APPENDIX

Presentations for the Lectures, Workshop in Japan

Appendix 1
Remote Sensing Analysis

How to download LANDSAT data

SUMIKO Resources Exploration & Development Co.,Ltd

LANDSAT

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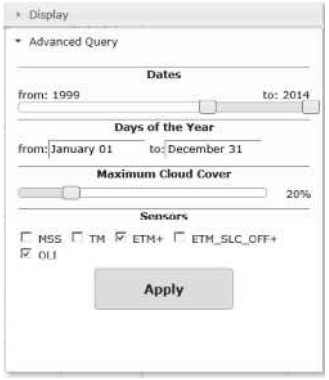
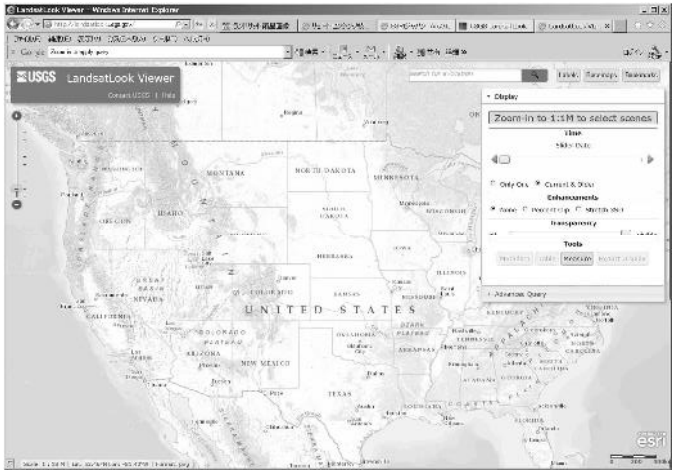
Yo an od y t d a lt a a t y a o o a lo d o an and n o l ton n Ad an d Q y w ndow



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.



-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.

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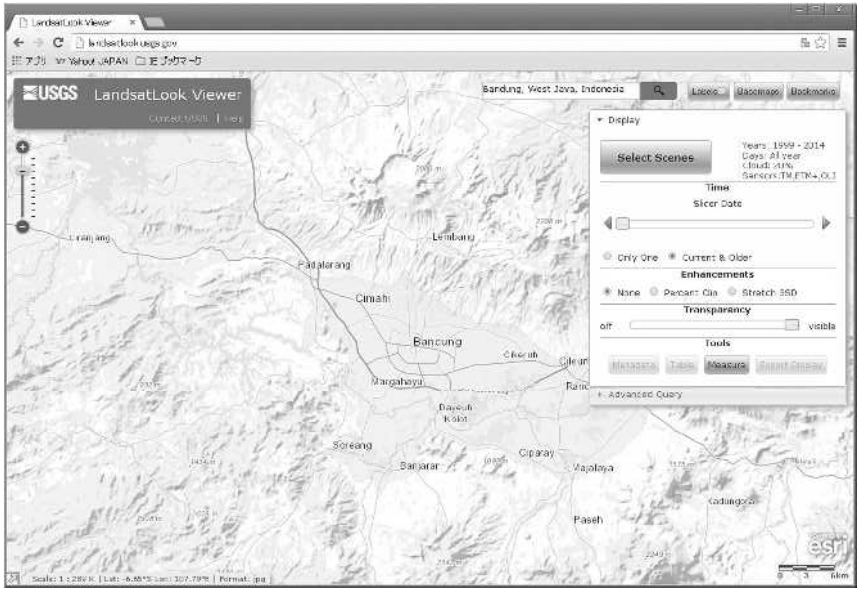
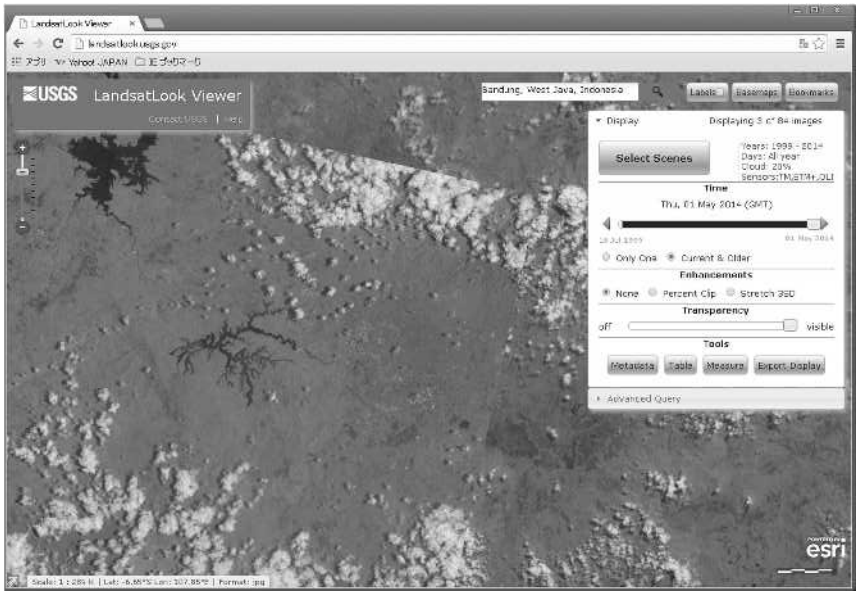
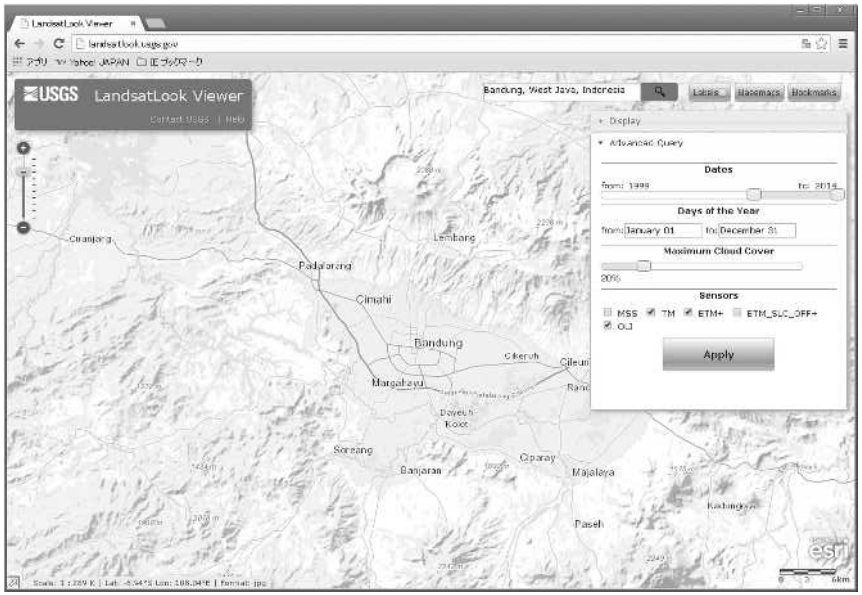


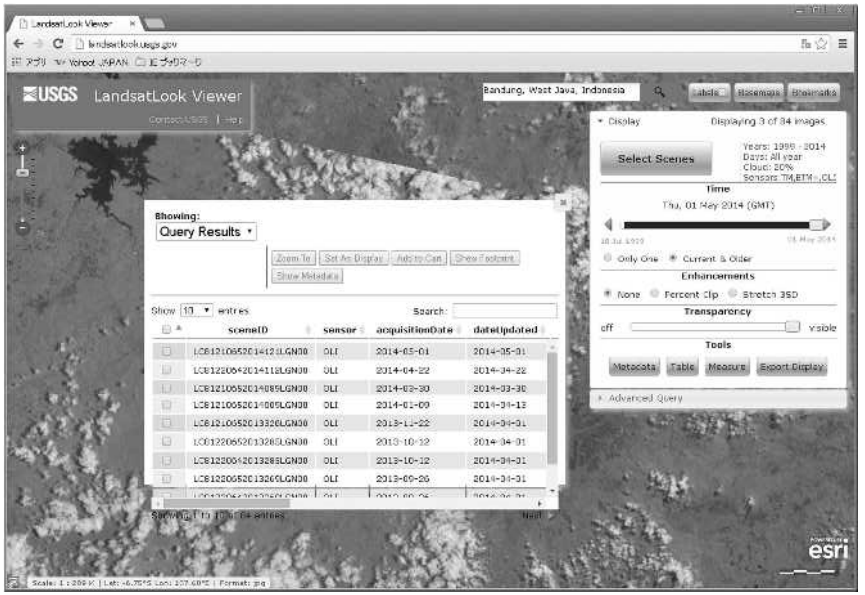
-This is result of search.



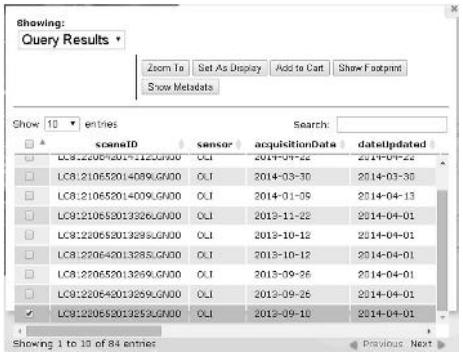
-You can find your area of interest by the text-based search tool in the upper right or by panning and zooming around the globe.



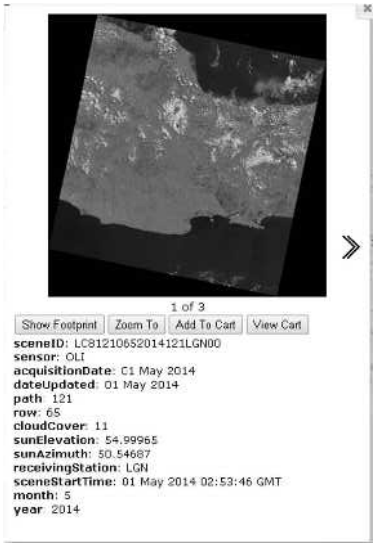
-This is result of search.



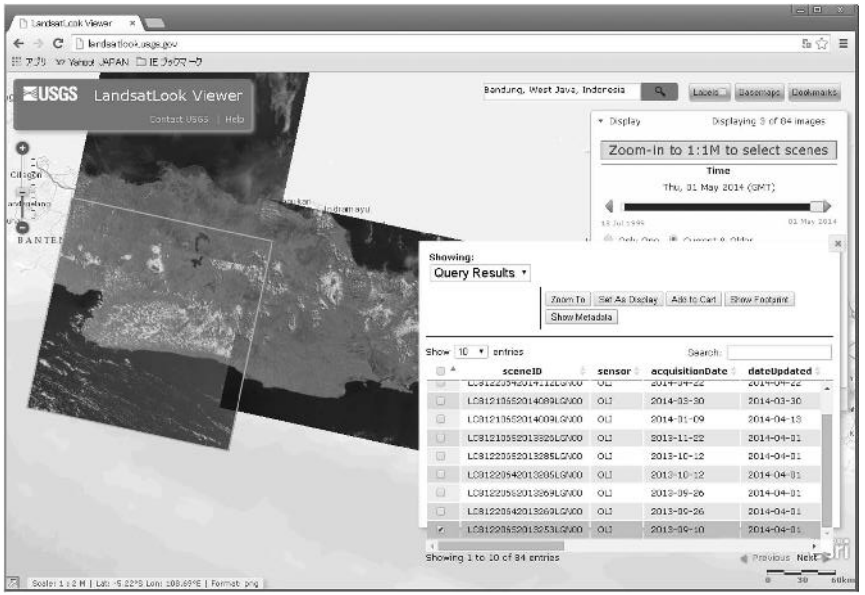
-Click "Table" in "Display" window, the table of images is shown.



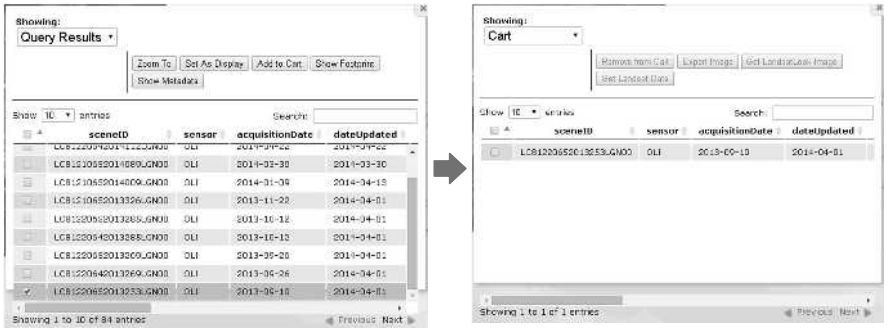
-Click "Metadata" in "Display" window, the browse image is shown. You can check images one by one.



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

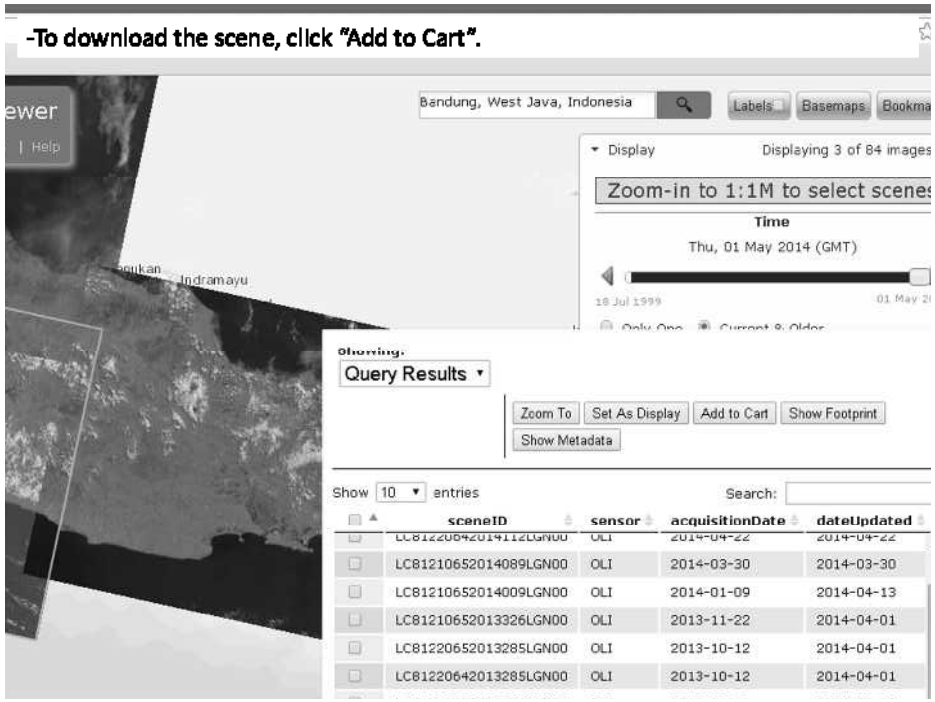


-Select data to be downloaded in "Query Results" window, and then click "Add to Cart".
-Select "Cart" in "Showing:" menu to go to "Cart" window.

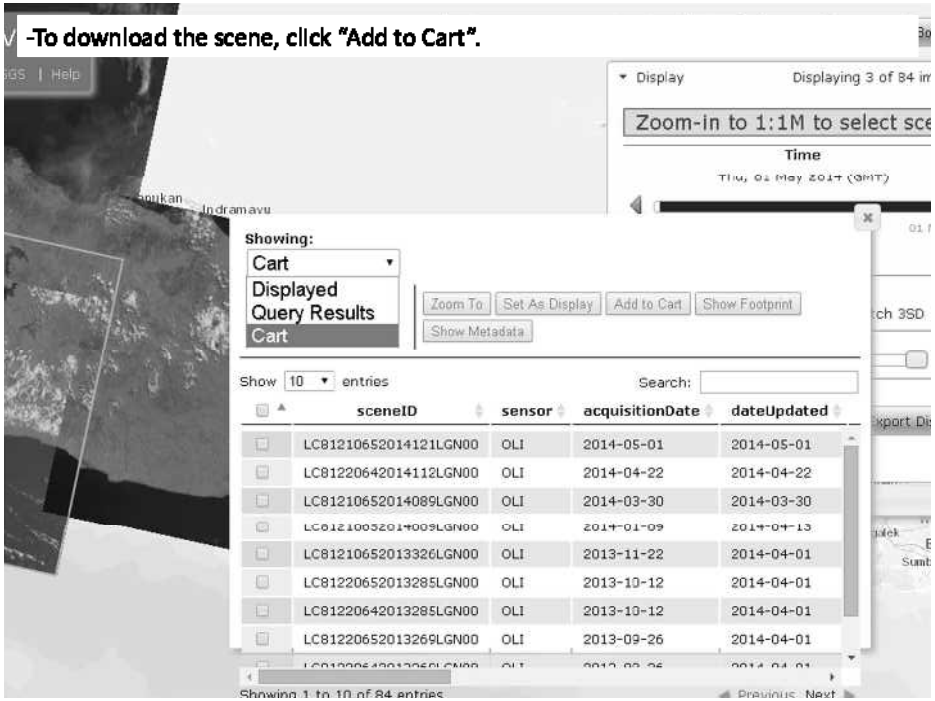


-Select data to be downloaded in "Cart" window, and then click "Get Landsat Data".

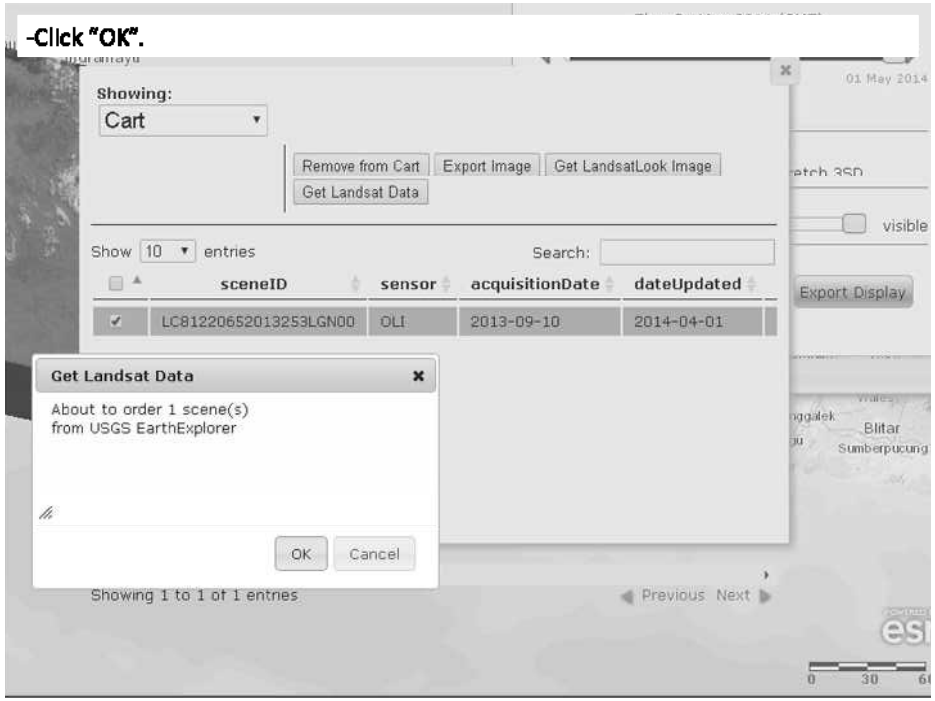
-To download the scene, click "Add to Cart".



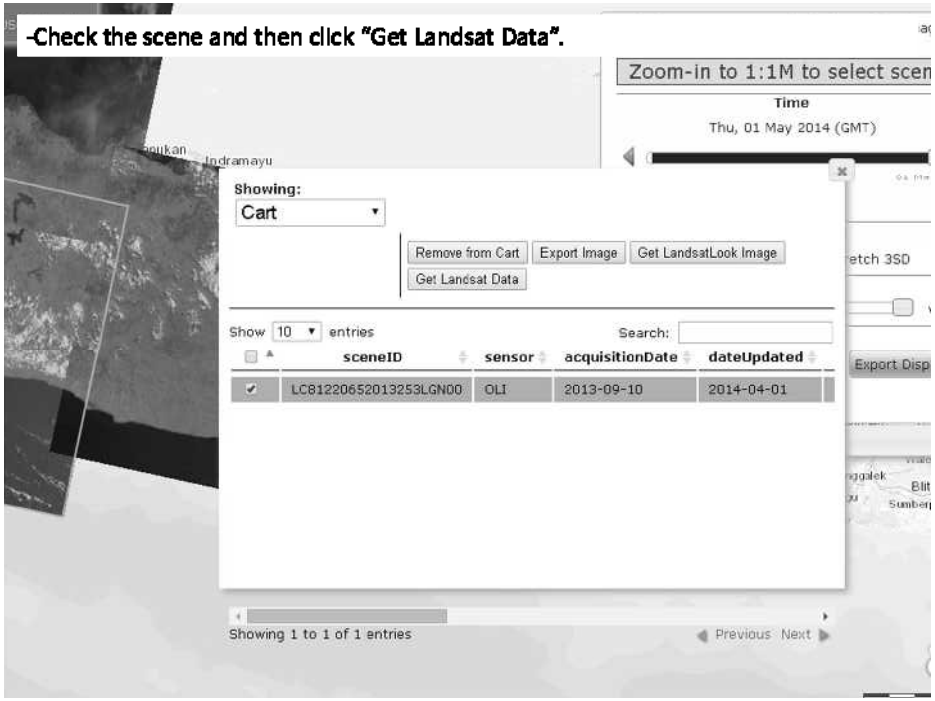
-To download the scene, click "Add to Cart".



-Click "OK".

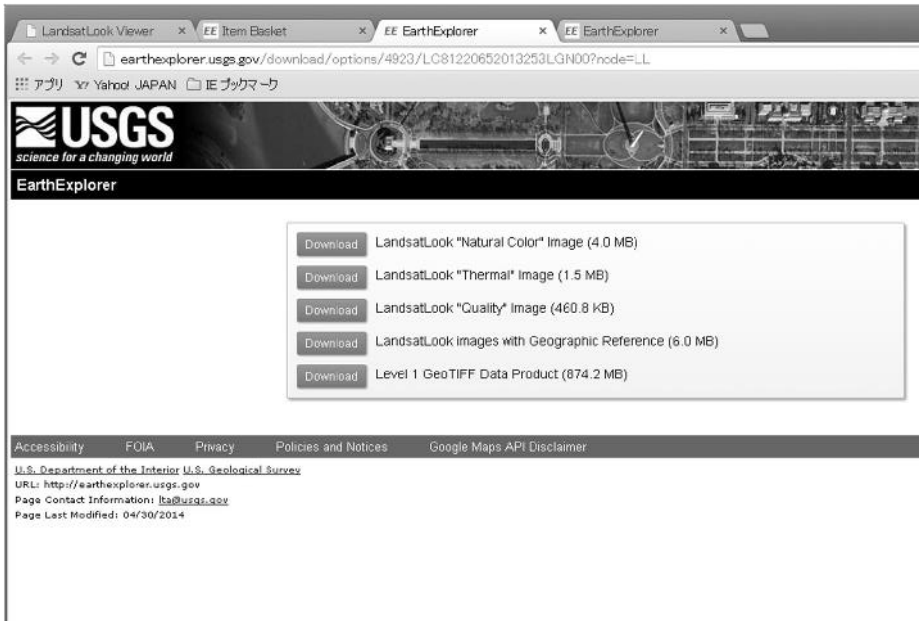


-Check the scene and then click "Get Landsat Data".



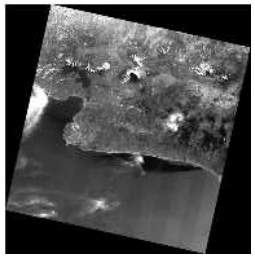
-Check "Bulk Download" and then click "Apply".

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

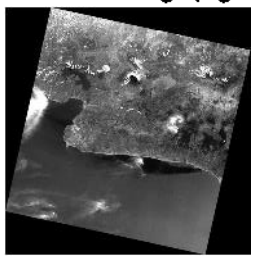


Creation of Pansharpened image

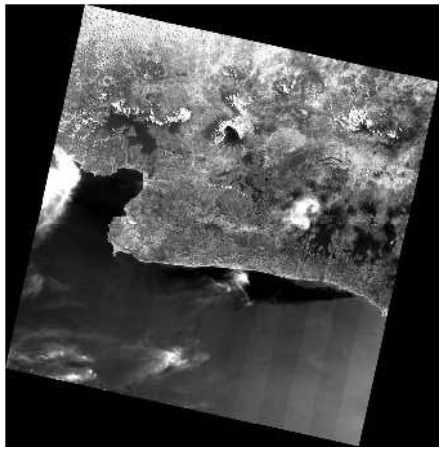
True color Image (low resolution)



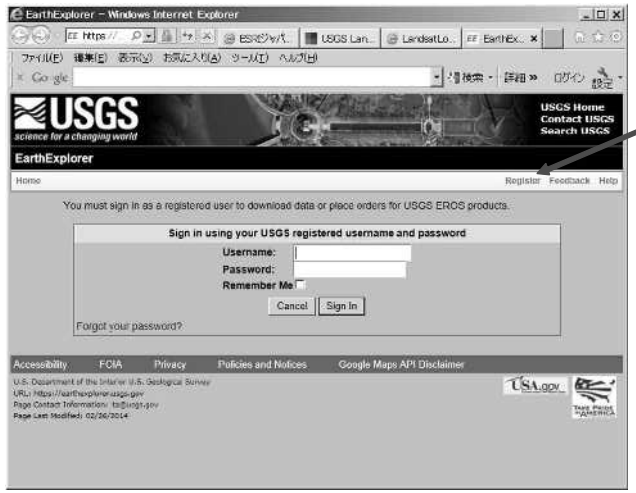
Panchromatic Image (high resolution)



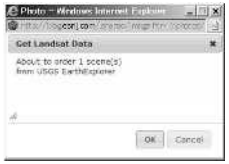
Pansharpened Image (high resolution)



-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.

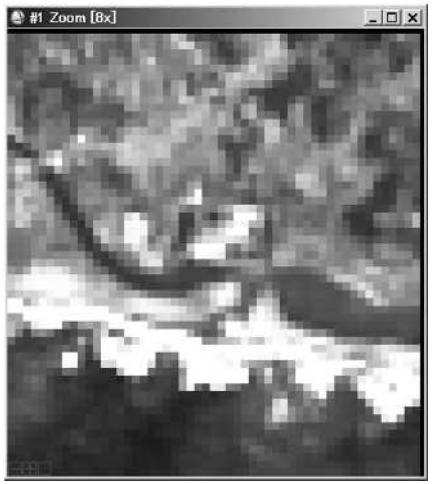


Click "Register" to do registration.



Resolution of each band

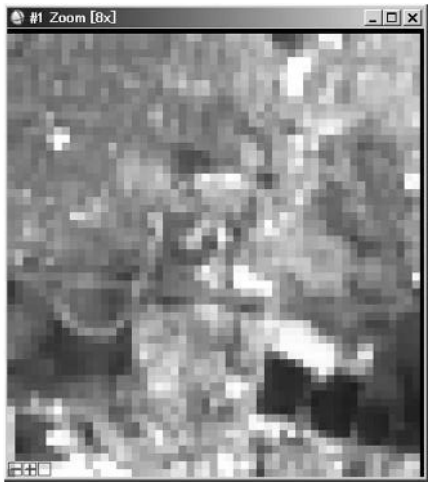
True Color image (RGB=B4,B3,B2)
Resolution: 30m



Panchromatic Image (B8)
Resolution: 15m

Resolution of each band

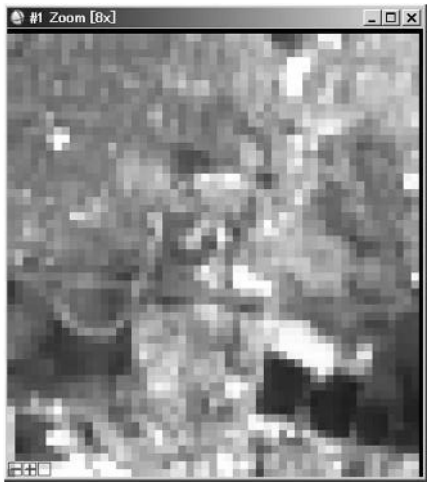
True Color image (RGB=B4,B3,B2)
Resolution: 30m



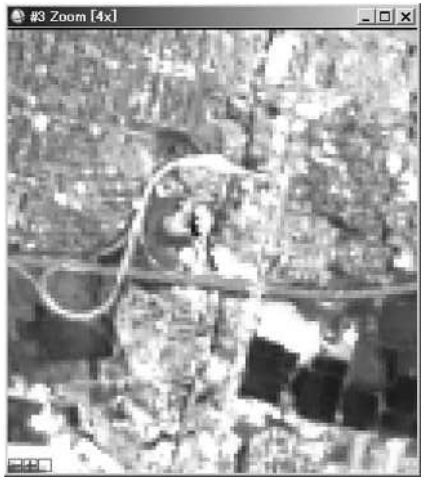
Panchromatic Image (B8)
Resolution: 15m

Result of Pansharpen

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

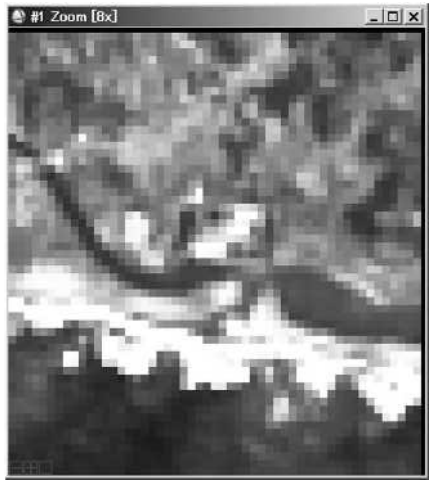


Pansharpened Image
(RGB=B4,B3,B2)
Resolution: 15m



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 cientific and operational requirements for observing land use and land cover change.

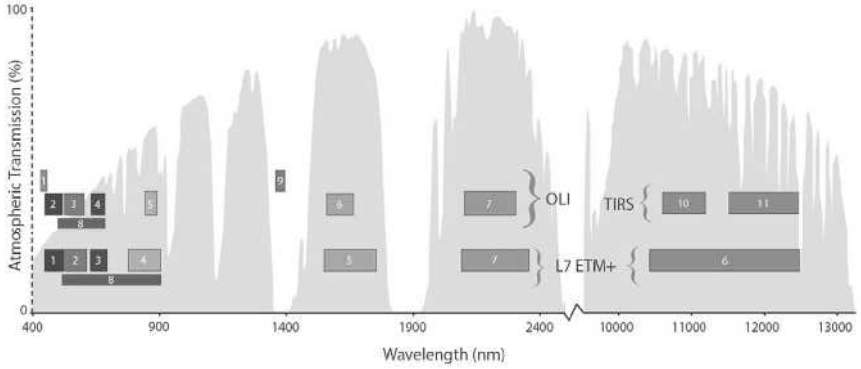
from USGS WEB site

Processing parameters for Landsat 8 standard data products

Product Type: Level 1T (terrain corrected)
Data type: 16-bit unsigned integer
Output format: GeoT FF
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 confiden

from USGS WEB site

Comparison of Band Location between LANDSAT 7 and LANDSAT 8



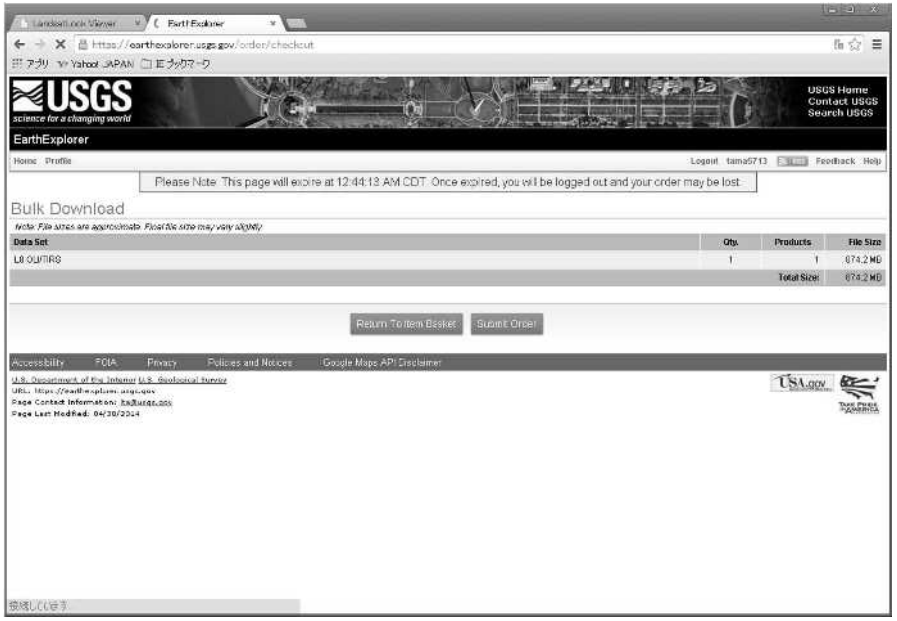
Band passes of the Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) instruments

from USGS WEB site

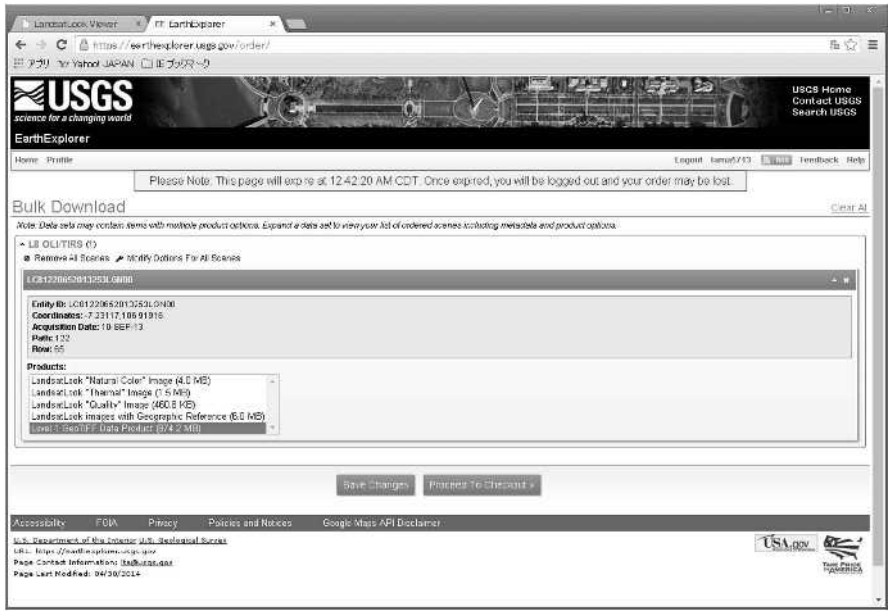
-Check "Bulk Download" and then click "Apply".

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

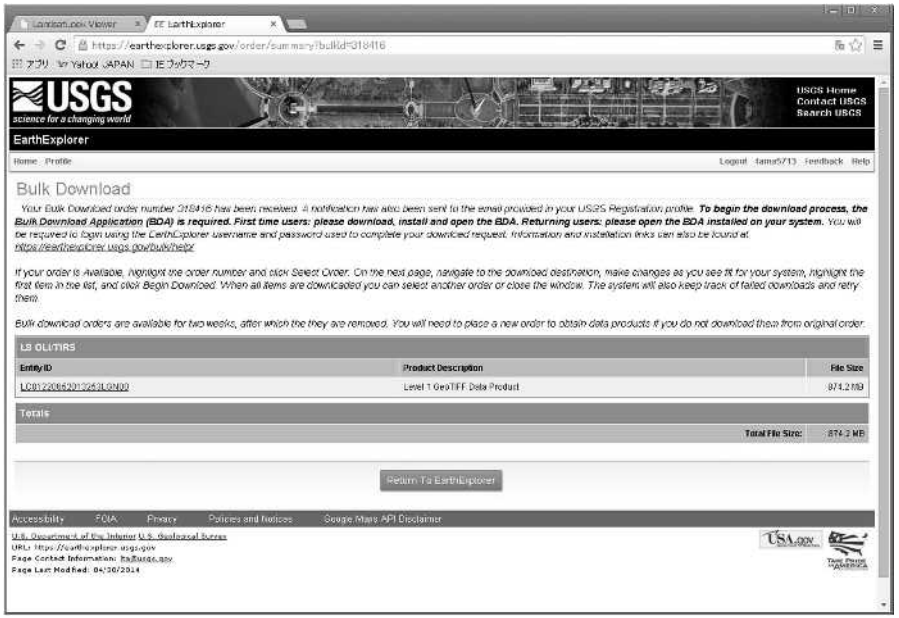
-Check "Bulk Download" and then click "Apply".



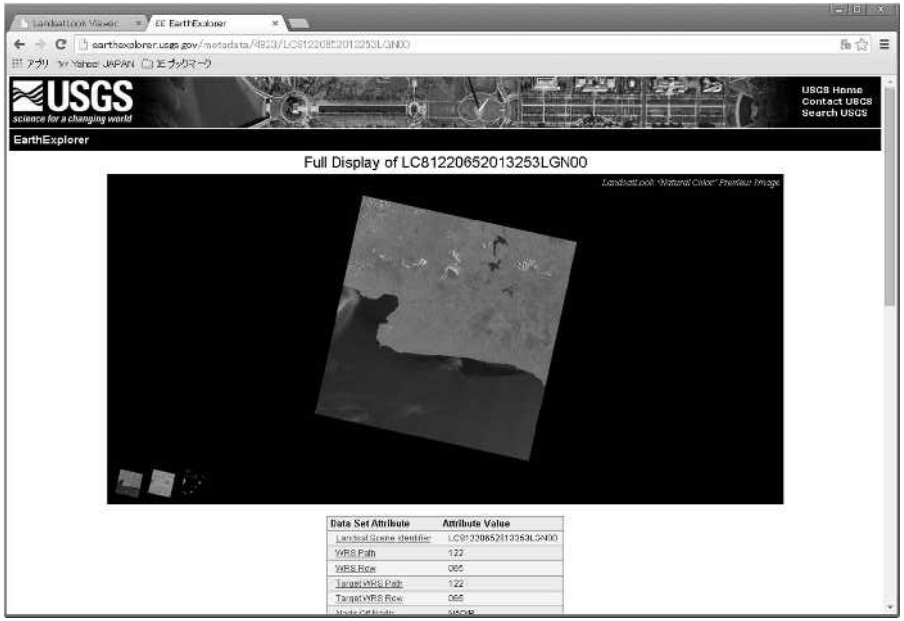
-Check "Bulk Download" and then click "Apply".



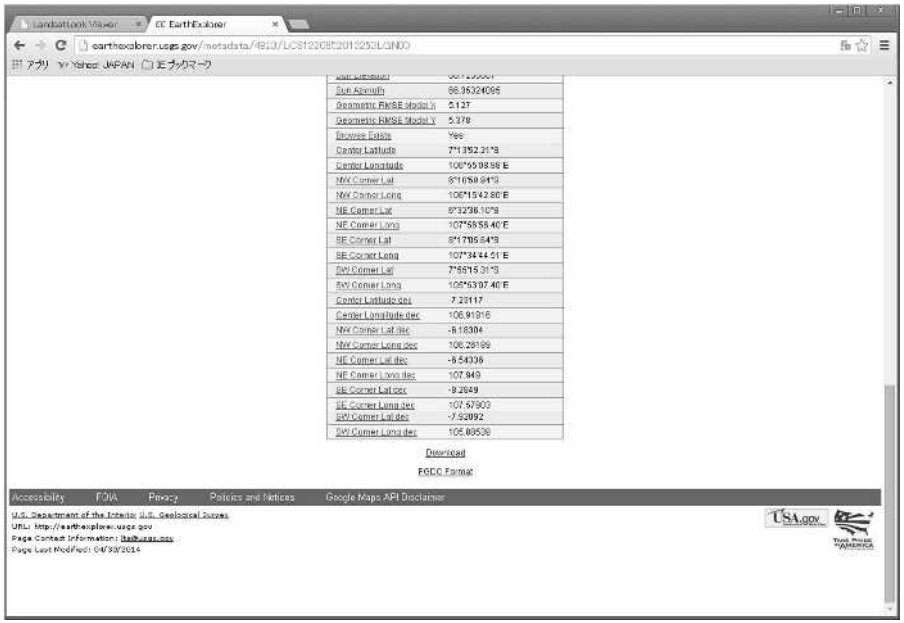
-Check "Bulk Download" and then click "Apply".



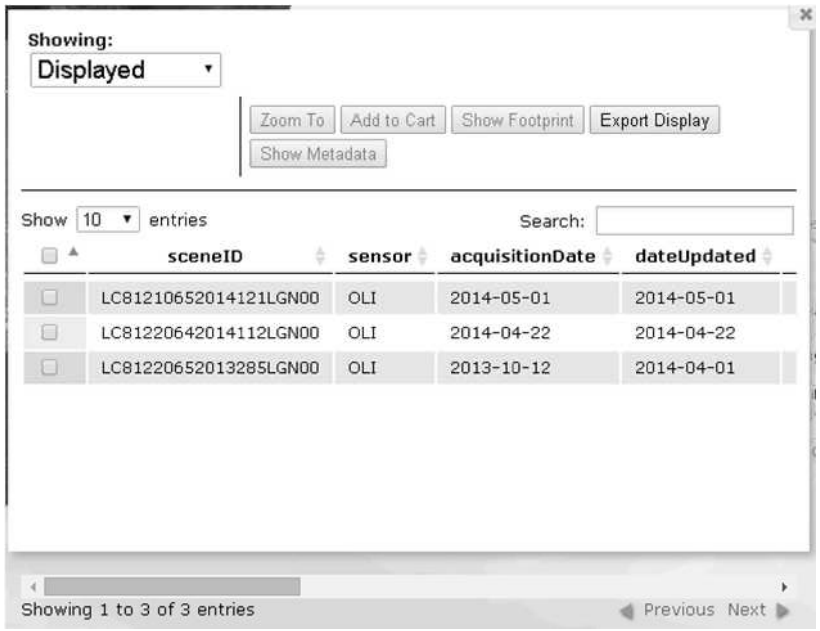
-Full display of the scene.

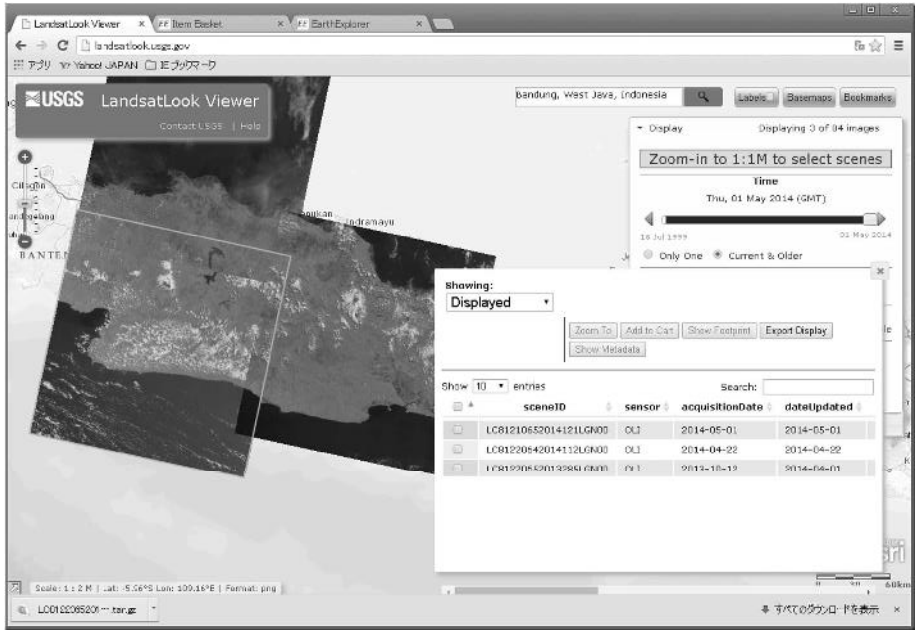


-The specification of the scene.



-The specification of the scene.




LandsatLook Viewer
Item Basket
EarthExplorer
landsatlook.usgs.gov
USGS LandsatLook Viewer
Contact USGS | Help
bandung, west java, indonesia
Labels
Basemaps
Bookmarks
Display
Displaying 3 of 84 images
Zoom-in to 1:1M to select scenes
Time
Thu, 01 May 2014 (GMT)
16 Jul 1999
01 May 2014
Only One
Current & Older
Showing:
Displayed
Zoom To
Add to Cart
Show Footprint
Export Display
Show Metadata
Show 10 entries
Search:
sceneID
sensor
acquisitionDate
dateUpdated
LC81210652014121LGN00
OLI
2014-05-01
2014-05-01
LC81220542014112LGN00
OLI
2014-04-22
2014-04-22
すべてのダウンロードを表示

How to use MultiSpec

SUMIKO Resources Exploration & Development Co.,Ltd

Contents of this program

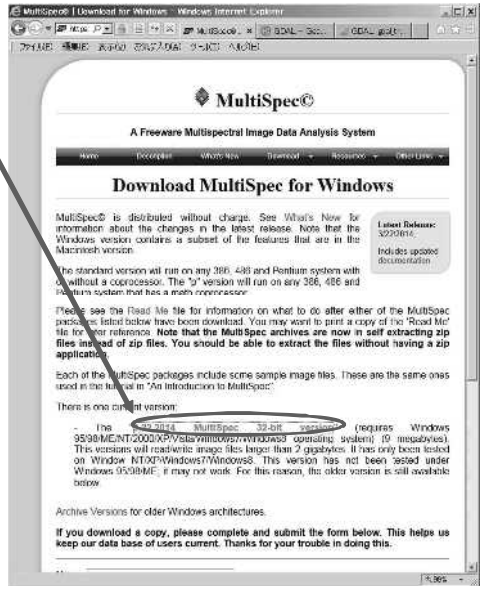
1. Installation of MultiSpec
2. Creation of Band composite image
3. File Format Change of ASTER HDF to GeoTIFF Format

Installation of MultiSpec

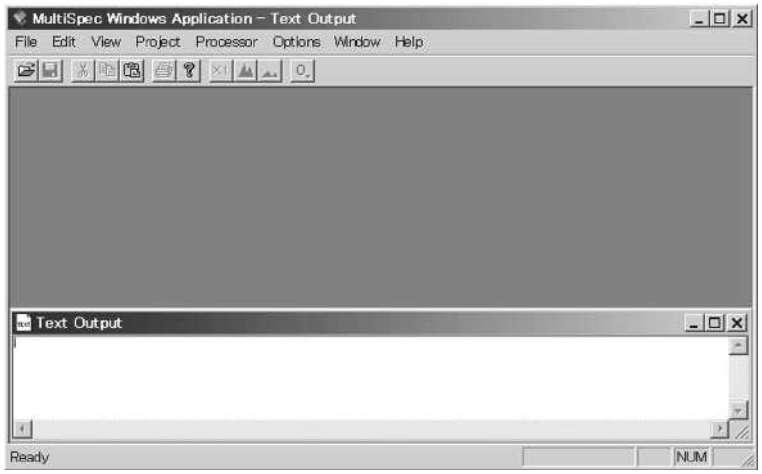
Download software from the following website.
https://engineering.purdue.edu/~biehl/MultiSpec/

Click here

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

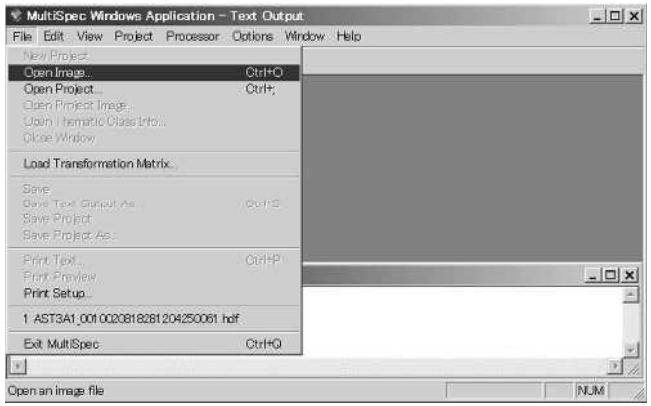


-Click MultiSpecW32.exe in the folder to run.
-Main window appears.



Creation of Band composite image

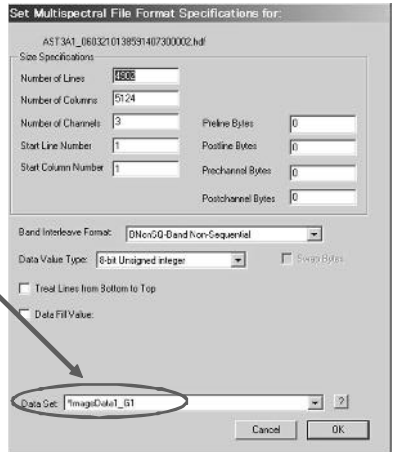
-Select and Click “File-Open Image” in main menu.



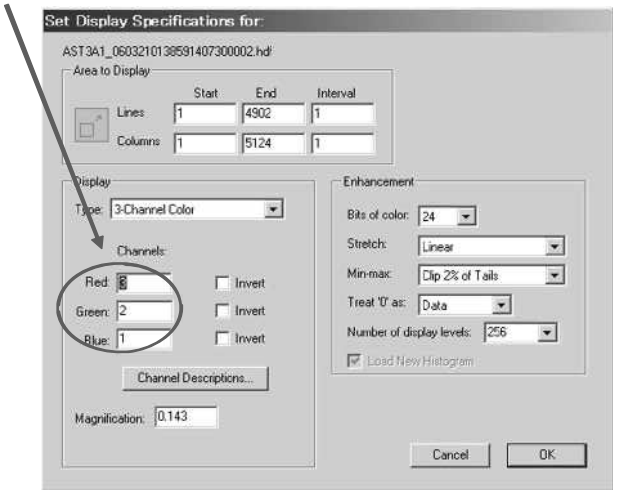
-”Open File” window appears.
-Select a ASTER HDF file.
e.g.: AST3A1_06032101385914073000002.hdf
-Click “Open”.

-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” .

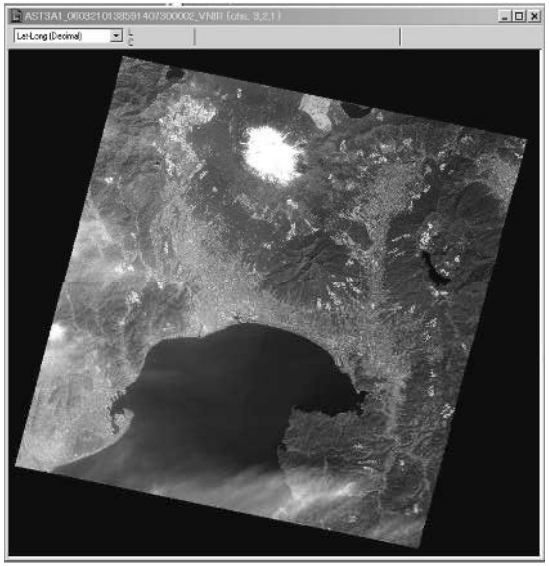


-"Set Display Specifications for" window appears.
-The parameters needed for image display are set automatically, click "OK" to proceed.

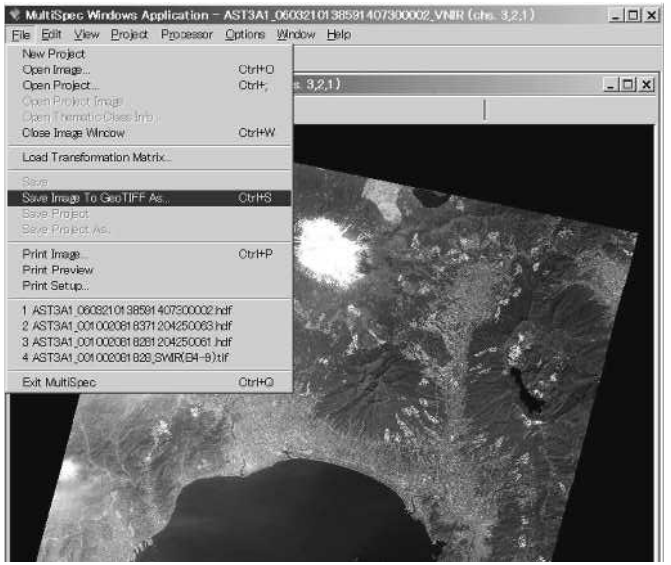


-"Set Histogram Specifications" window appears.
-The parameters needed for image display are set automatically.
-Click "OK" to proceed.

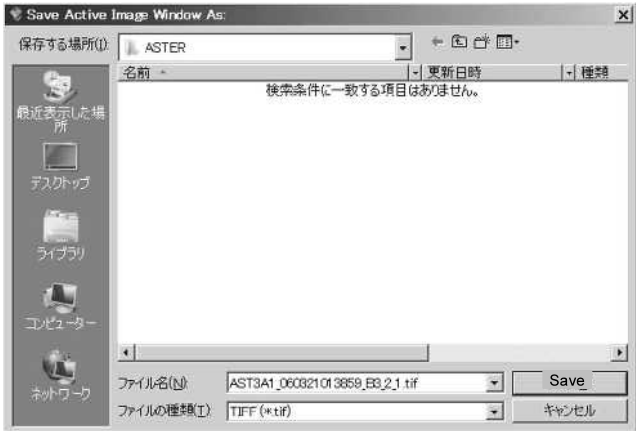
-ASTER false color image (RGB=Band3,2,1) appears in the created image display.



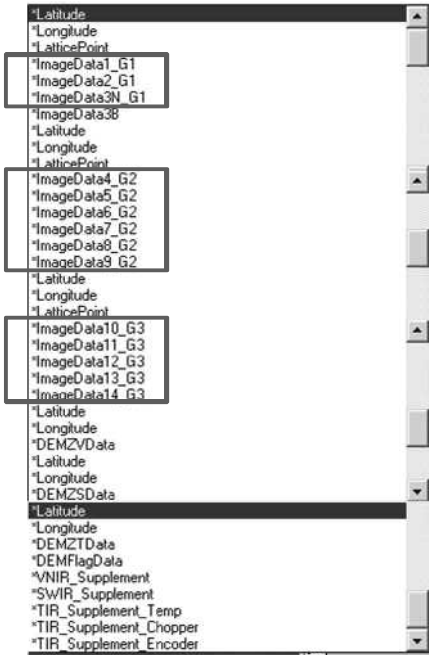
-To save the image, Select and click "File-Save Image To GeoTIFF As" in main menu.



-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”.

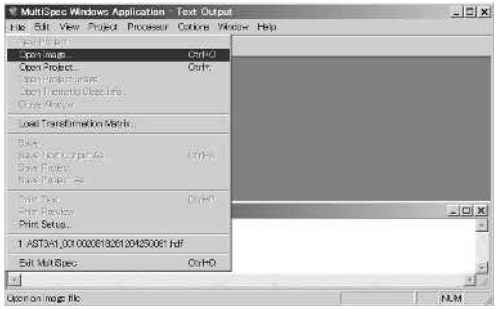


ATTENTION:
-Click ▼ in “Data Set” box.
-The list of components in the HDF file appears
From *ImageData1_G1 to *ImageData3N_G1 is VNIR data of Band1, 2, 3.
From *ImageData4_G2 to *ImageData9_G2 is SWIR data of Band4, 5, 6, 7, 8, 9.
From *ImageData10_G3 to *ImageData14_G3 is TIR data of Band10, 11, 12, 13, 14.

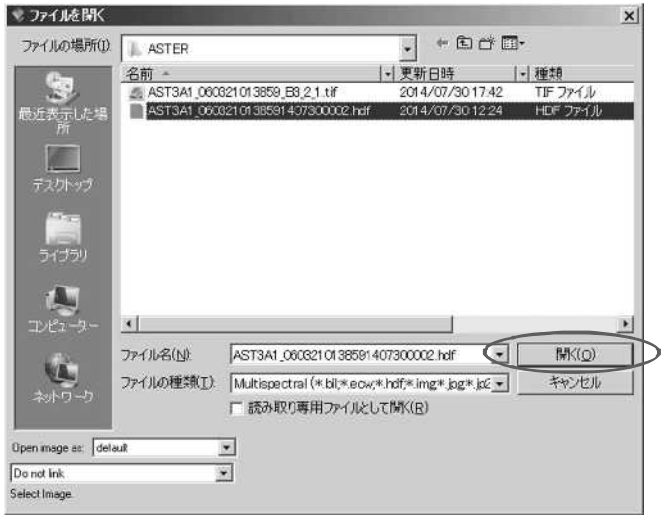


File Format Change of ASTER HDF to GeoTIFF Format

-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.

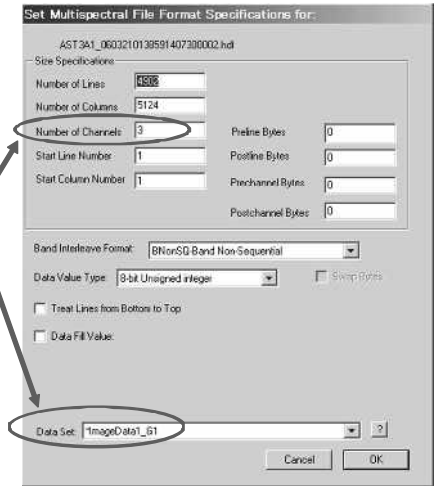


-Select ASTER HDF file.
e.g.: AST3A1_06032101385914073000002.hdf
-Click “Open”.

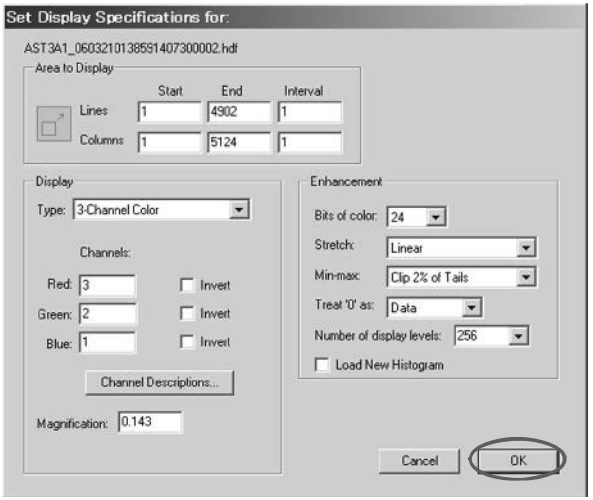


-Set “Multispectral File Format Specification” window appears.
-Select one group of data in “Data Set” box to save in GeoTIFF format.
-Click “OK”.

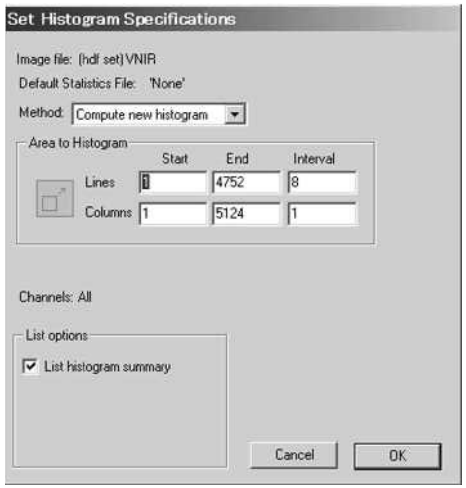
-If you select one group of data in “Data Set” box, the number of channels is entered in “Number of Channel” box automatically.
-The number of bands of VNIR is 3,
SWIR is 6, TIR is 5.



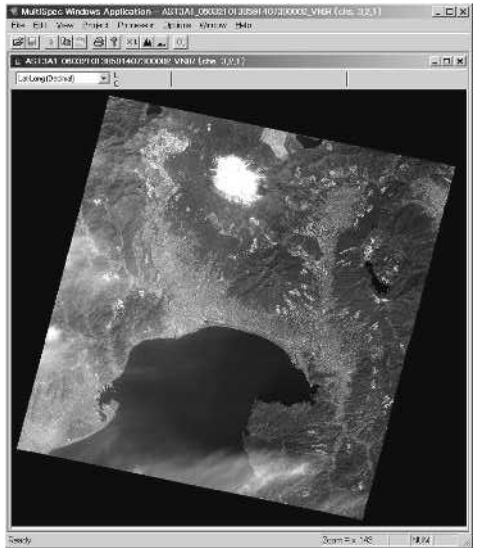
-”Set Display Specifications for” window appears.
-Use default parameters in this window.
-Click “OK” to proceed.



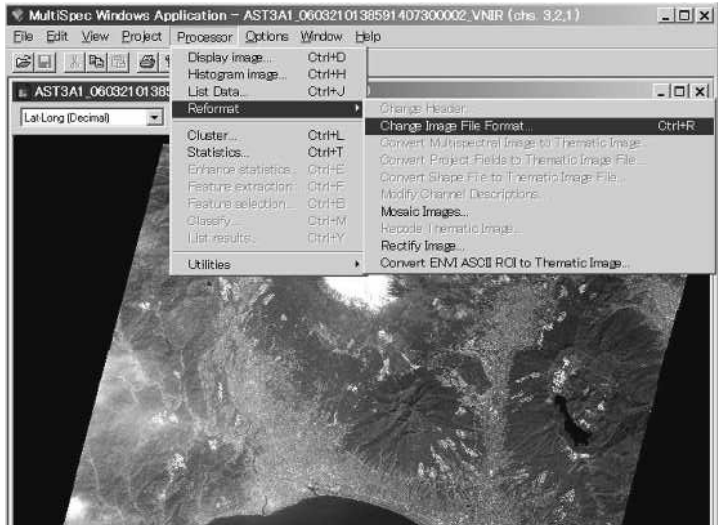
-If ”Set Histogram Specifications” window appears, click “OK” to proceed.



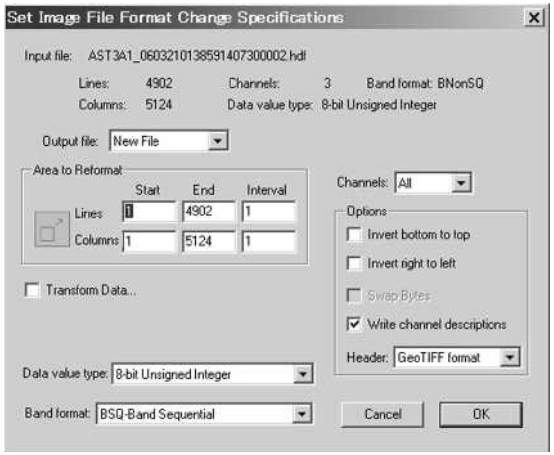
-The band composite image of ASTER appears in the image display.



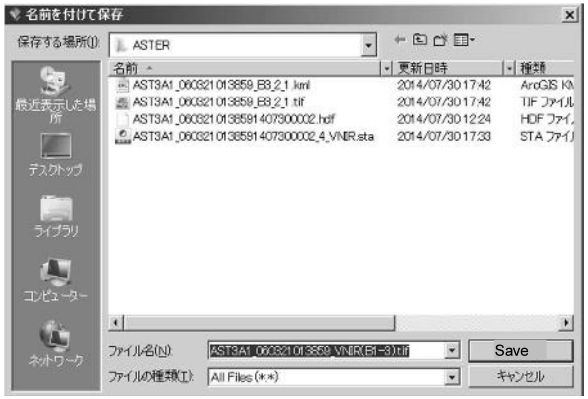
-To save the image in GeoTIFF format, Select and click “Processor-Reformat-Change Image File Format” in main menu.



-”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_0603210138591407300002.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/~biehl/MultiSpec/

URL of Open Data

-ASTER GDEM data
http://www.jspacesystems.or.jp/ersdac/GDEM/E/index.html

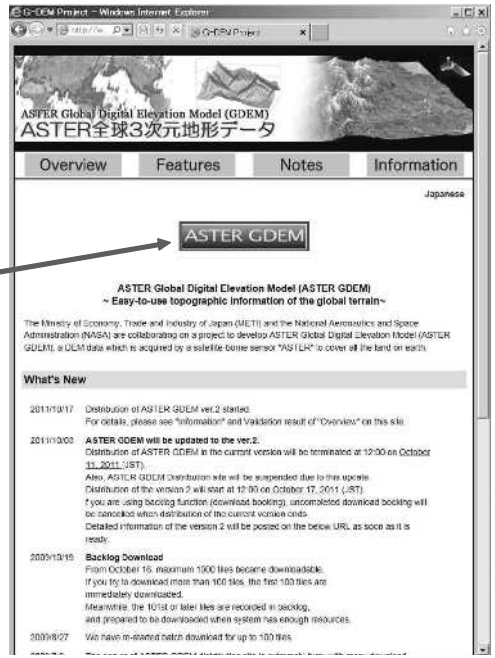
-LANDSAT
http://landsatlook.usgs.gov/
http://glcfapp.glcf.umd.edu:8080/esdi/index.jsp

- 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

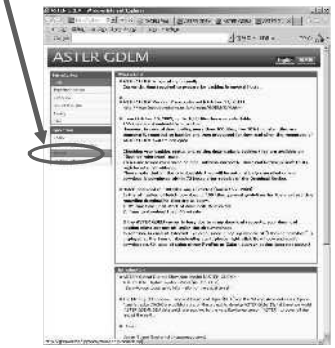
ASTER G-DEM

-Go to the following,
http://www.jspacesystems.or.jp/ersdac/GDEM/E/index.html

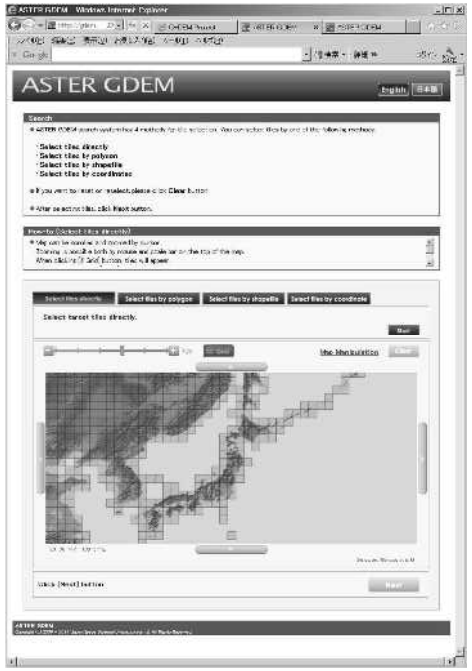
-Click ASTER GDEM



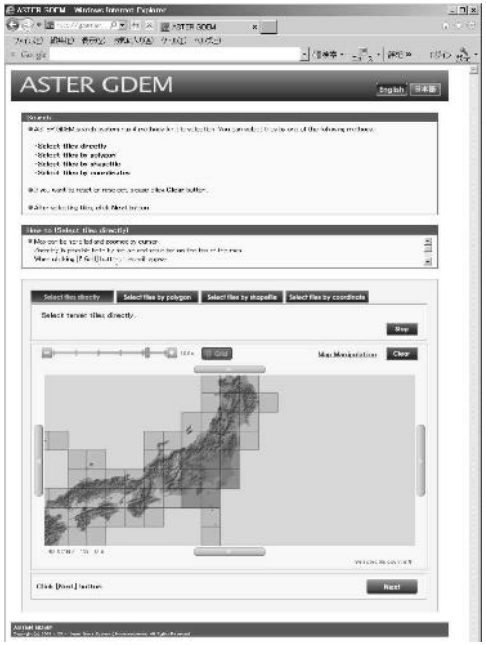
-Click Search



-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.

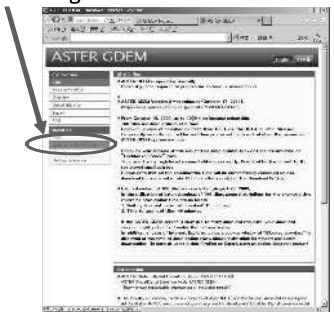


-Tile list appears. After checking the contents of the list, click Next button.

-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.

-Click Register & Modification

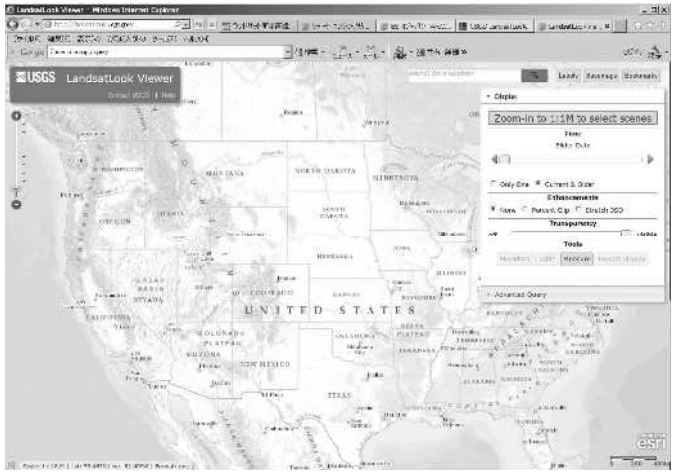


-New window is opened (right). Registration is done by filling the blanks.

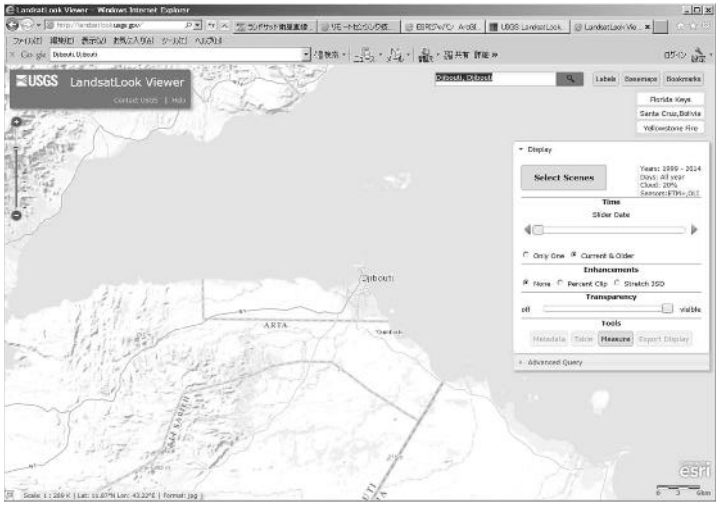
LANDSAT

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

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



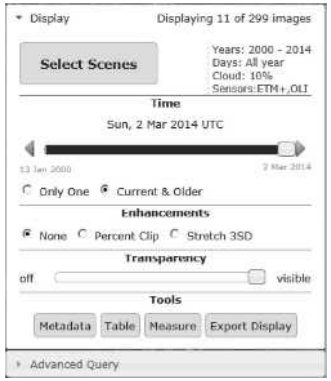
-You can find your area of interest by the text-based search tool in the upper right or by panning and zooming around the globe.



LANDSAT

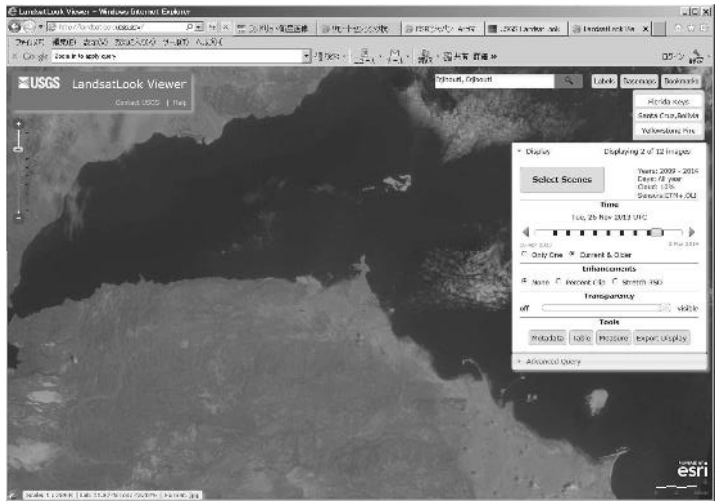
-Go to the following, http://landsatlook.usgs.gov/

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.

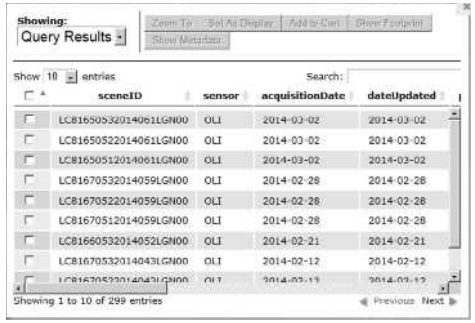


You can modify the default parameters: years of coverage, cloud cover ranges, and sensor selection in Advanced Query window.

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

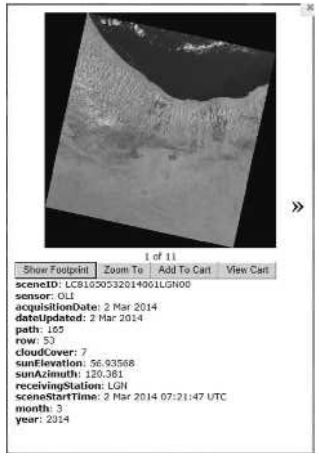


-Click Table in Display windows, the table of images is showed.



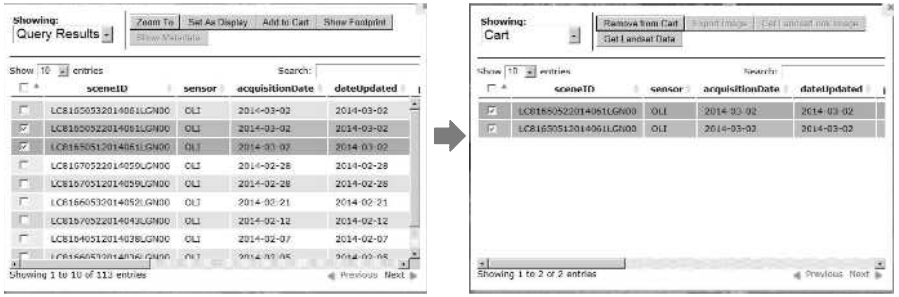
-Click Table in Display windows, the table of images is showed.

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



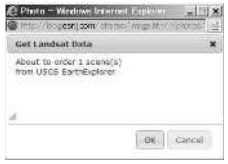
-Select data to be downloaded in Query Results windows, and then click Add to Cart.
-Select Cart in Showing: menu to go to Cart window.

-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.



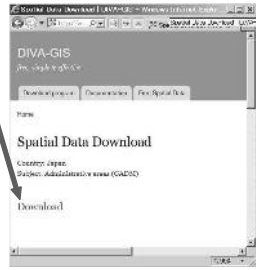
Basic Information

-Go to the following, http://www.diva-gis.org/gdata

-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.

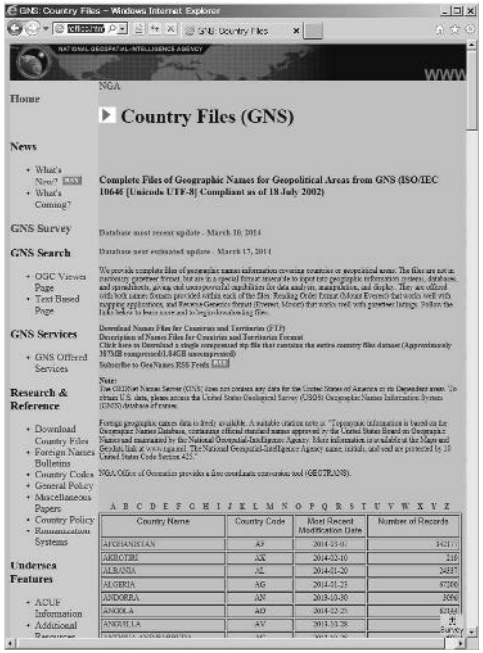


-You can download data as shape files.

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.



1. Theory of Remote sensing and Spectrum

SUMIKO Resources Exploration & Development Co.,Ltd

Outline of Presentation

Optical Sensor

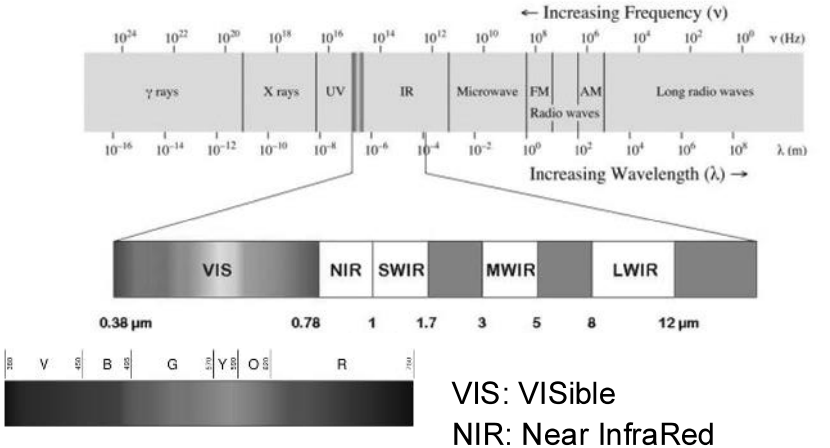
- Wavelength and spectra
- Spatial resolution
- Spectral resolution
- Mineral mapping theory

Synthetic Aperture Radar

- Features
- Polarization
- Wavelength

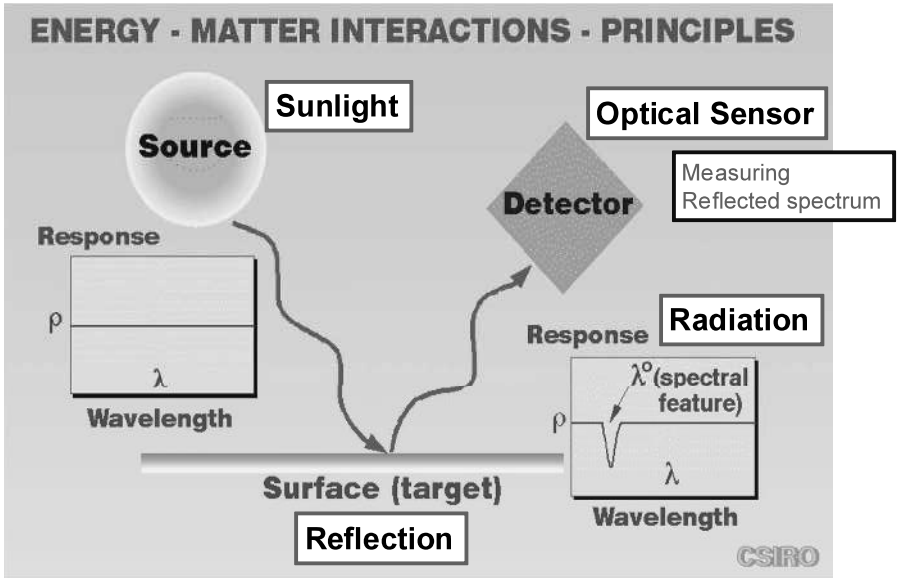
Optical Sensor

Wavelength



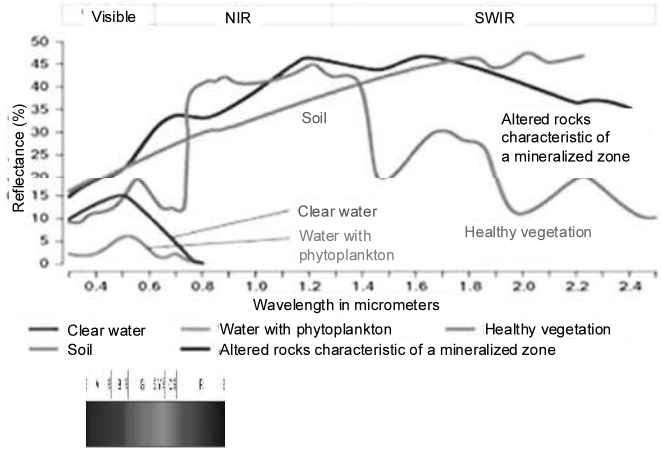
VIS: VISible
NIR: Near InfraRed
SWIR: Short Wave InfraRed

Mineral Mapping Theory by Optical Sensor

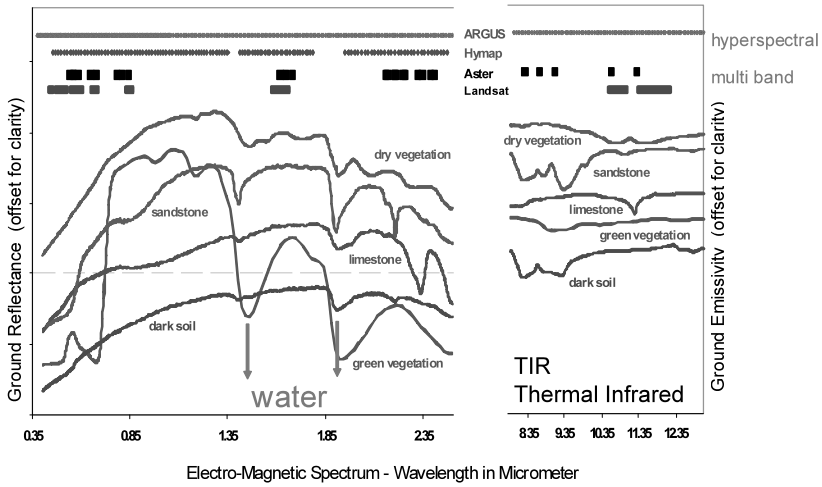


Spectral pattern

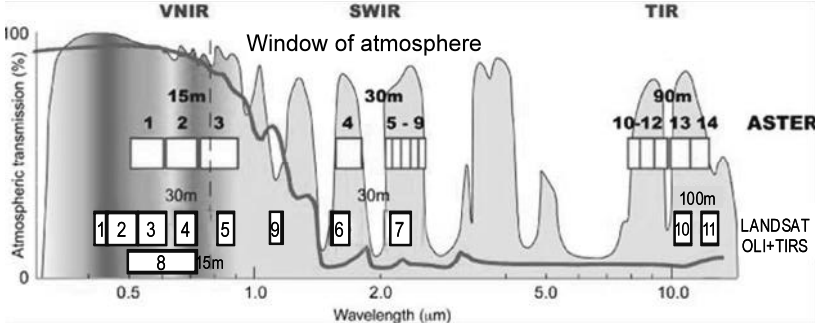
Generalized reflectance spectra of some earth surface materials

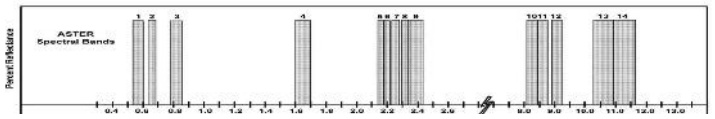


Spectral patterns and bands location



Band location of ASTER and LANDSAT





Multiband sensor

Spatial Resolution
and
Spectral Resolution

Spatial Resolution

Actual size per pixel

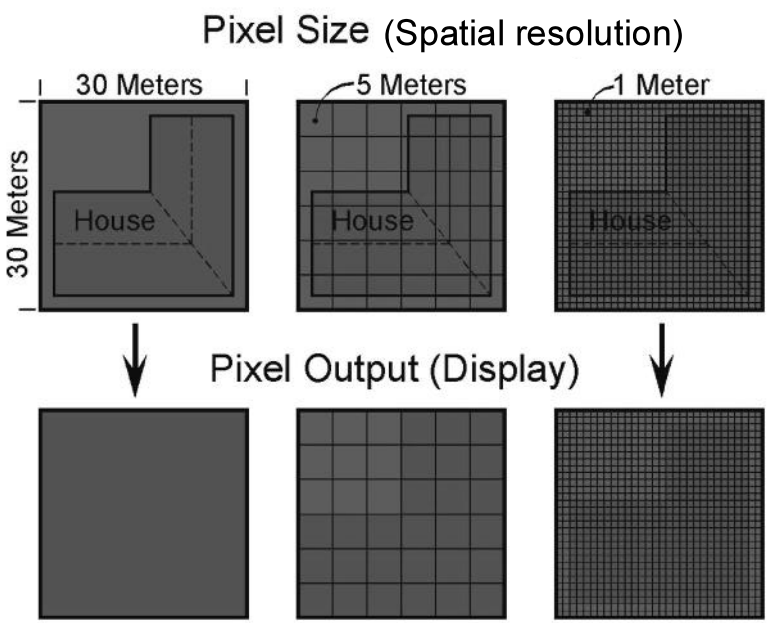
High spatial resolution : 0.4 - 4 m

» 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

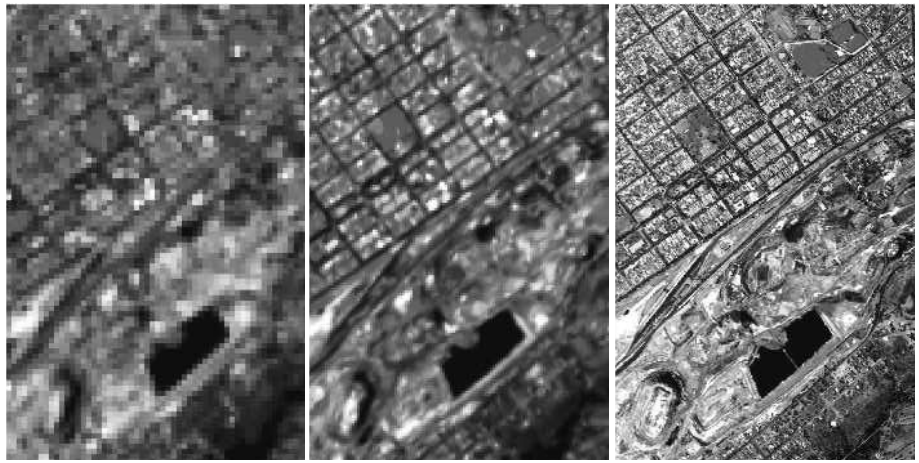
HyMap and AVIRIS are hyperspectral airborne sensor



LANDSAT
RGB=B4,B3,B2
30m

ASTER
RGB=B3,B2,B1
15m

HyMap
RGB=B25,B16,B9
3.3m



Vegetation is shown in red color.

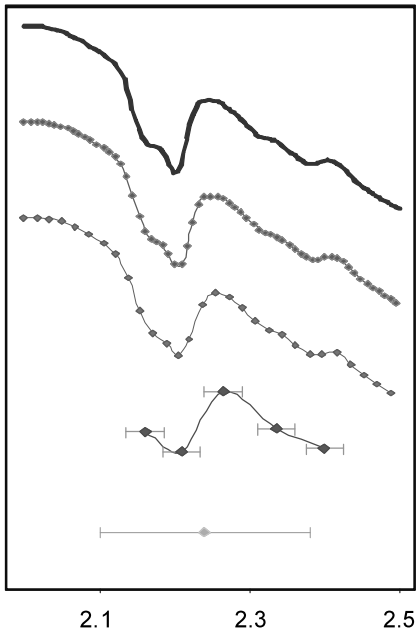
Spectral Resolution

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: <= 4 bands
» QuickBird
» IKONOS/GeoEye
» ALOS
» SPOT-5



Comparison of spectral patterns (spectral resolution)

Spectrometer

AVIRIS

HyMap

ASTER

LANDSAT

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)
	HyMap	128	3-5	V. High
Space-borne	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

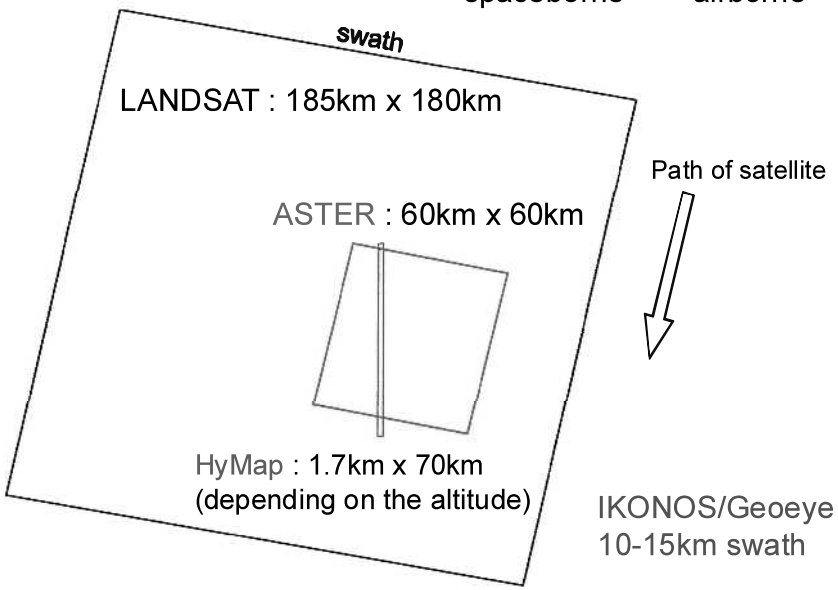
Problems

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.

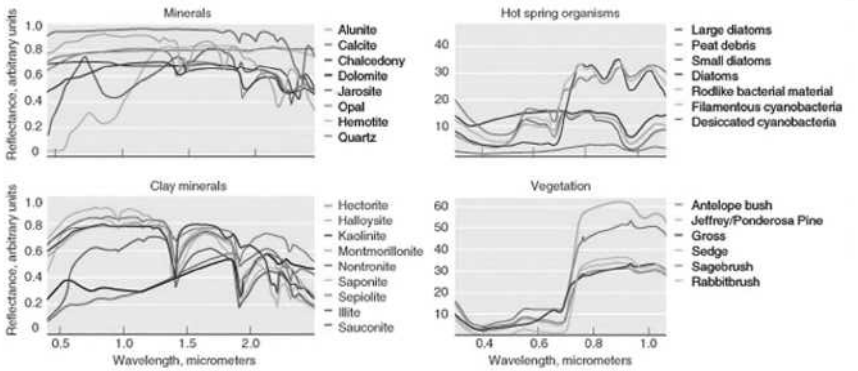
Coverage area of one scene : LANDSAT / ASTER / HyMap
spaceborne airborne



Mineral mapping theory

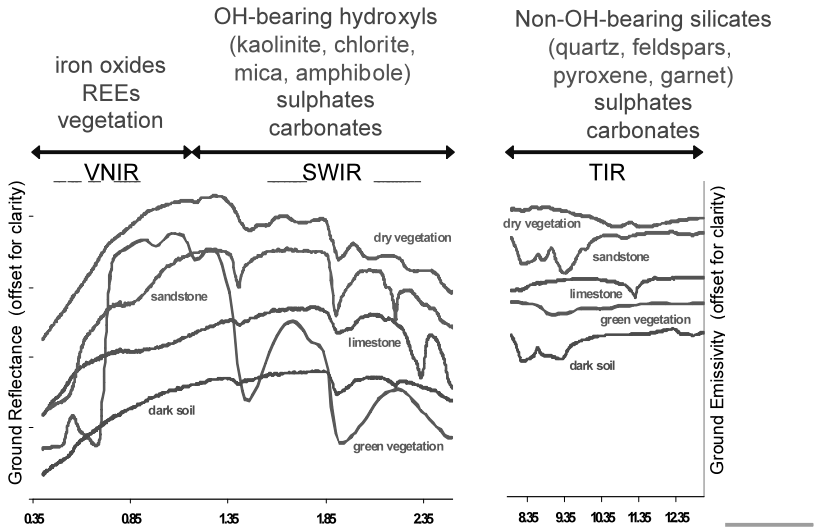
Hyperspectral images provide distinctive spectral shapes that allow identification of mineral types, clay soil types, plant species, plant health within species types, and hot and cold spring microorganisms.

These spectra are from Mammoth Mountain–Long Valley hyperspectral imagery but are representative of most areas.



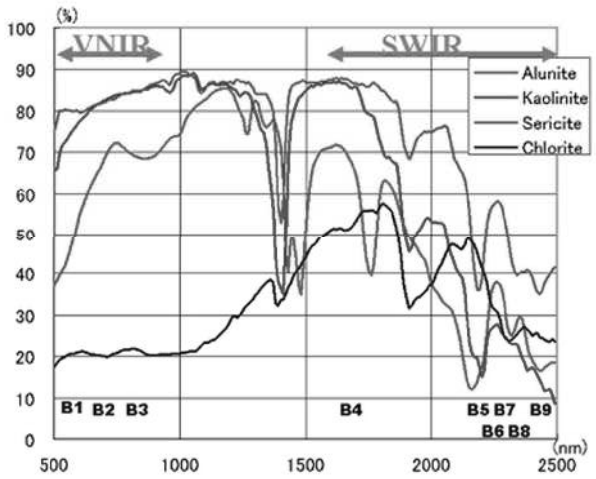
Hyperspectral sensor has 120 to 250 bands.

Spectral-Mineral Wavelength Regions



Electro-Magnetic Spectrum - Wavelength in Micrometer

Spectral patterns of alteration minerals



Absorption bands in ASTER

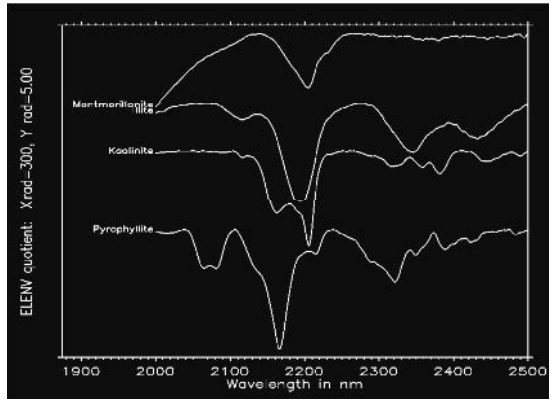
B5
B6,B5
B6,B8
B8

ASTER bands (B1 to B9)

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

} Acidic alteration

- Sericite : B4/B6, B4/B8
- Montmorillonite : B4/B6

} Phyllic alteration

- Chlorite : B4/B8, B3/B4
- Epidote : B4/B8, B6/B7
- Calcite : B4/B8

} Propylitic alteration

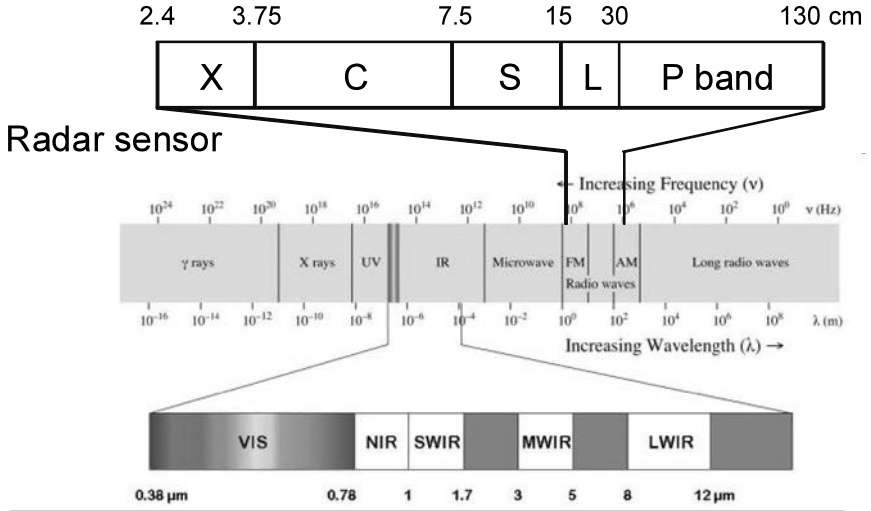
Synthetic Aperture Radar

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

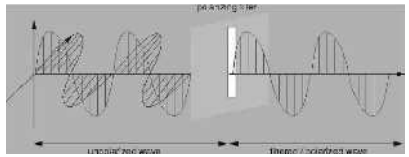
Wavelength of radar sensors



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

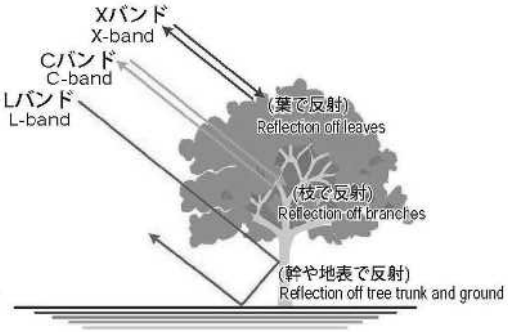
Transmit \ Receive	Horizontal	Vertical
Horizontal	HH	HV
Vertical	VH	VV

Kind of SAR : Difference of wavelength

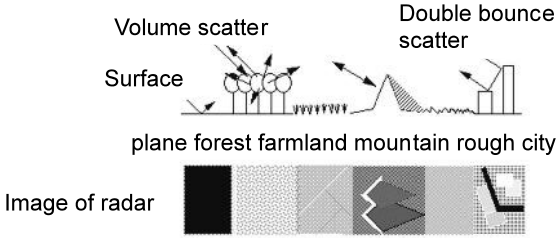
In general, short-wavelength radio waves are easily reflected from the surface of the material and long-wavelength radio waves can penetrate vegetation with some substances.
- Objects larger than the half of wavelength : reflection
- Objects smaller than the quarter of wavelength : penetration

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



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)



PALSAR

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

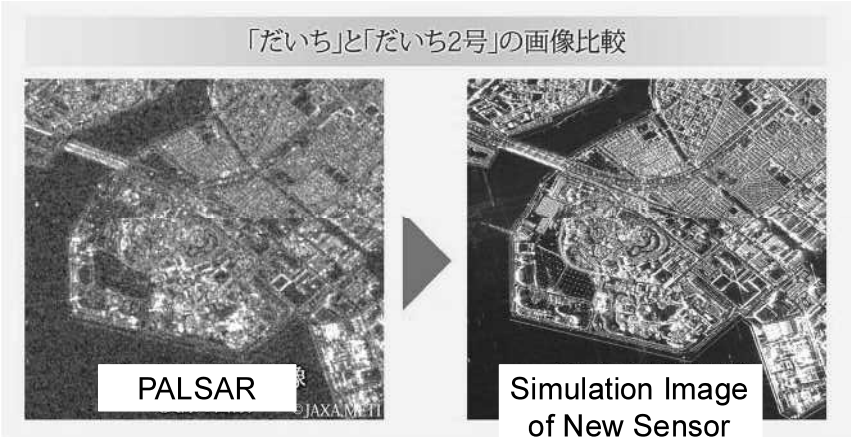
In addition to its all-weather observation capability regardless of day and night, PALSAR incorporated many highly advanced observation technologies, and has contributed greatly in areas such as resource exploration, environmental monitoring on earth and monitoring of natural disasters.

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

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

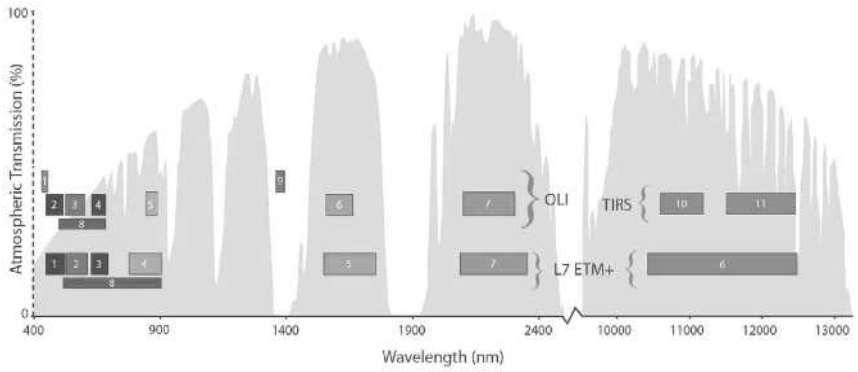
Appendix

Sensor	# of Band	Spatial res.

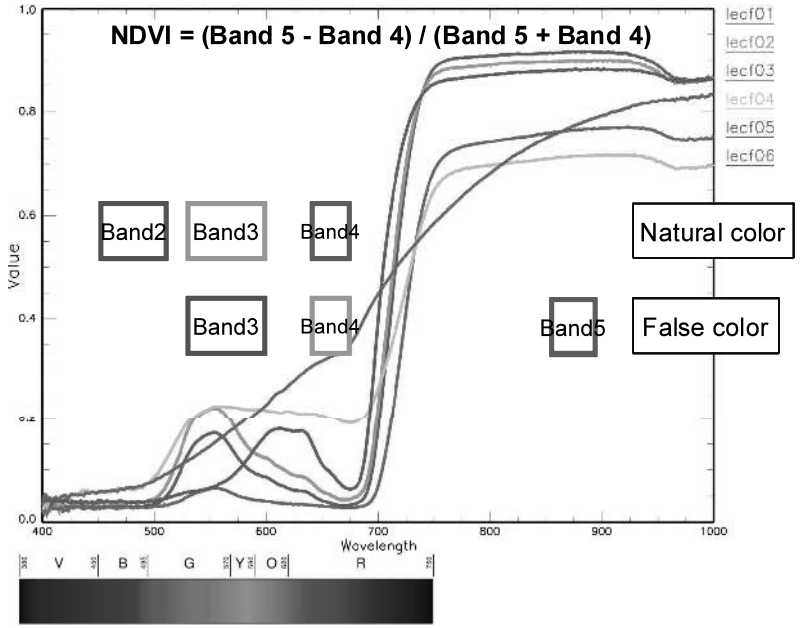
衛星/センサ名 国	波長域 (μm)	バンド数	波長分解能	空間分解能	S/N	打上予定
ALOS-3/HISUI 日本	0.4-0.97 0.9-2.5	57 128	10nm 12.5nm	30m	450@620nm 300@2100nm	2015年
EO-1/Hyperion アメリカ	0.4-1.0 1.0-2.5	60 150	10nm	30m	140-190@550-700nm 96@1225nm 38@2125nm	2000/11
PROBA/CHRIS ESA, イギリス	0.4-1.05	61	5-12nm	18m/36m	200	2001/10
IMS-1/HySI インド	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	2009/09
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
HyspIRI アメリカ	0.38-2.5	213	10nm	60m	不明	未定

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_
EnMAP: http://www.enmap.org/
HysplRI: http://hyspiri.jpl.nasa.gov/

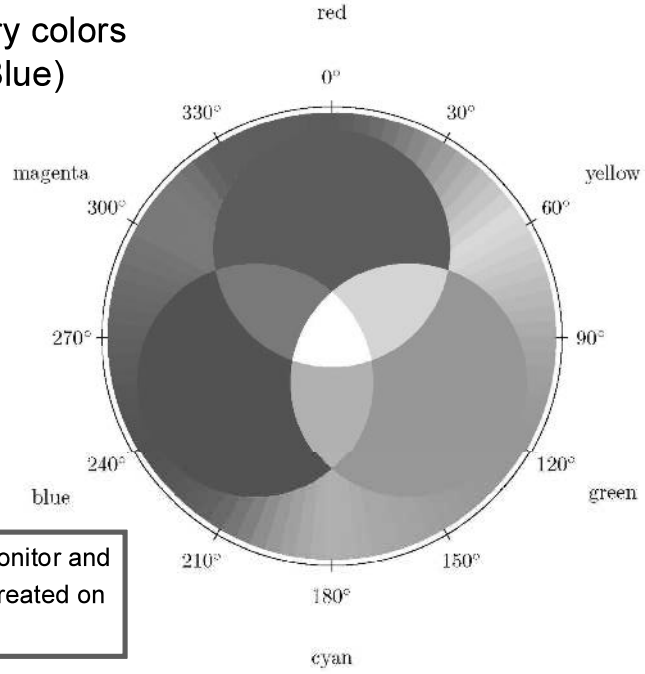
Band location of LANDSAT 8 & 7



Band Composite of LANDSAT 8



Additive primary colors (Red, Green, Blue)

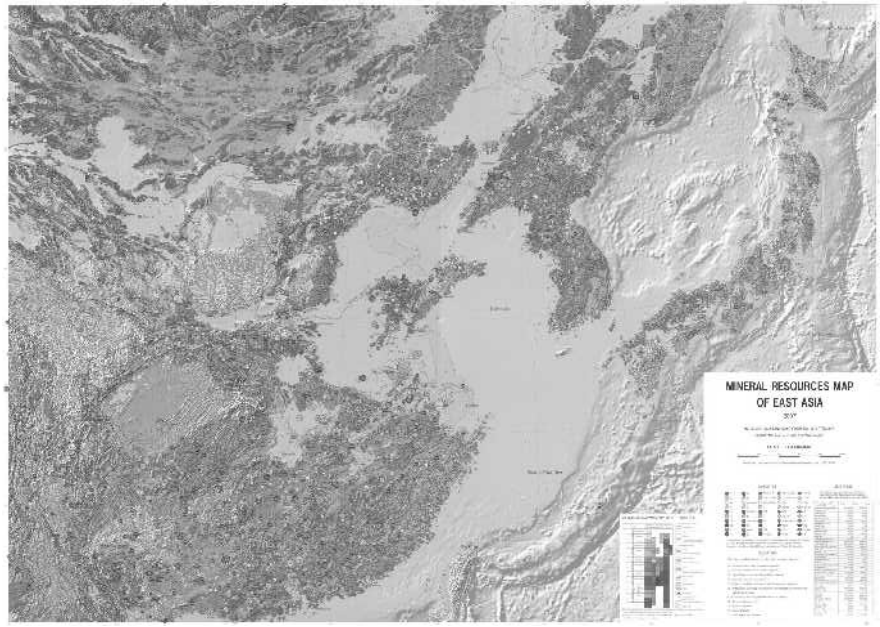


Images of TV/PC monitor and digital camera are created on this theory.

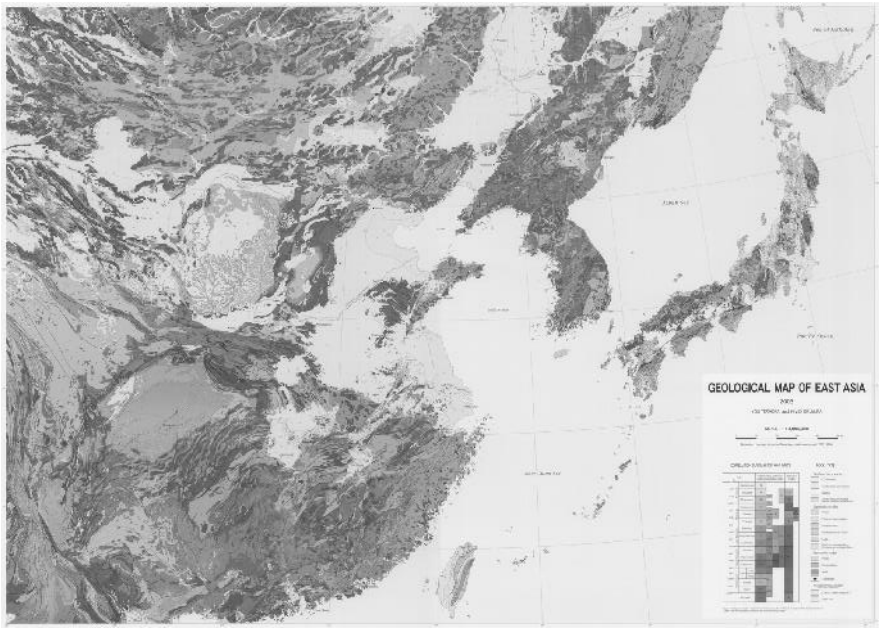
Appendix 2
Mineral Resources

Introduction of Mineral Resources Maps of Asia (GSJ)

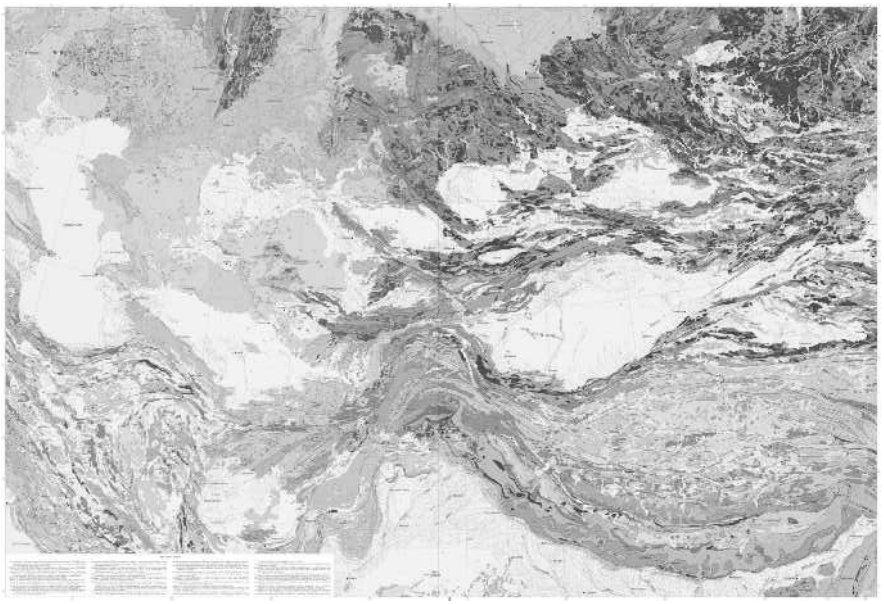
OHNO Tetsuji GSJ, AIST



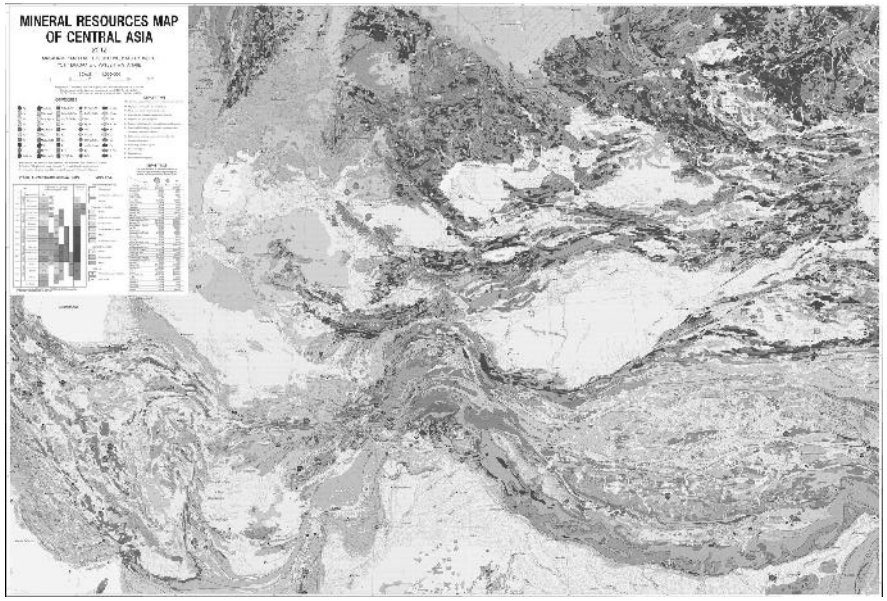
1:3,000,000 Mineral Resources Map of East Asia (GSJ, 2007)



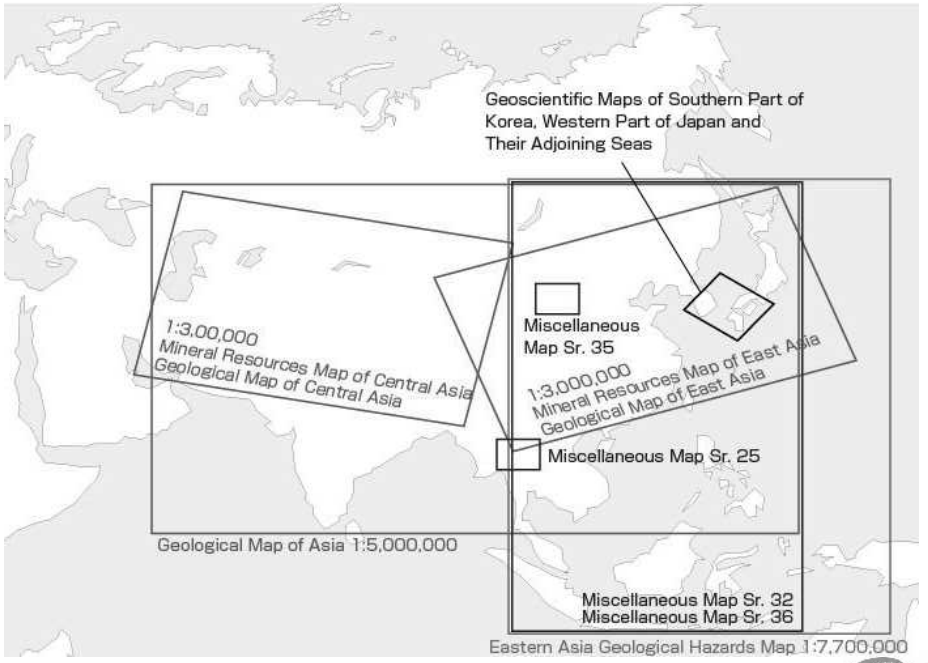
1:3,000,000 Geological Map of East Asia (GSJ, 2003)



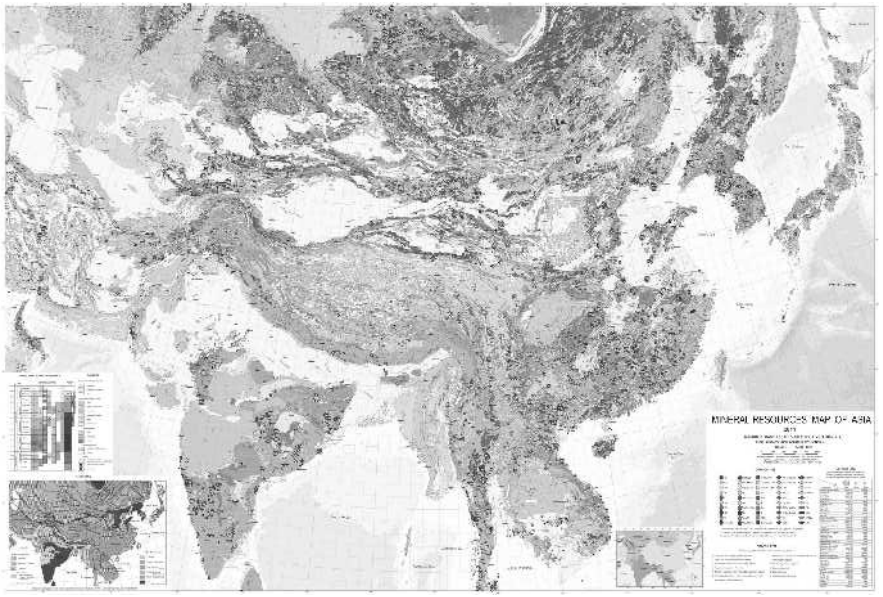
1:3,000,000 Geological Map of Central Asia (GSJ, 2007)



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)

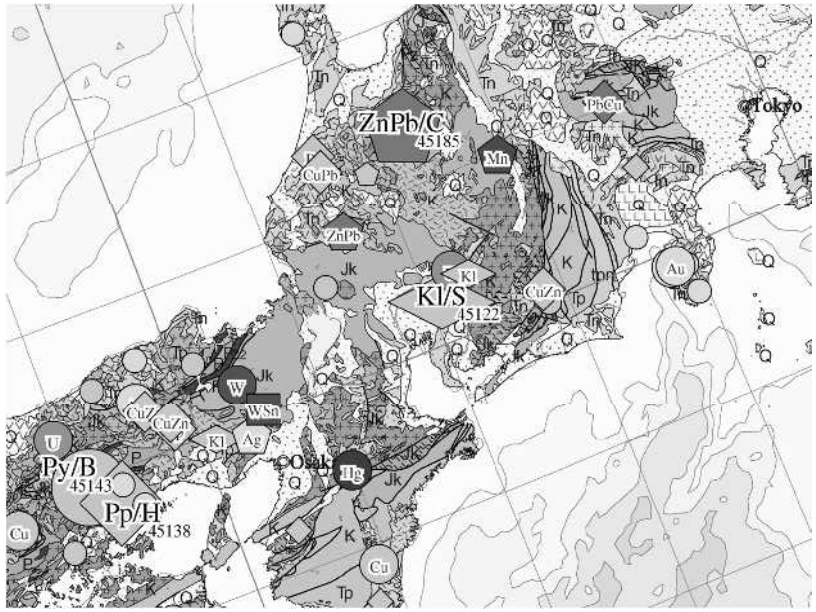
1:5,000,000 Mineral Resource Map of Asia

* 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

COMMODITIES

W	Sn,SnBi	WSn,SnW	NbTa,TaNb	Be,Bi
Cu	Mo,MoW	CuMo,CuW,CuSn	CuZn,CuPb	CuNi
Au	Ag,AgAu	AgPb,AgSb	Gm	Dm
Py	S	Li	Pp,Ps	Kl,Rc
Cr	Ni,NiCu	PGE	TiV	Tl
Na	Tn	K	Gp,Ah	B
Pb	PbZn,ZnPb	Zn	PbCu,ZnCu	Sr
Hg	Sb	F	AsCo,CoAs	Ba
U	V,VU	REE	Gr	P,PFe
Fe,FeMn	Mn,MnFe	Ti,TiZr,Zr	FeTi	Al

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



Sample of mineral deposit figures

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 >	Medium >	Small
Aluminum (bauxite) (Al_2O_3)	100,000,000		1,000,000
Antimony (Sb)	500,000		10,000
Arsenic (As)	1,000,000		10,000
Barite ($BaSO_4$)	5,000,000		50,000
Beryllium (BeO)	1,000		10
Boron (B_2O_3)	10,000,000		100,000
Chromium (Cr_2O_3)	1,000,000		10,000
Cobalt (Co)	20,000		1,000
Copper (Cu)	1,000,000		50,000
Diamond (Dm)	20,000		1,000
Fluorite (CaF_2)	5,000,000		100,000
Gold (Au)	200		10
Graphite (fixed C) (Gr)	1,000,000		10,000

DEPOSIT TYPE

The following abbreviations are shown in commodity symbols.

M: Magmatic and irregular massive deposits.

C: Skarn and contact metasomatic deposits.

H: Hydrothermal vein and fissure-filling deposits.

G: 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.

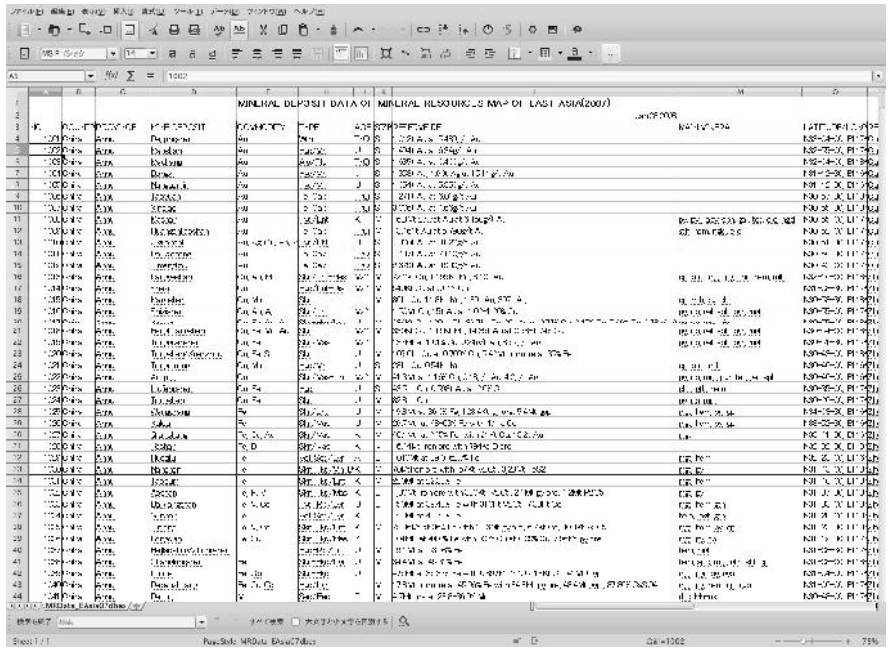
T: Metamorphic deposits.

W: Weathering residual deposits.

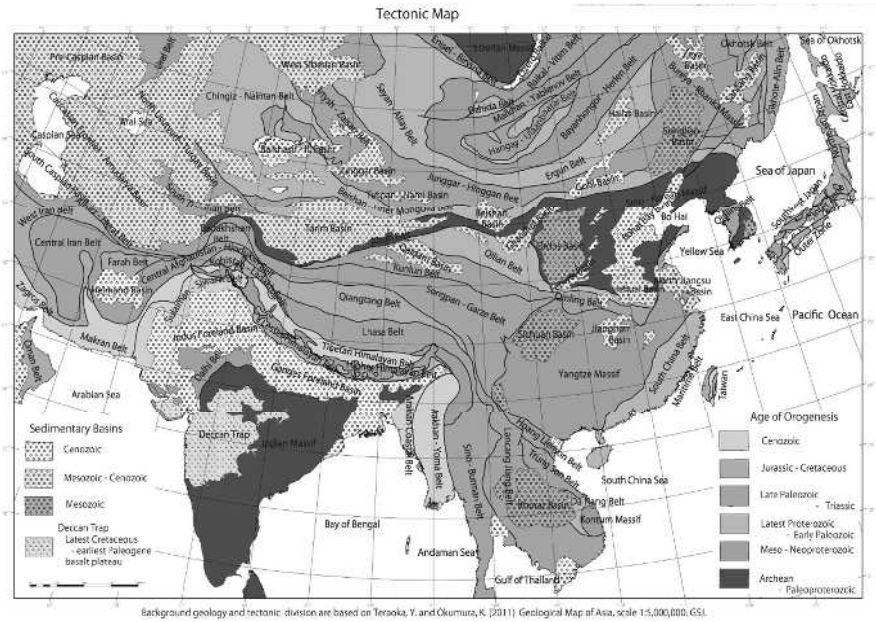
E: Evaporite deposits.

D: Placer deposits.

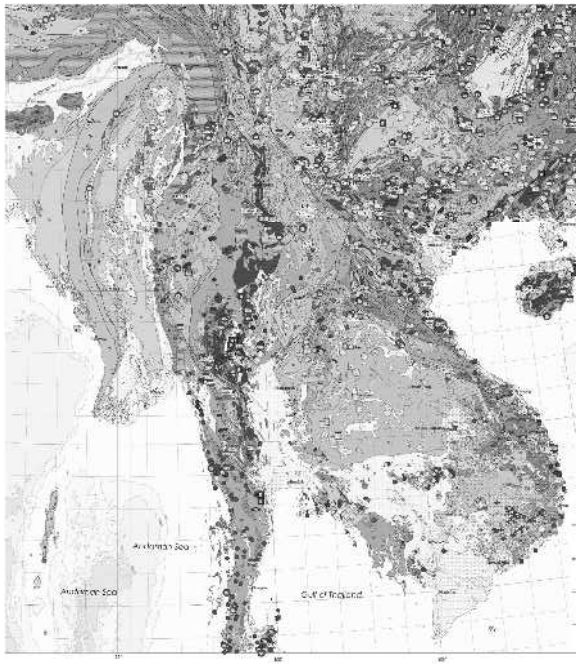
U: Undifferentiated deposits.



https://www.gsj.jp/Map/EN/asia-area-geoscience.html

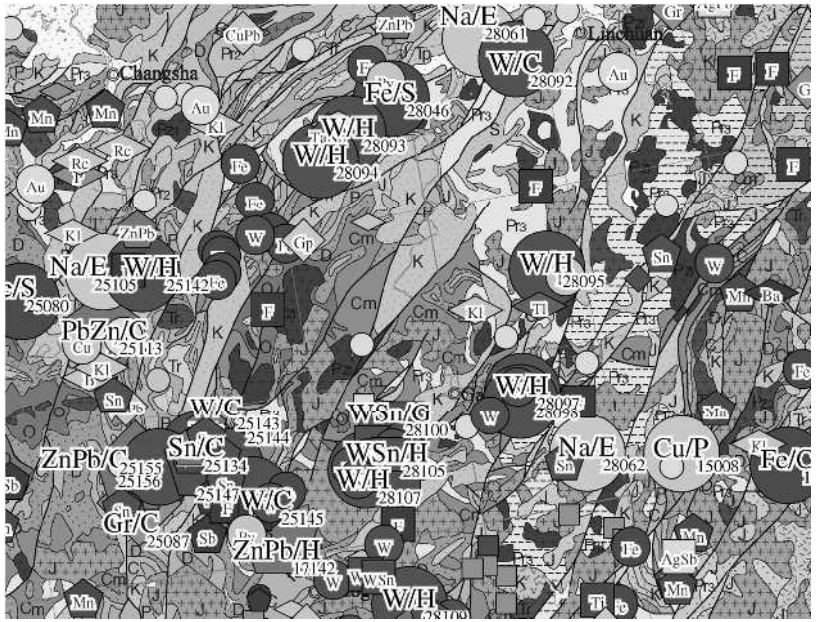


Tectonic Map of Asia

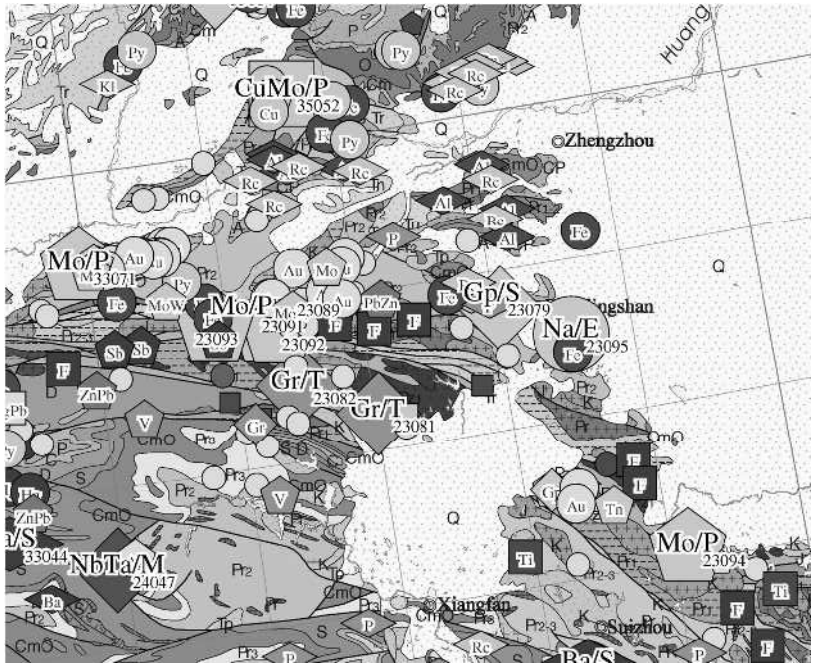


ASEAN countries in the Mineral Resources Map of Asia

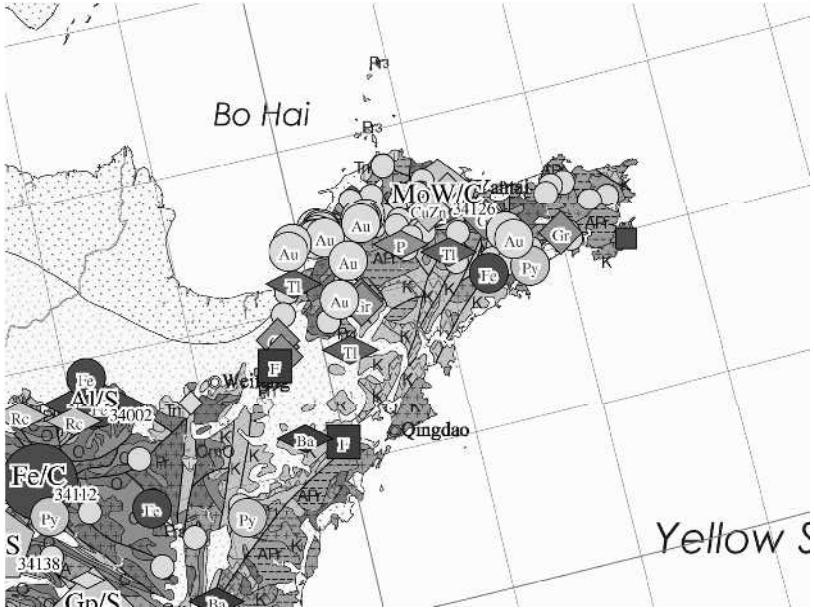
- Vietnam (356)
- Laos (197)
- Cambodia (74)
- Thailand (237)
- Myanmar (225)



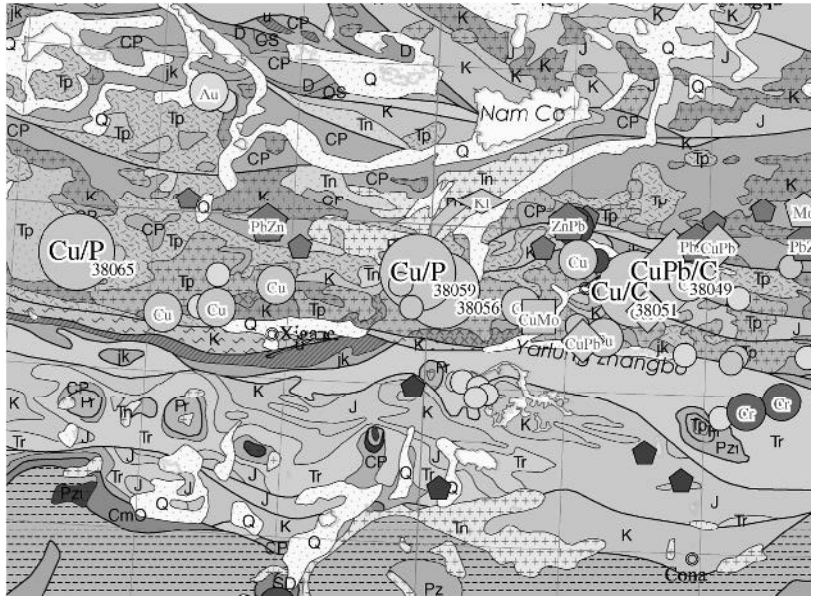
Tungsten-Bismas and Lead-Zinc-Tin in Huanan (China)



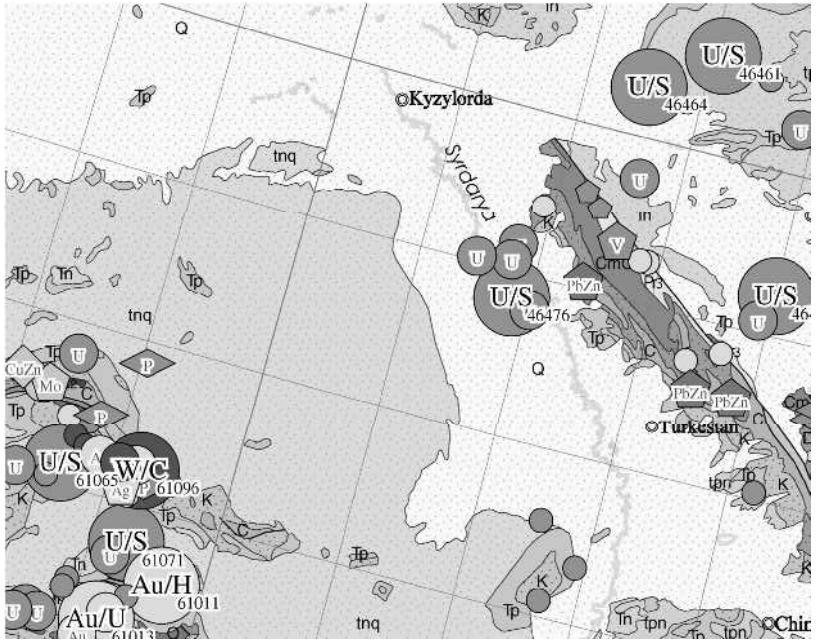
Magmatic Copper Molybdenum in Yangtze (China)



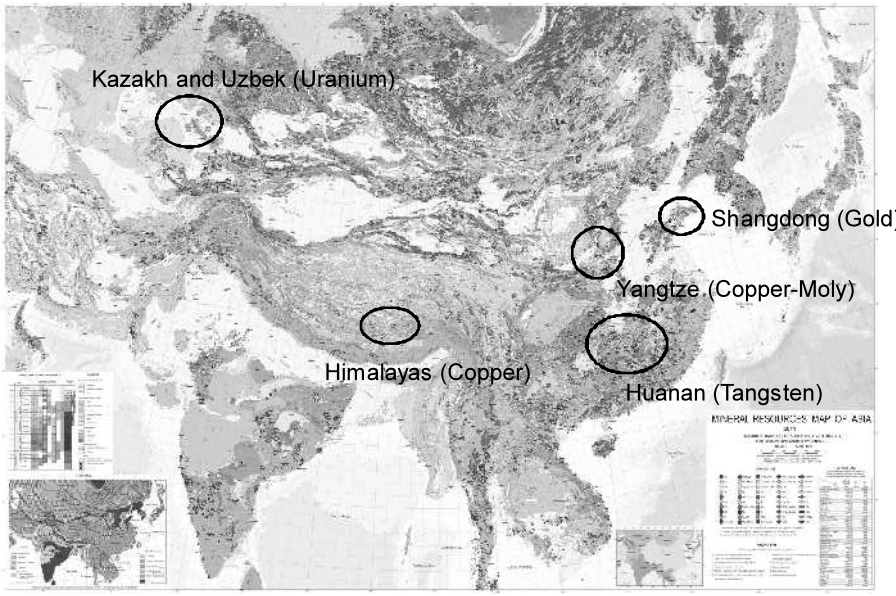
Hydrothermal Gold in Shandong (China)



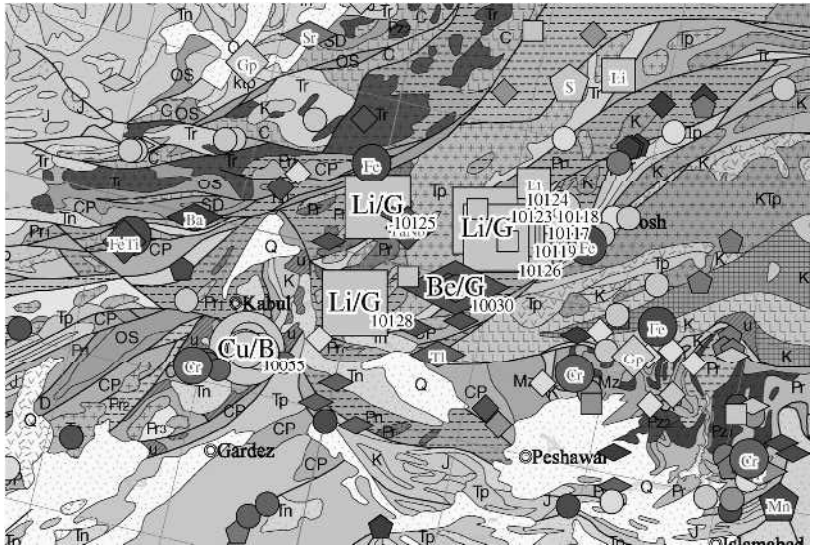
Porphyry Copper deposits in Himalayas (China)



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.