuickBird	4	0.6/2.5	High

## Problems

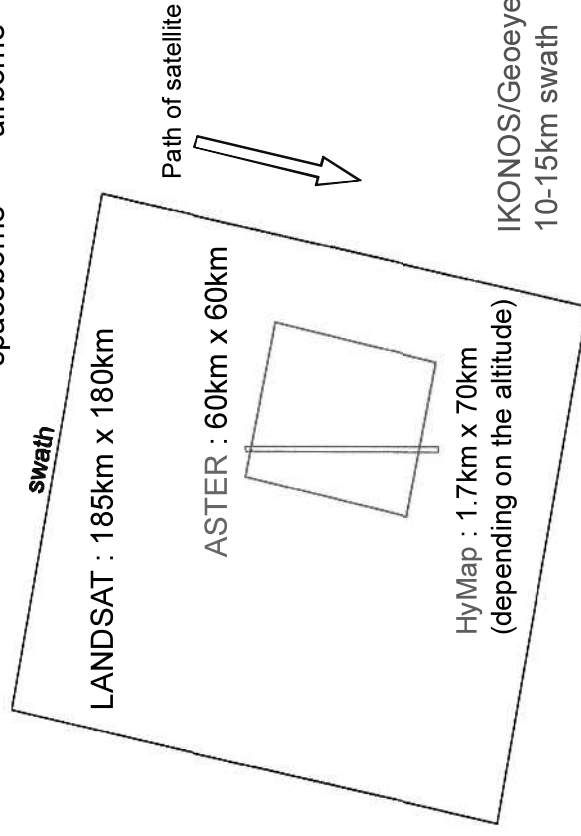
1. Higher resolution needs more data volume.
2. High resolution sensor has difficulties in mechanism.

Spaceborne data has more noise than airborne data.  
Hyperspectral sensor uses many sensors.



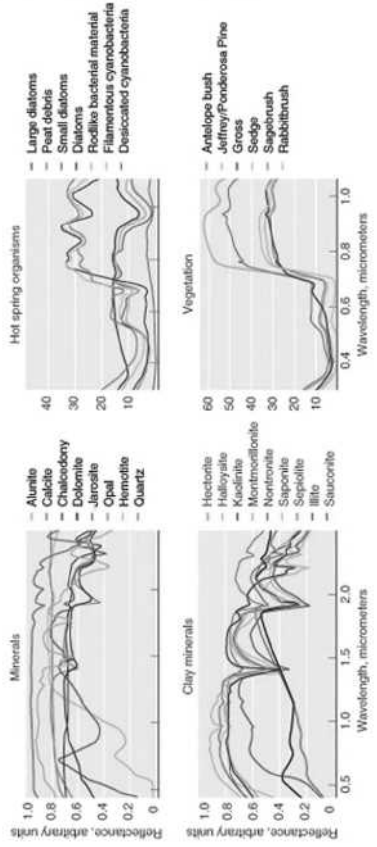
Generally, high spatial resolution spaceborne sensors have 4 to 5 bands and hyperspectral sensors have narrow swath.

Coverage area of one scene : LANDSAT / ASTER / HyMap  
spaceborne                      airborne



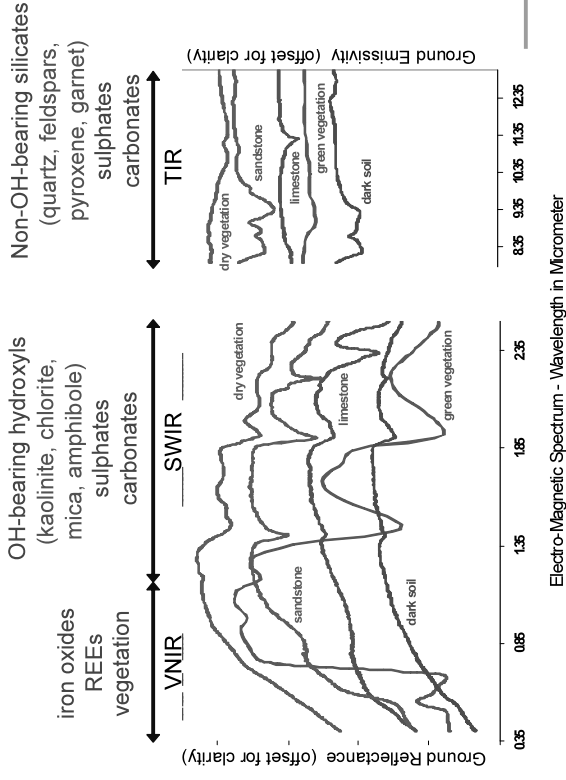
## Mineral mapping theory

Hyperspectral images provide distinctive spectral shapes that allow identification of mineral types, clay soil types, plant species, plant health within species types, and hot and cold spring microorganisms. These spectra are from Mammoth Mountain–Long Valley hyperspectral imagery but are representative of most areas.

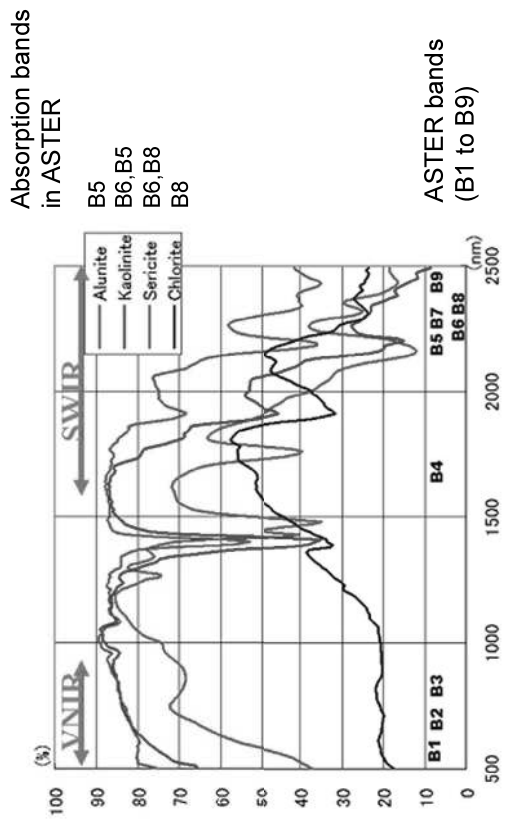


Hyperspectral sensor has 120 to 250 bands.

## Spectral-Mineral Wavelength Regions



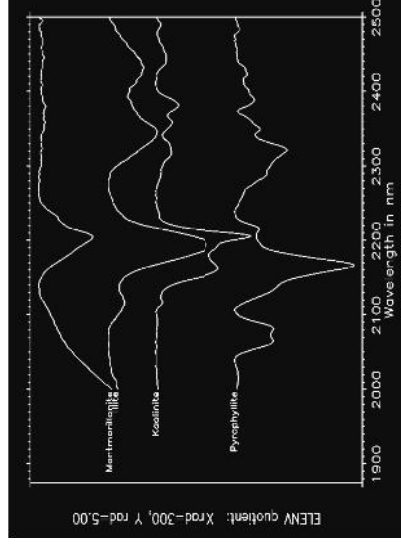
## Spectral patterns of alteration minerals



## Mineral Mapping Theory

Diagnostic absorption features of hydroxyl mineral groups in the SWIR

- \* Al(OH) : 2170 - 2210 nm  
Topaz, Pyrophyllite, Kaolinite, Montmorillonite, Muscovite, Illite
- \* "Mg(OH)" : 2300 - 2400 nm  
Chlorite, Talc, Epidote, Amphibole, Antigorite, Biotite, Phlogopite
- \* "Fe(OH)" : 2250 - 2300 nm  
Jarosite, Nontronite, Saponite, Hectorite
- \* Si(OH) : 2240 nm (broad)  
Opaline silica



## ASTER data analysis to detect minerals

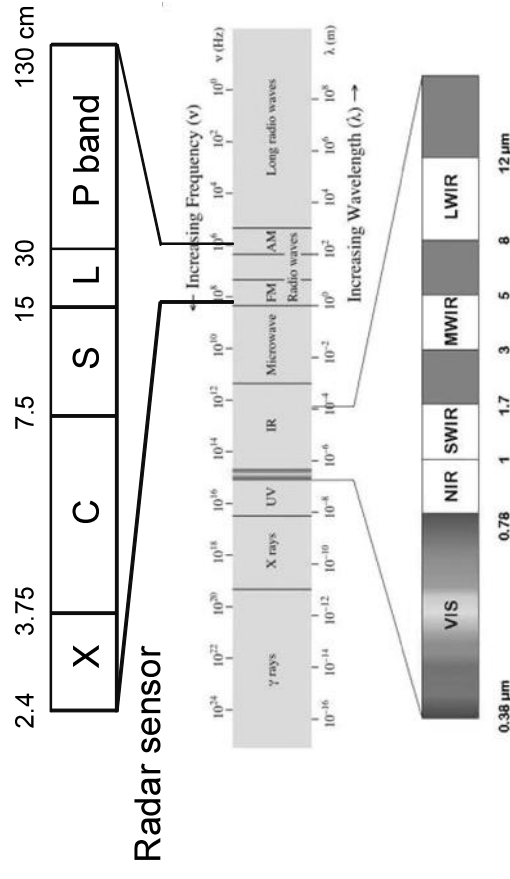
- Alunite : B4/B5, B6/B5
  - Pyrophyllite : B4/B5
  - Kaolinite : B4/B6, B4/B5
  - Sericite : B4/B6, B4/B8
  - Montmorillonite : B4/B6
  - Chlorite : B4/B8, B3/B4
  - Epidote : B4/B8, B6/B7
  - Calcite : B4/B8
- Acidic alteration
- Phyllic alteration
- Propylitic alteration

## Synthetic Aperture Radar

## Features of SAR (Synthetic Aperture Radar)

- Advantage**
- Active type microwave sensor
  - No influence of weather and time (day/night)
  - Different wavelength gives different backscatter. (reflectance / penetration)
- Difficulty**
- Large affection of terrain by side looking
  - Much noise
  - Complexity of data process and analysis
  - Necessity of various corrections

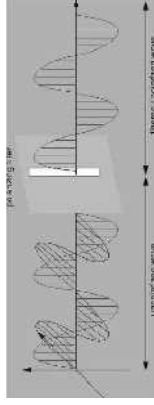
## Wavelength of radar sensors



## Multi-polarimetric SAR data

The combination of “transmission and reception” and “vertical and horizontal linear polarization” makes 4 kinds of polarization.

The strength of each polarization changes by reflected objects.



Linear polarization

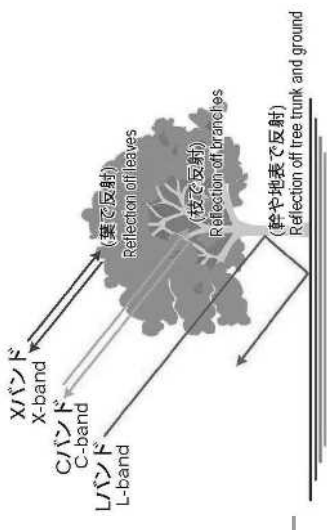
Receive / Transmit	Horizontal	Vertical
Horizontal	HH	HV
Vertical	VH	VV

## Kind of SAR : Difference of wavelength

In general, short-wavelength radio waves are easily reflected from the surface of the material and long-wavelength radio waves can penetrate vegetation with some substances.

- Objects larger than the half of wavelength : reflection
  - Objects smaller than the quarter of wavelength : penetration
- SAR data needs to be selected according to the analytical purpose.

Band	Wavelength(cm)
P	130~30
L	30~15
C	7.5~3.75
X	3.75~2.4

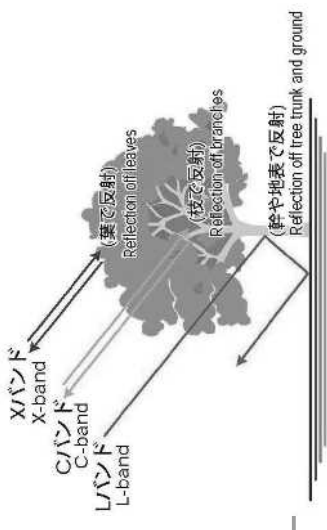


## Kind of SAR : Difference of wavelength

In general, short-wavelength radio waves are easily reflected from the surface of the material and long-wavelength radio waves can penetrate vegetation with some substances.

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X	3.75~2.4



## PALSAR

### Phased Array type L-band Synthetic Aperture Radar onboard Advanced Land Observing Satellite (ALOS)

In addition to its all-weather observation capability regardless of day and night, PALSAR incorporated many highly advanced observation technologies, and has contributed greatly in areas such as resource exploration, environmental monitoring on earth and monitoring of natural disasters.

The operation was started in January, 2006 and finished in May, 2011

Band	Satellite	Airplane
P		AIRSAR(USA)
L	PALSAR(JAPAN)	AIRSAR(USA)
C	ENVISAT ASAR (Europe) SAR-C/X-SAR (USA, etc) *RADARSAT-2 (CAN)	AIRSAR(USA) C/X-SAR(CAN)
X	TerraSAR X (DEU) SAR-C/X-SAR(USA, etc) *COSMO(ITA)	C/X-SAR(CAN)

Volume scatter



Surface

plane forest farmland mountain rough city



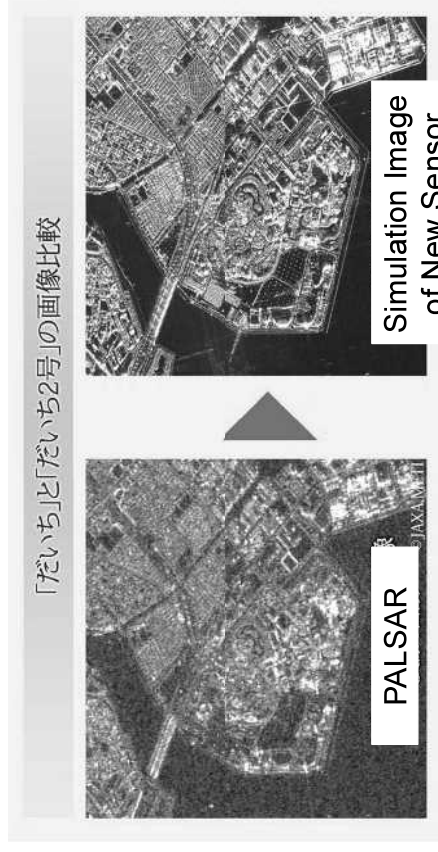
Image of radar

## PALSAR-2

ALOS-2 loaded with PALSAR-2 was launched in May 24, 2014, as successor sensor to PALSAR. It has 3m resolution.



from JAXA's WEB site



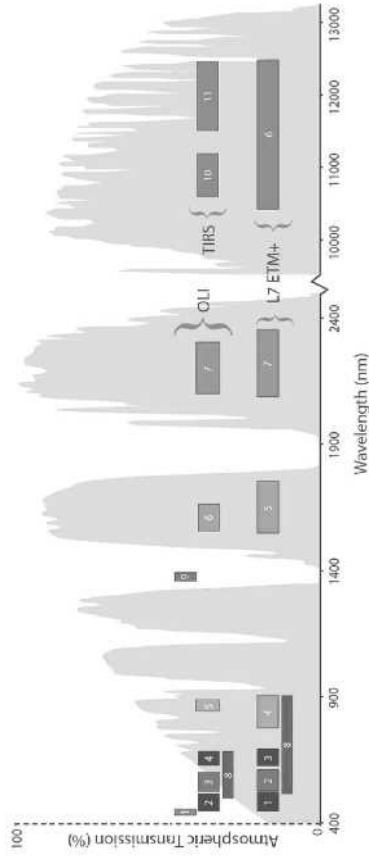
from JAXA's WEB site

## Appendix

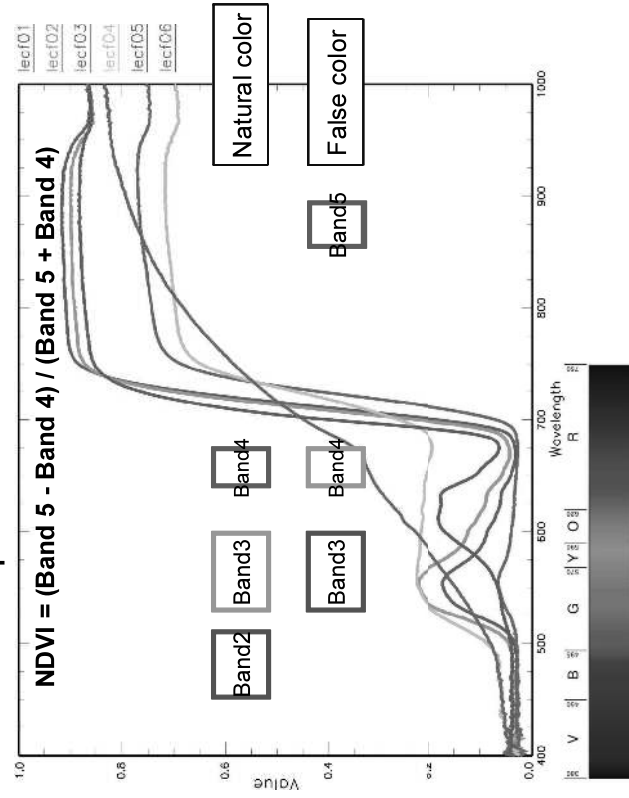
衛星/センサー名 国	# of Band				Spatial res.		打上予定
	波長域 ( $\mu$ m)	バンド数	波長分解能	空間分解能	S/N		
ALOS-3/HISUI 日本	0.4-0.97 0.9-2.5	57 128	10nm 12.5nm	30m	450@620nm 300@2100nm		2015年
EO-1/Hyperion アメリカ	0.4-1.0 1.0-2.5	60 150	10nm	30m	140-190@650-700nm 96@1,225nm 38@2125nm		2000/11
PROBA/CHRIS ESA, イギリス	0.4-1.05	61	5-12nm	18m/36m	200		2001/10
IMS-1/HySI インド	0.4-0.95	64	8nm	505.6m	不明		2008/04
HICO アメリカ	0.38-1.0	124	5nm	100m	200		2008/08
PRISMA イタリア	0.4-1.010 0.92-2.505	92 157	<10nm	30m	650@650nm 400@1550nm 200@2100nm		2013年
EnMAP ドイツ	0.42-1.0 0.90-2.45	94 134	6.5nm 10nm	30m	500@495nm 150@2200nm		2014年
HysafRI アメリカ	0.38-2.5	213	10nm	60m	不明		未定

## Band location of LANDSAT 8 & 7

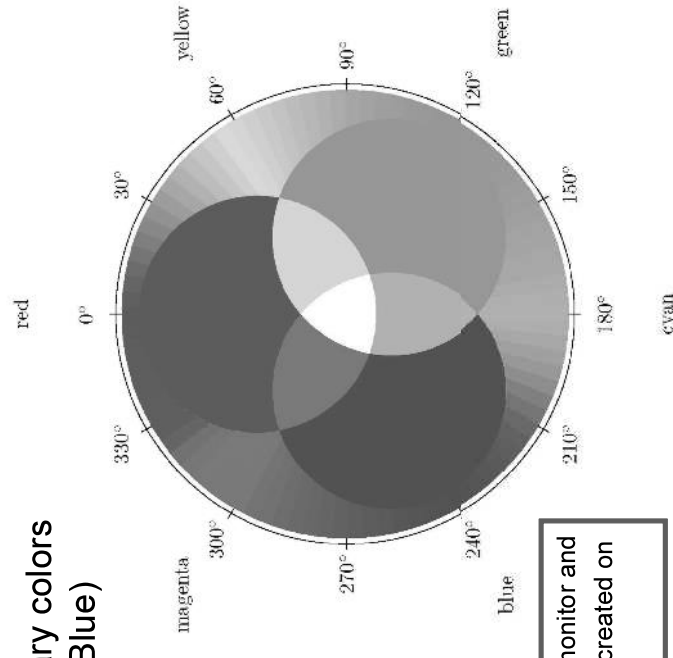
- Hyperion :**  
<http://eo1.gsfc.nasa.gov/Technology/Hyperion.html>
- CHRIS:**  
<http://earth.esa.int/missions/thirdpartymission/proba.html>
- HySI:** <http://www.nrsc.gov.in/ims-1.html>
- HICO:**  
<http://events.eoportal.org/presentations/330/10001432.html>
- Prisma:**  
[http://www.asi.it/en/activity/earth\\_observation/prisma](http://www.asi.it/en/activity/earth_observation/prisma)
- EnMAP:** <http://www.enmap.org/>
- HypIRI:** <http://hyspiri.jpl.nasa.gov/>



## Band Composite of LANDSAT 8



## Additive primary colors (Red, Green, Blue)



Images of TV/PC monitor and digital camera are created on this theory.

## 卷末資料 2

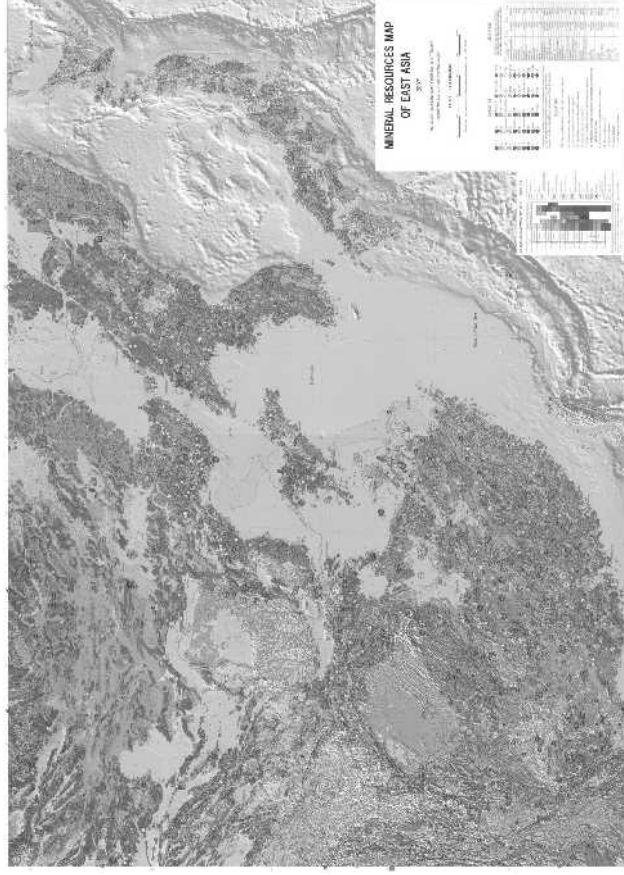
### 鉦物資源



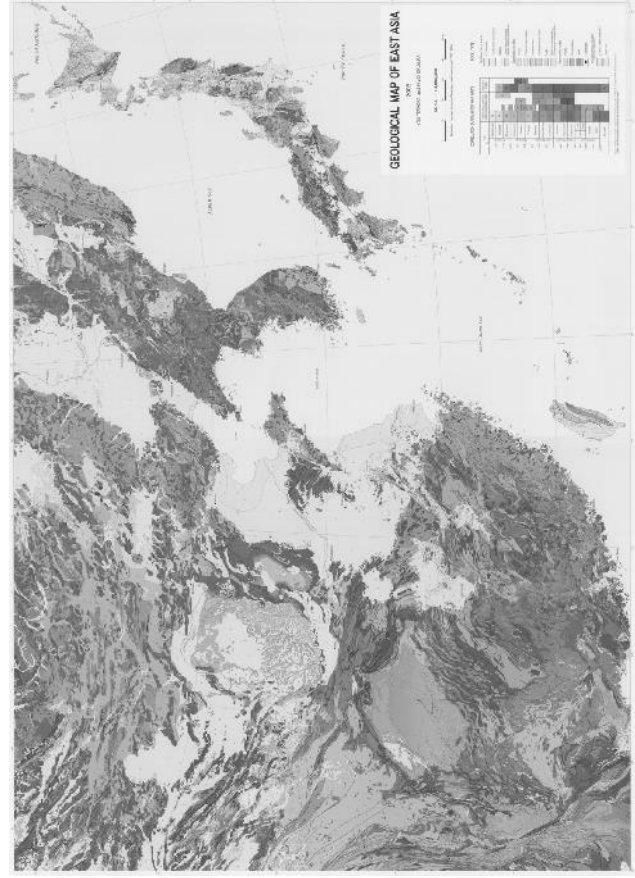


## Introduction of Mineral Resources Maps of Asia (GSJ)

OHNO Tetsuji GSJ, AIIST



1:3,000,000 Mineral Resources Map of East Asia (GSJ, 2007)

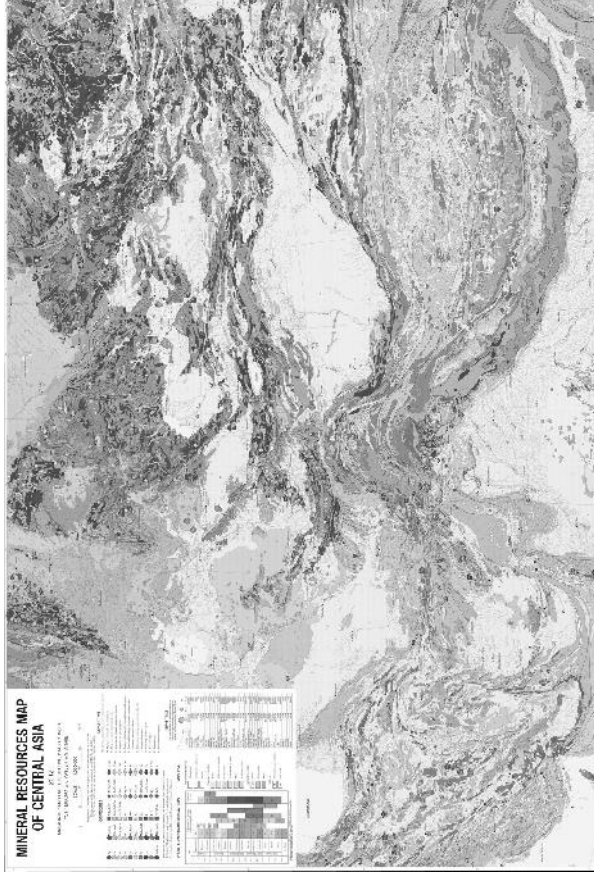


1:3,000,000 Geological Map of East Asia (GSJ, 2003)

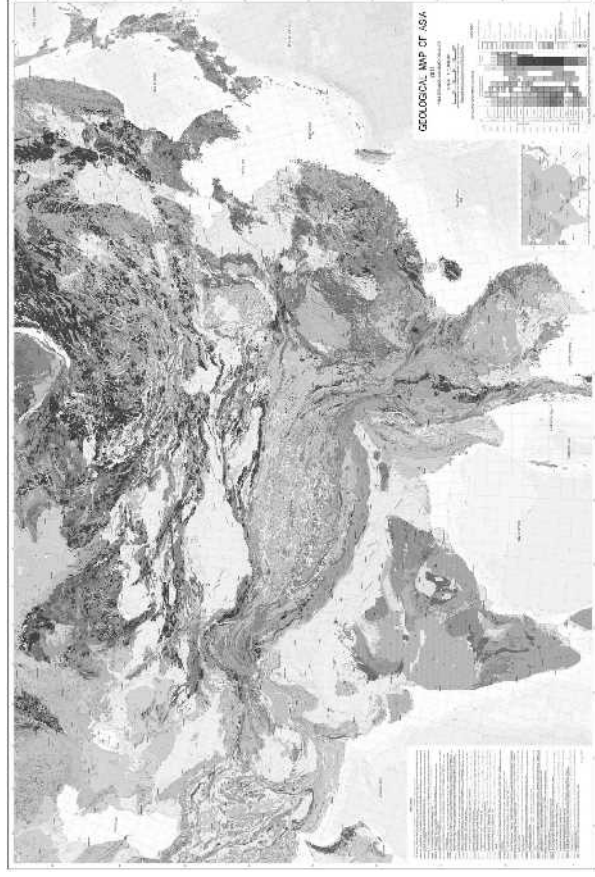
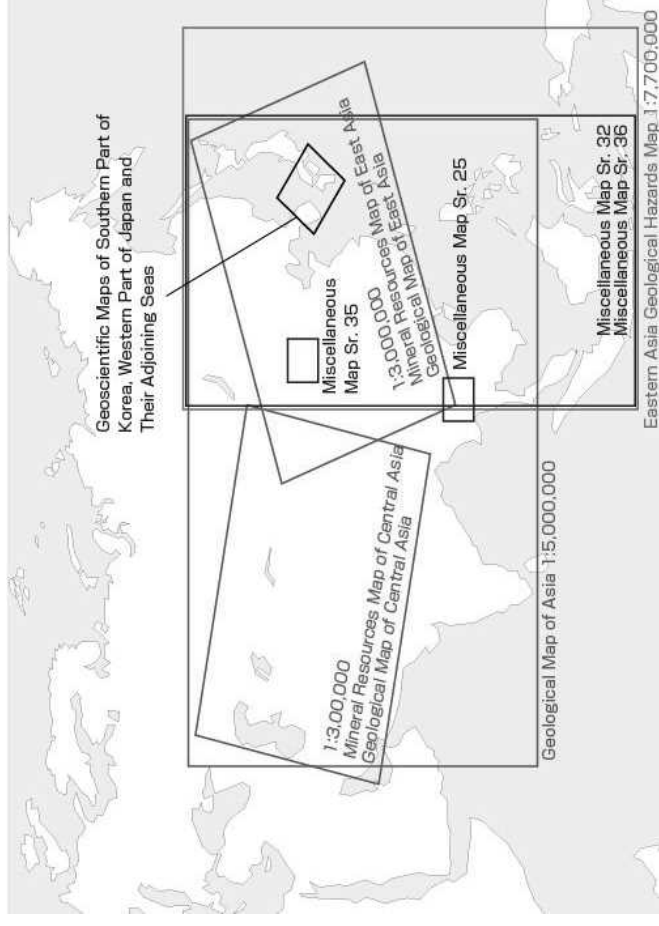


1:3,000,000 Geological Map of Central Asia (GSJ, 2007)

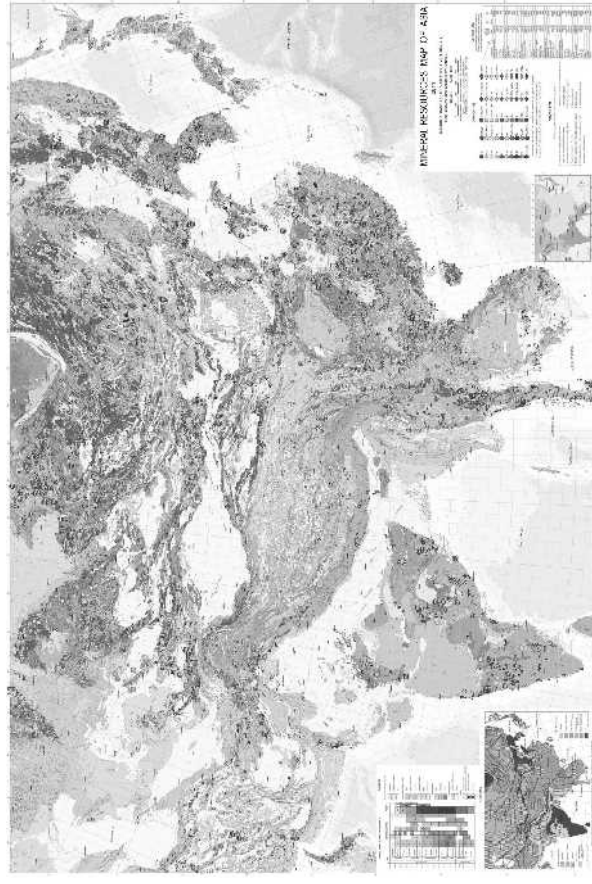




1:3,000,000 Mineral Resources Map of Central Asia (GSJ, 2012)



1:5,000,000 Geological Map of Asia (GSJ, 2011)

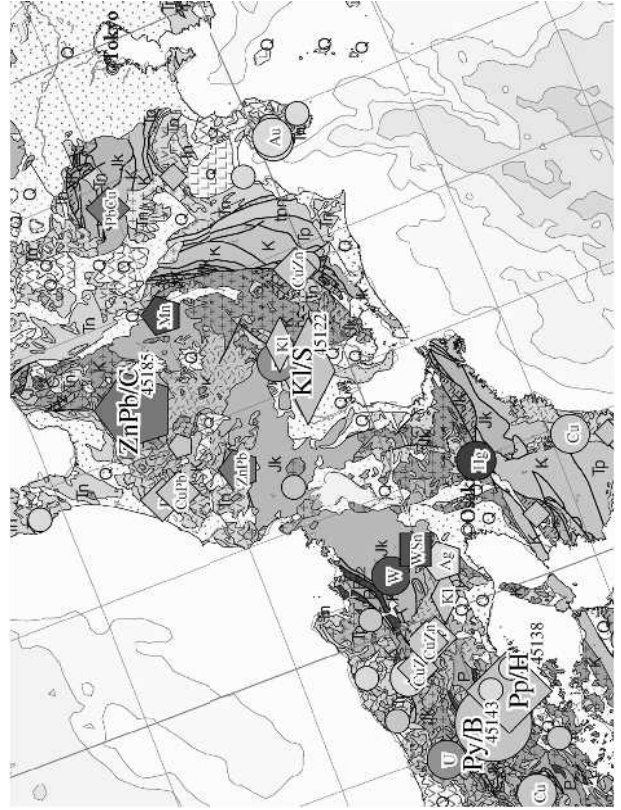


1:5,000,000 Mineral Resources Map of Asia (in preparation)



# 1:5,000,000 Mineral Resource Map of Asia

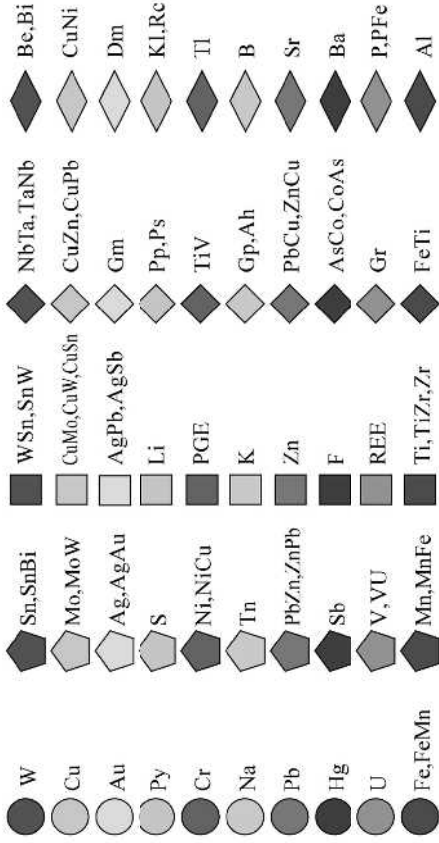
- \* Based on 1:5,000,000 Geological Map of Asia (GSJ, 2011)
- \* include main metallic mineral, non-metallic mineral and Uranium
- \* plotted about 8,000 mines
- \* Classified 50 commodities and 3 sizes



Sample of mineral deposit figures



## COMMODITIES



Abbreviations; Ah: anhydrite, Dm: diamond, Gm: gemstones, Gp: gypsum, Gr: graphite, Kl: kaolin, PGE: platinum group elements, Pp: pyrophyllite, Ps: pottery stones, Py: pyrite, Re: refractory clay, REE: rare earth elements, Tl: tale, Tn: thenardite



## DEPOSIT SIZE

Size limits are shown in metric tons of metals or minerals except for diamond and precious gems in carats. Past production and/or reserves totaled.

Commodity	Size		
	Large > 100,000,000	Medium > 10,000,000	Small > 1,000,000
Aluminum (bauxite) (Al <sub>2</sub> O <sub>3</sub> )	100,000,000	10,000,000	1,000,000
Antimony (Sb)	500,000	10,000	1,000
Arsenic (As)	1,000,000	10,000	1,000
Barite (BaSO <sub>4</sub> )	5,000,000	50,000	10
Beryllium (BeO)	1,000	100,000	10
Boron (B <sub>2</sub> O <sub>3</sub> )	10,000,000	100,000	10,000
Chromium (Cr <sub>2</sub> O <sub>3</sub> )	1,000,000	10,000	1,000
Cobalt (Co)	20,000	50,000	1,000
Copper (Cu)	1,000,000	50,000	1,000
Diamond (Dm)	20,000	1,000	100,000
Fluorite (CaF <sub>2</sub> )	5,000,000	100,000	10
Gold (Au)	200	10,000	10,000



## DEPOSIT TYPE

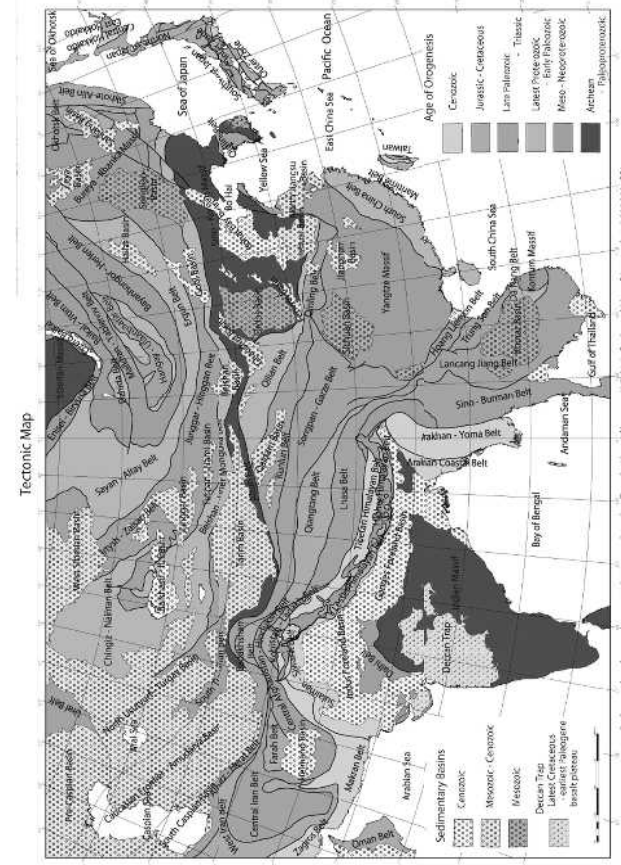
The following abbreviations are shown in commodity symbols.

- M: Magmatic and irregular massive deposits.
- C: Skarn and contact metamorphic deposits.
- II: Hydrothermal vein and fissure-filling deposits.
- Gi: Pegmatite and greisen deposits.
- P: Porphyry including stockwork and disseminated deposits.
- B: Stratabound including volcanogenic sedimentary and sedimentary exhalative deposits.
- S: Sedimentary including sandstone-hosted deposits.
- T: Metamorphic deposits.
- W: Weathering residual deposits.
- E: Evaporite deposits.
- D: Placer deposits.
- U: Undifferentiated deposits.

NO.	SYMBOL	DEPOSIT TYPE	COMMODITY	RESERVE	REMARKS
1	U	Undifferentiated			
2	S	Sedimentary			
3	T	Metamorphic			
4	W	Weathering residual			
5	E	Evaporite			
6	D	Placer			
7	M	Magmatic and irregular massive			
8	C	Skarn and contact metamorphic			
9	II	Hydrothermal vein and fissure-filling			
10	Gi	Pegmatite and greisen			
11	P	Porphyry including stockwork and disseminated			
12	B	Stratabound including volcanogenic sedimentary and sedimentary exhalative			

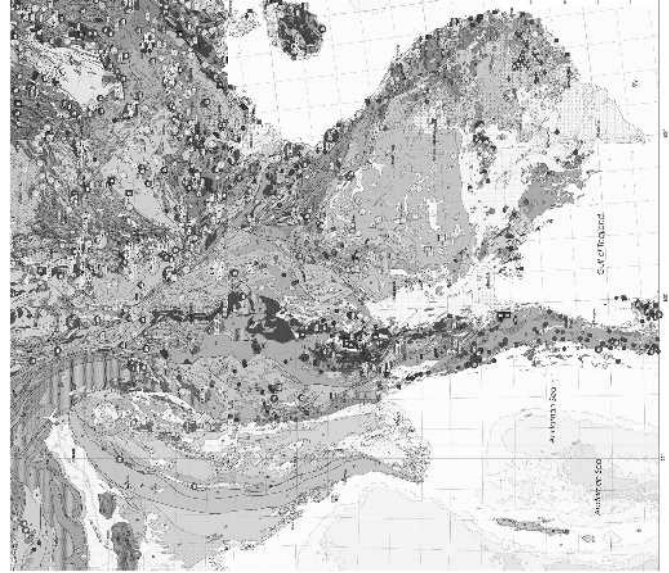


<https://www.gsj.jp/Map/E/asia-area-geoscience.html>



Background geology and tectonic division are based on Inosaka, Y. and Okumura, K. (2011) Geotectonic Map of Asia, scale 1:5,000,000, GSI.

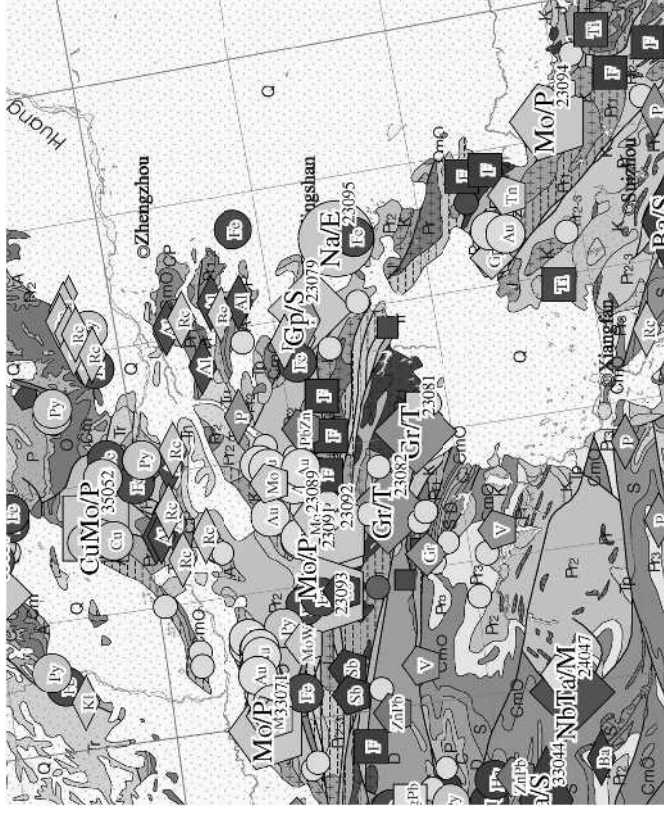
Tectonic Map of Asia



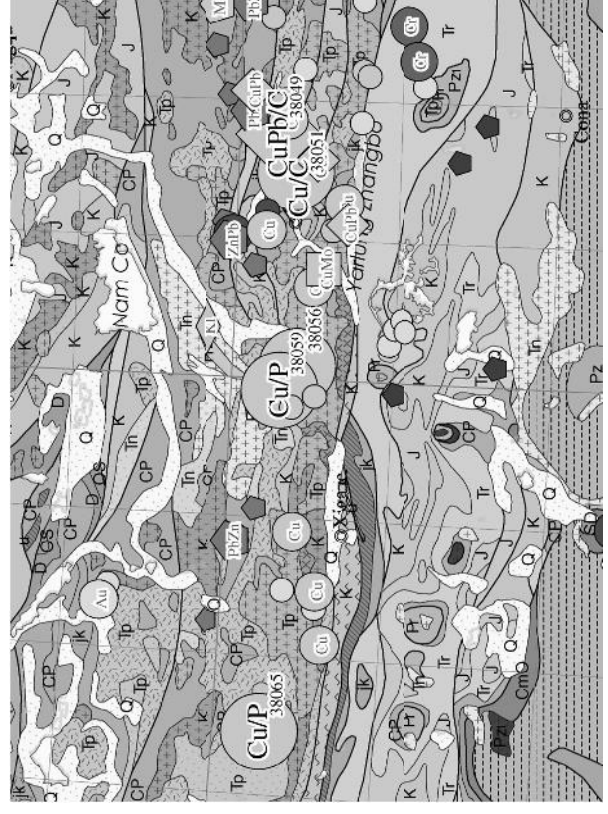
ASEAN countries in the Mineral Resources Map of Asia

- Vietnam (356)
- Laos (197)
- Cambodia (74)
- Thailand (237)
- Myanmar (225)

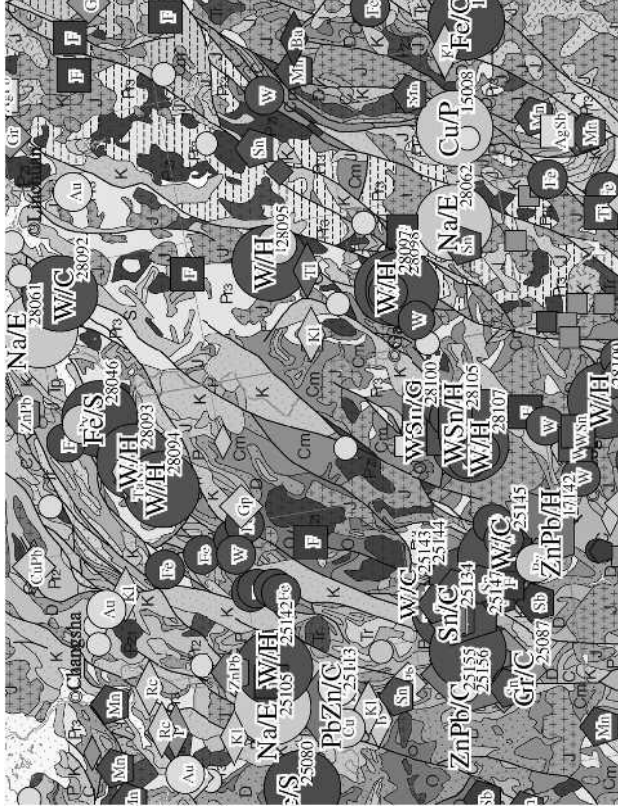




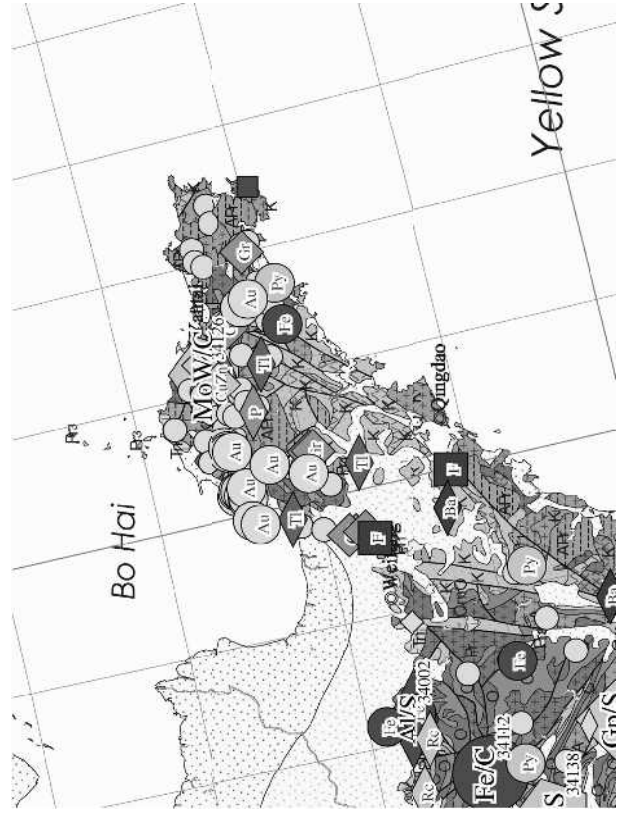
Magmatic Copper Molybdenum in Yangtze (China)



Porphyry Copper deposits in Himalayas (China)

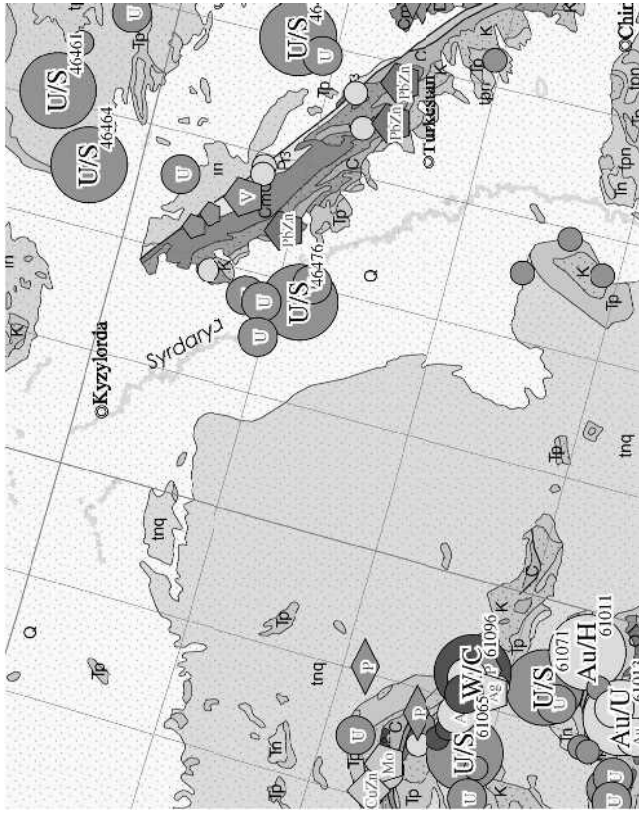


Tungsten-Bismuth and Lead-Zinc-Tin in Huanan (China)

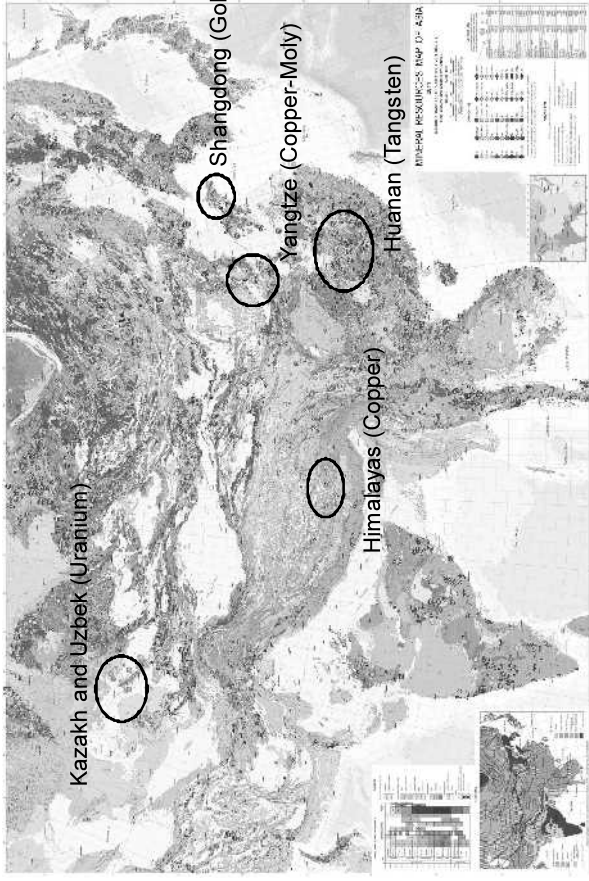


Hydrothermal Gold in Shandong (China)

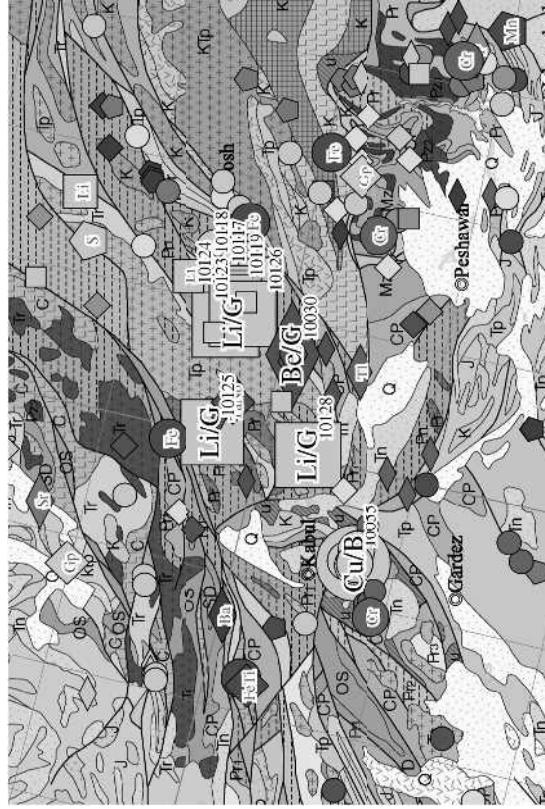




SandStone Hosted Uranium in Kazakhstan and Uzbekistan



1:5,000,000 Mineral Resources Map of Asia (in preparation)



Pegmatite Lithium in Afghanistan



Thank you for your attention.

