Mineral Exploration
Unit-3

Remote Sensing Based Mineral Targeting:

Mapping of Lithologically, Structurally and Geomorphologically Controlled Mineral Deposits Using Raw and Digitally Enhanced Data.

RS is largely used for mineral exploration, especially for

(i) Mapping regional lineaments,

(ii) Mapping local fracture patterns that may control individual ore deposits,

(iii) Detecting hydro-thermally altered rocks associated with ore deposits, and

(iv) Providing basic geologic data.

- Various digital image processing procedures were applied such as ratioing, PC analysis. Band Ratio: It is used mainly to suppress the topographic variations and the brightness variation related to the grain size variations.
- The ratio of ETM+ Band 3 to Band 1 (3/1) renders most of the area in rather dark gray or bright grey, which corresponds to zones of strong hematitic alteration.
- The Spectral response of the weathered iron minerals has weak reflectance in the blue region (band1) and strong reflectance in the red region (band 3), so the ratio 3/1, which has high values can be used for iron oxide.

- Absorption caused by kaolinite, montmorillonite and clay minerals results in low reflectance in band 7 and high reflectance in band 5. So, the ratio image 5/7 would have bright signatures for clay minerals. Unaltered rock in bands 5 and 7 are identical in brightness.

- Mapping of different rock type using remote sensing images have been carried out by different techniques one of which is band ratio method.
- In this technique, spectral information has been enhanced.
- Ratio of 3/1, 5/7 & 5/4 used for arid to semi-arid regions.
- These ratio generally are directly related to the presence of ferric iron (3/1), ferrous iron and hydroxyl bearing minerals (5/7)

- Material with high content of iron oxides have their maximum reflectance in band 3, thus in ratio of 3/1(red/blue) the ferruginous or iron –rich materials should have very bright signature.
- Band ratio 5/3 Reflected IR/Red) was selected due to its colour clearly distinguish most terrain type and geologic formations.
- Band ratio 7/5 has distinctive bright signatures associated with hydrothermally altered rocks.

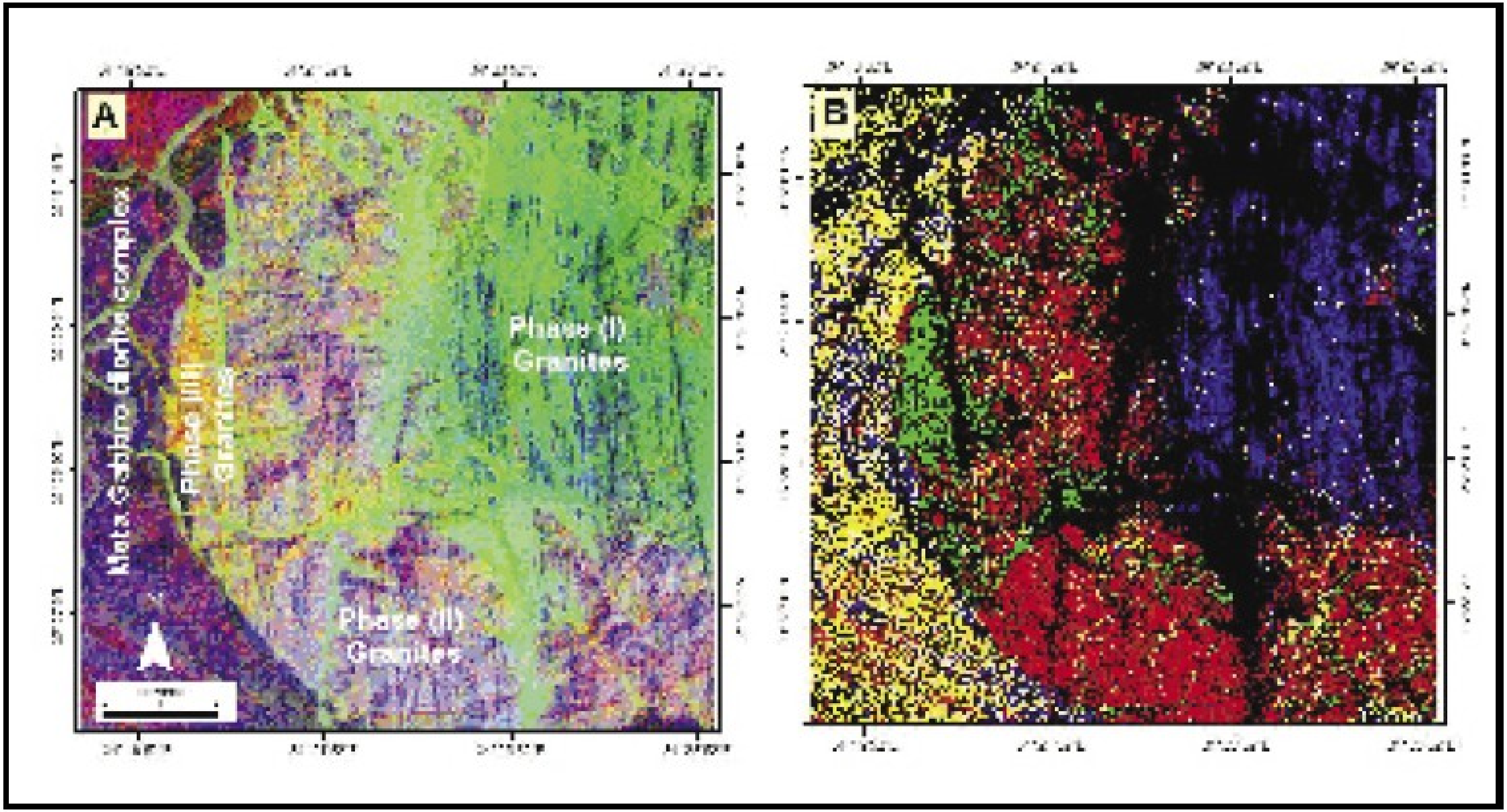


Figure 5: A) Band ratio image and B): Supervised classification for the band ratio image for Kadabora area showing Phase (I) Granites in blue; Phase (II) Granites in red, Phase (III) Granites in green; Metagabbro Diorite complex in yellow; and unclassified areas have black color.

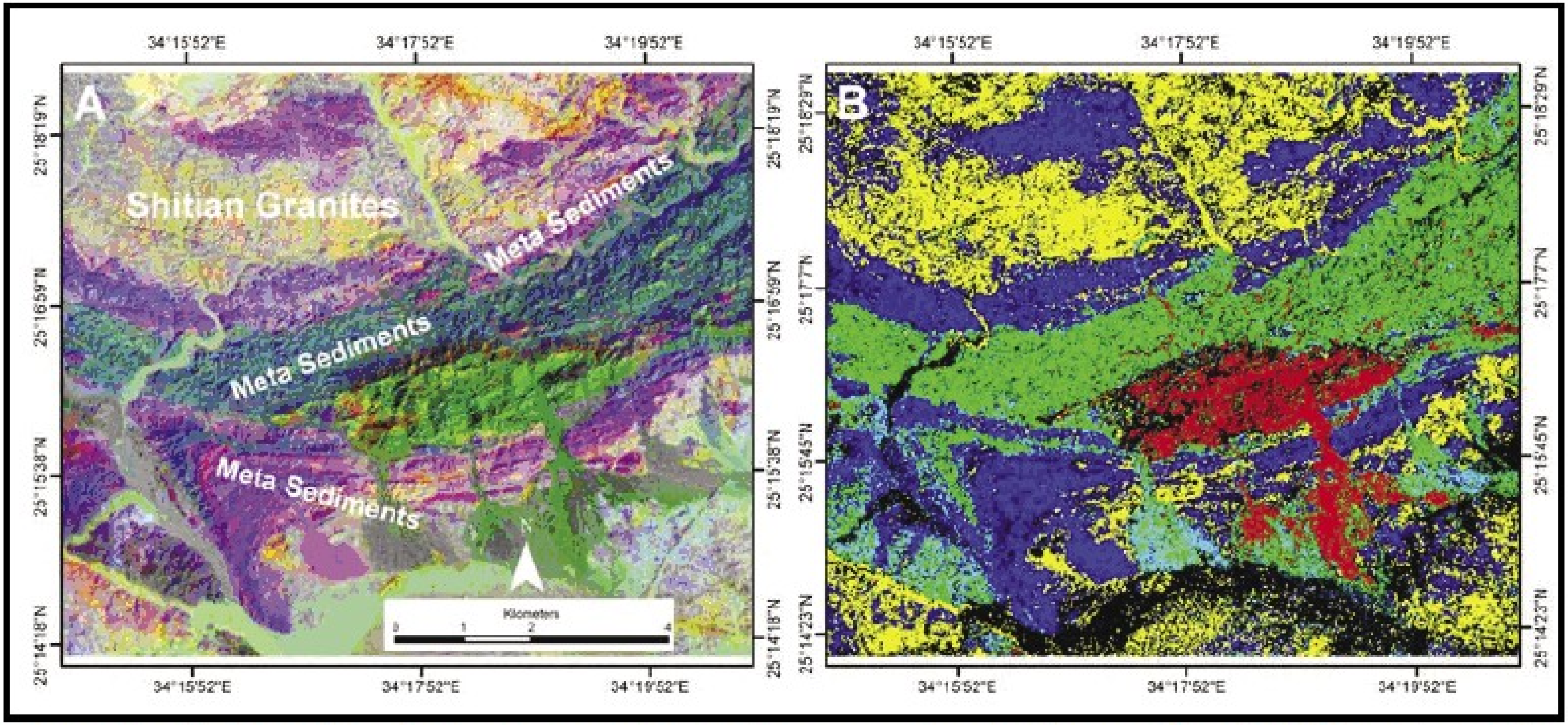
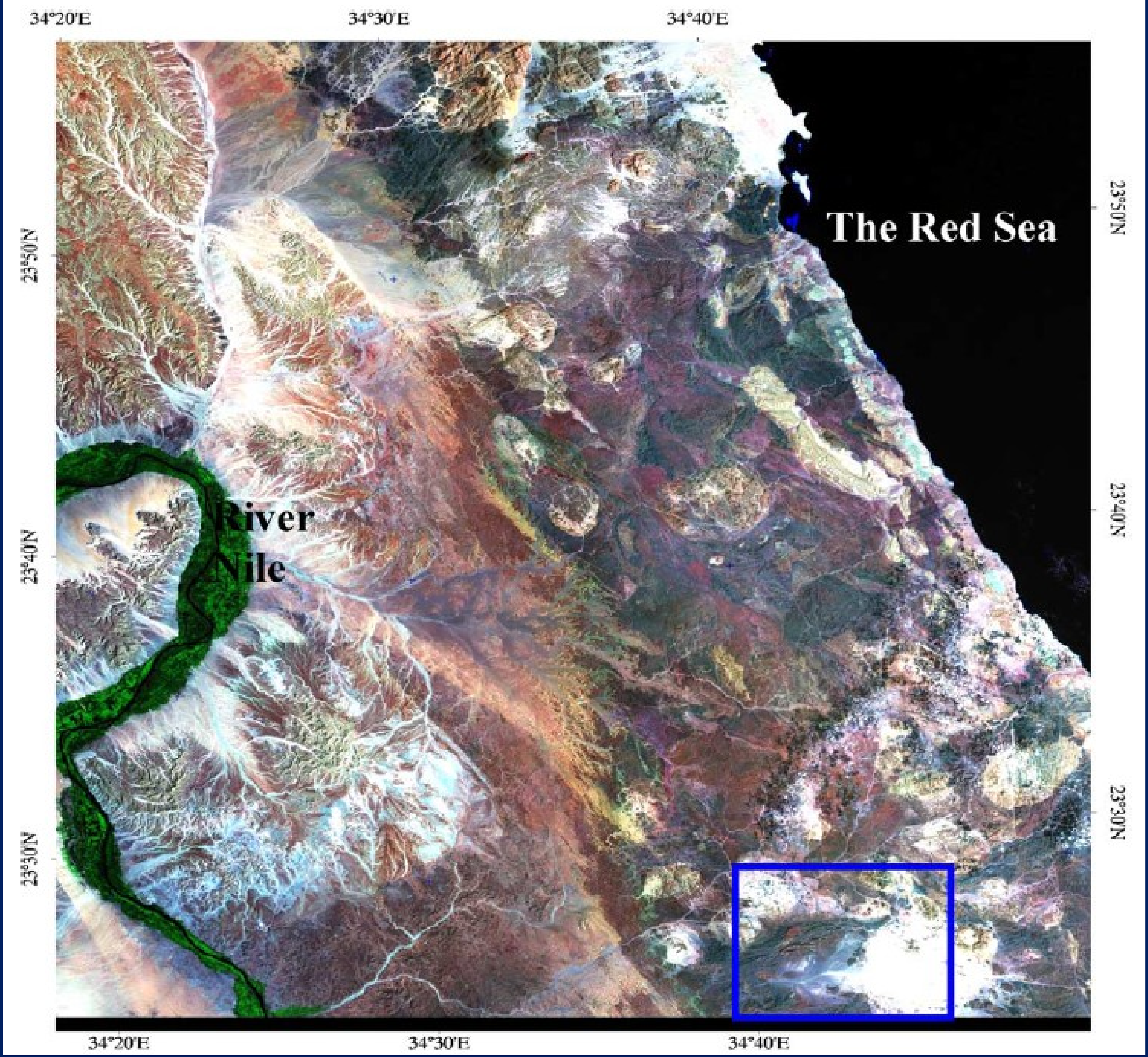


Figure 6: A) Band ratio image and previous geological map for Al Mayyit region. B) Supervised classification image showing that Serpentinites have a red color; metasediments with a green and blue color; Granites have a yellow color; and the unclassified areas have a black color.



34°20'E
34°30'E
34°40'E
The Red Sea
River
Nile
23°50'N
23°40'N
23°30'N

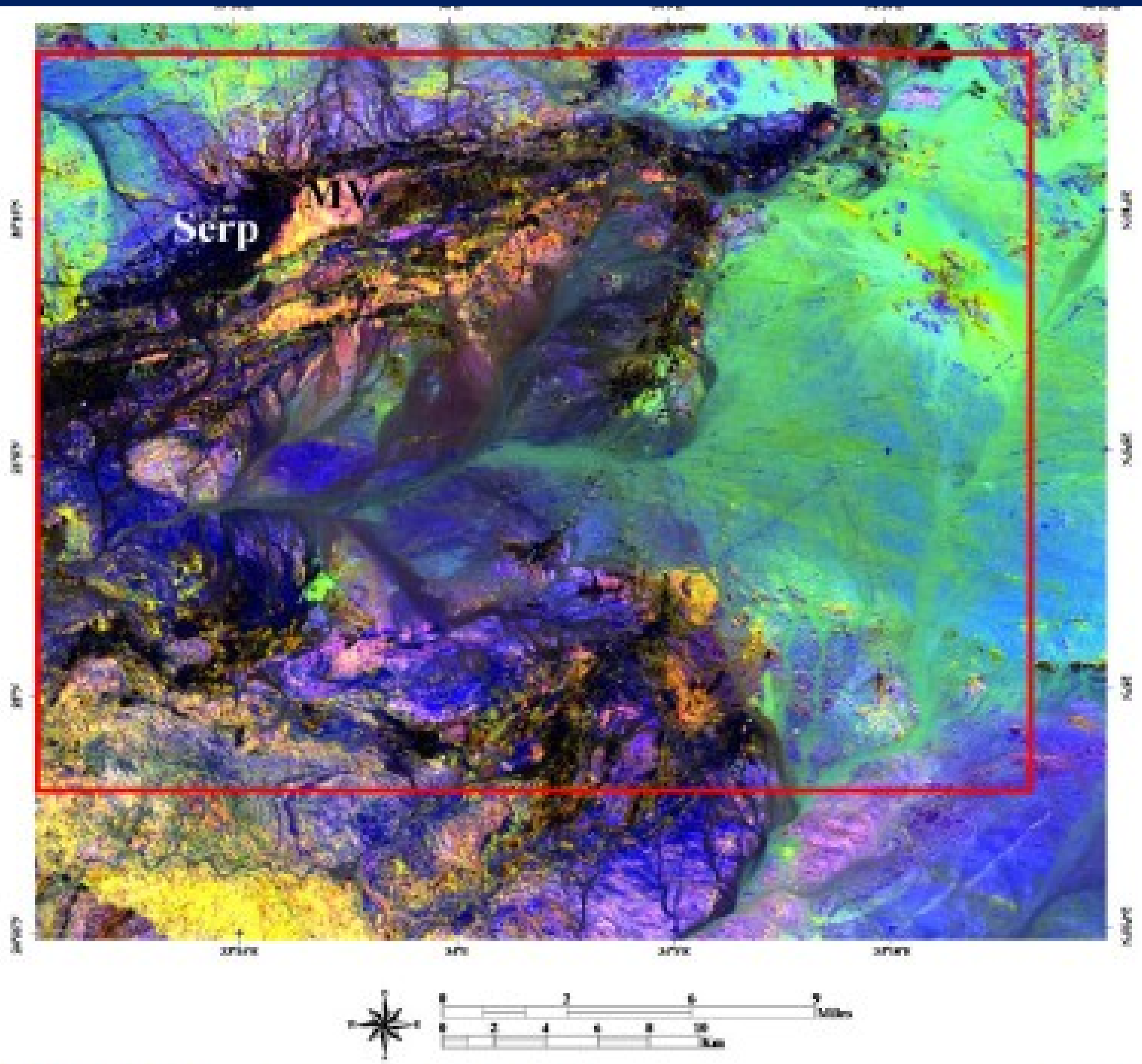


Fig. 4. Landsat TM RGB band ratio color image (5/3, 5/1, 7/5) for the study area. Serp: serpentinites and MV: metavolcanics.

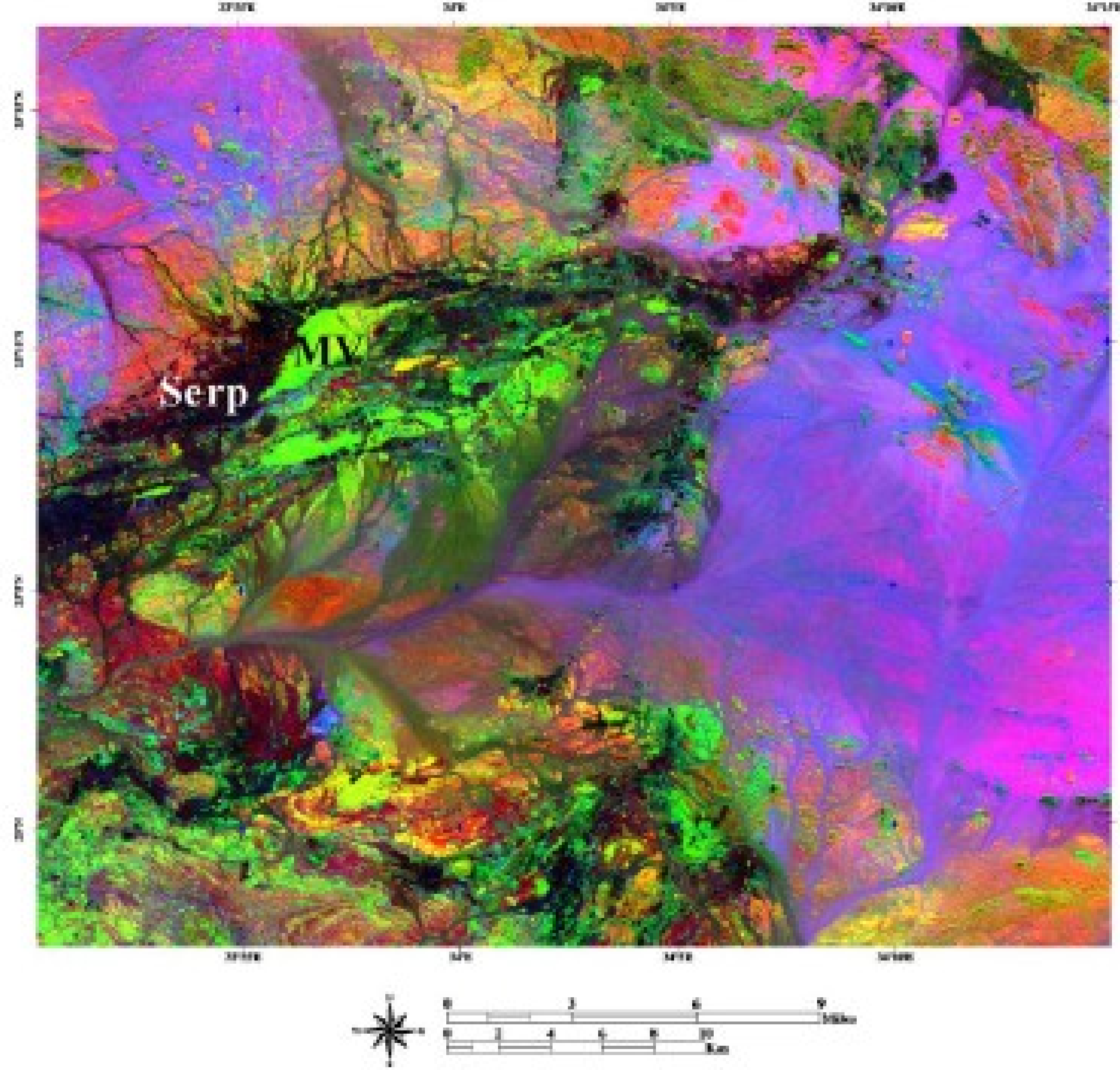
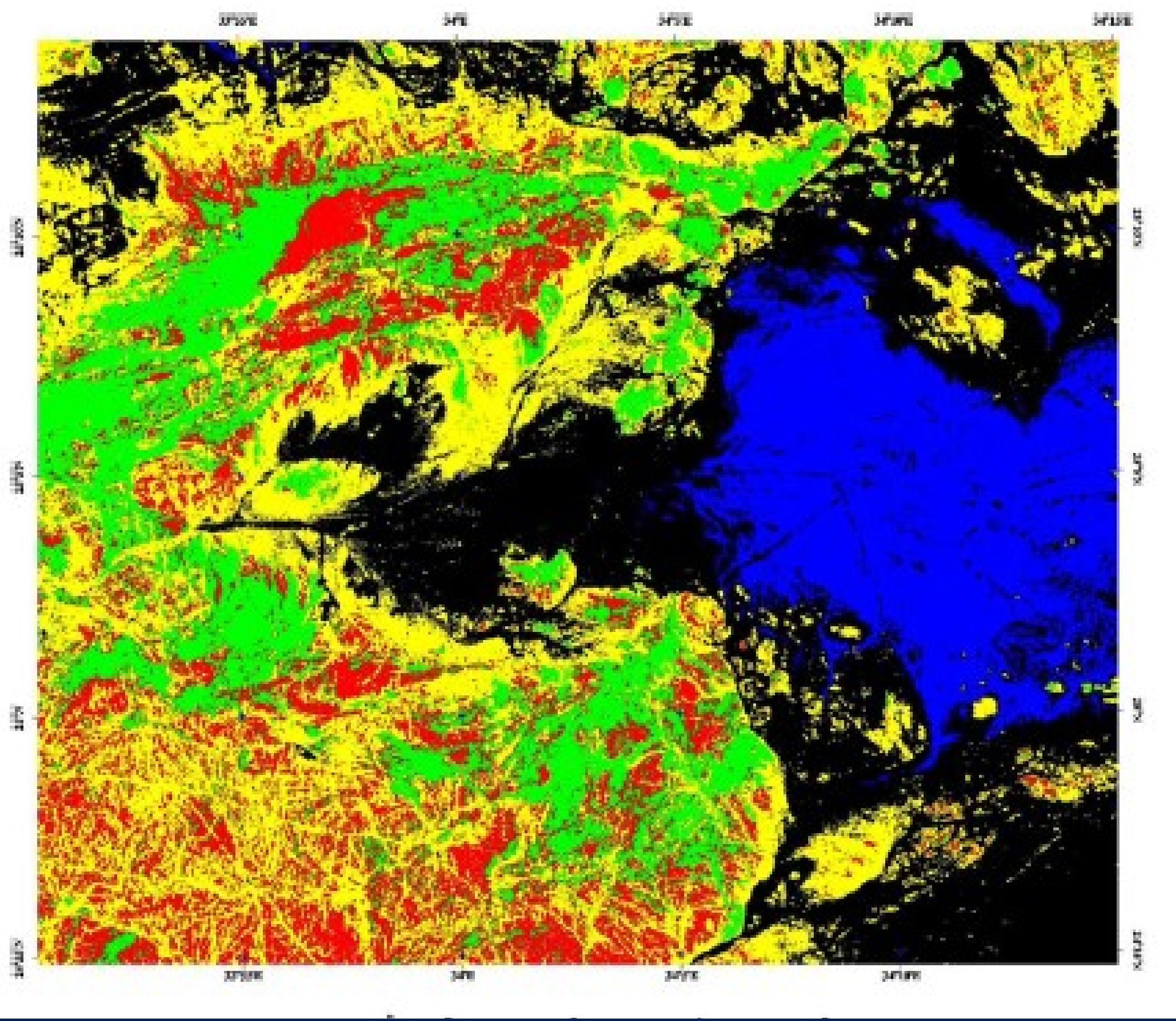


Fig. 5. Landsat TM RGB band ratio image (7/5, 5/4, 3/1) for the study area.



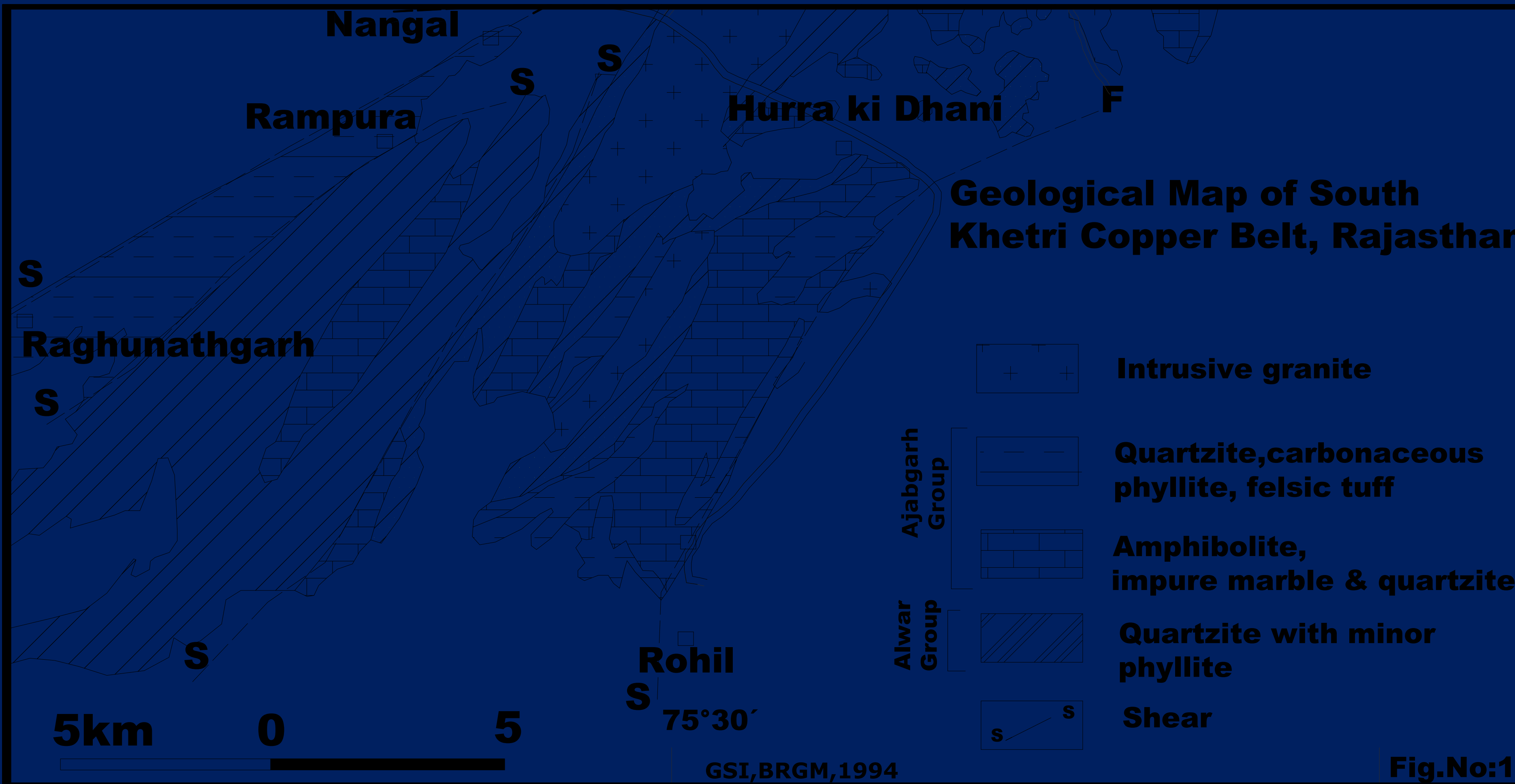
RESOLUTION MERGE

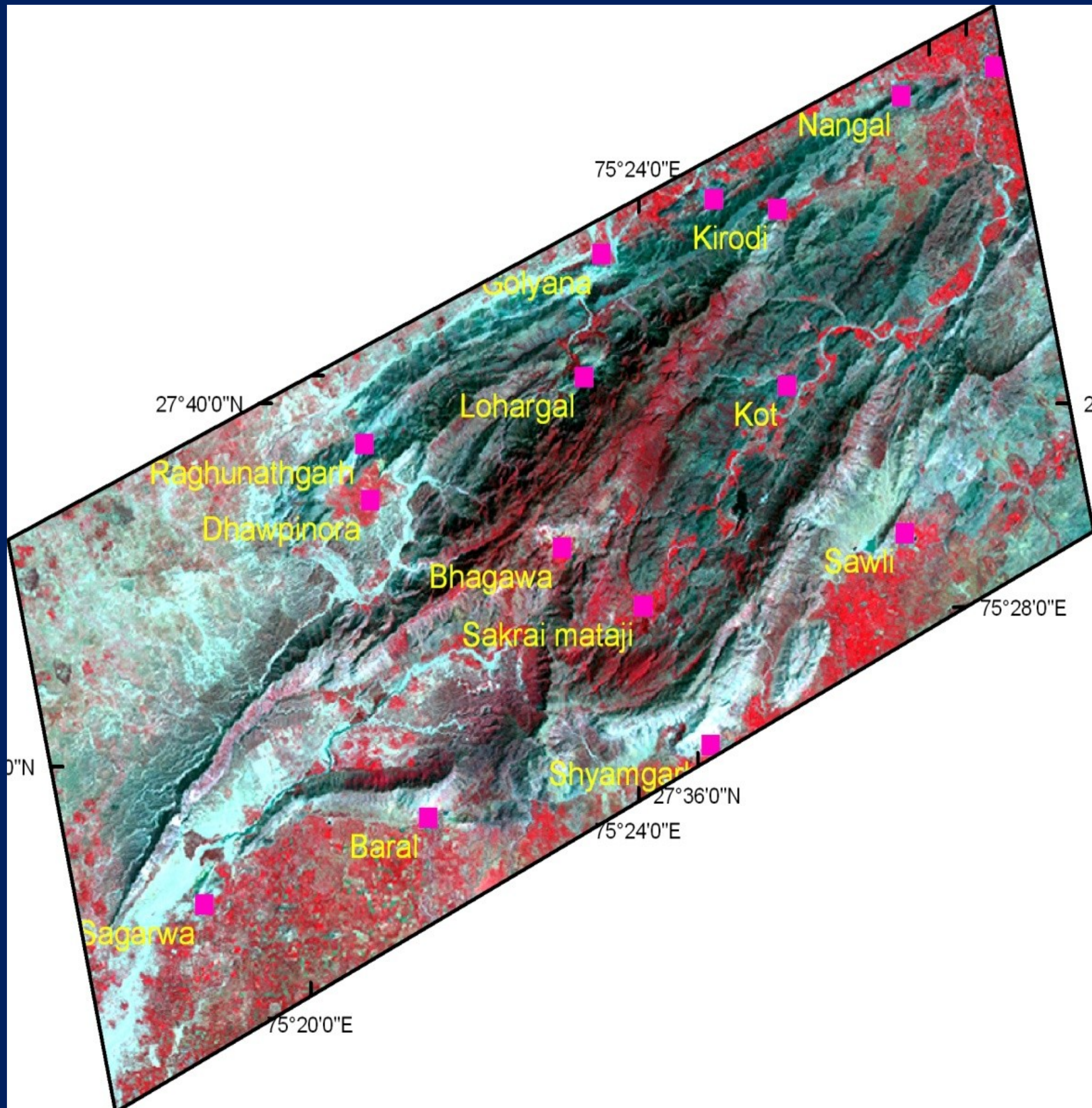
- Resolution merge is one of the enhancement techniques done in Digital Image Processing (DIP).
- In this analysis, spatial information has been taken from the higher resolution data such as PAN (~15 m) and spectral information has been taken from the lower resolution data (MSS) such as Landsat ETM+ (30 m).
- Resulted output is known as resolution merged MSS data with ~15 m spatial resolution.

THERMAL DATA OF LANDSAT ETM+

- Landsat ETM+ thermal data is a black and white image having 60m spatial resolution and 10.4 - 12.5 μm of spectral range.
- It was used to map the structural features like fold, fault and fractures / shears on 1:50,000 scales.
- Thermal data gives information about earth features based on the electromagnetic radiation, which is emitted by the earth system.

- Interpretation of this data was done on the basis of tonal and textural variation.
- Fractures can be mapped on the basis of cool linear anomalies.
- Lineaments mapped from the FCC and PAN can be modified with the help of thermal image.


Geological Map of South
Khetri Copper Belt, Rajasthan
Nangal
Rampura
Hurra ki Dhani
Raghunathgarh
Rohil
S
F
Intrusive granite
Ajabgarh Group
Quartzite,carbonaceous phyllite, felsic tuff
Amphibolite, impure marble & quartzite
Alwar Group
Quartzite with minor phyllite
Shear
5km 0 5
75°30´
GSI,BRGM,1994
Fig.No:1



Nangal
75°24'0"E
Kirodi
Golyana
Lohargal
Kot
27°40'0"N
27
Raghunathgarh
Dhawpinora
Bhagawa
Sawli
75°28'0"E
Sakrai mataji
0"N
Shyamgarh
27°36'0"N
75°24'0"E
Baral
Sagarwa
75°20'0"E

Supervised Classification

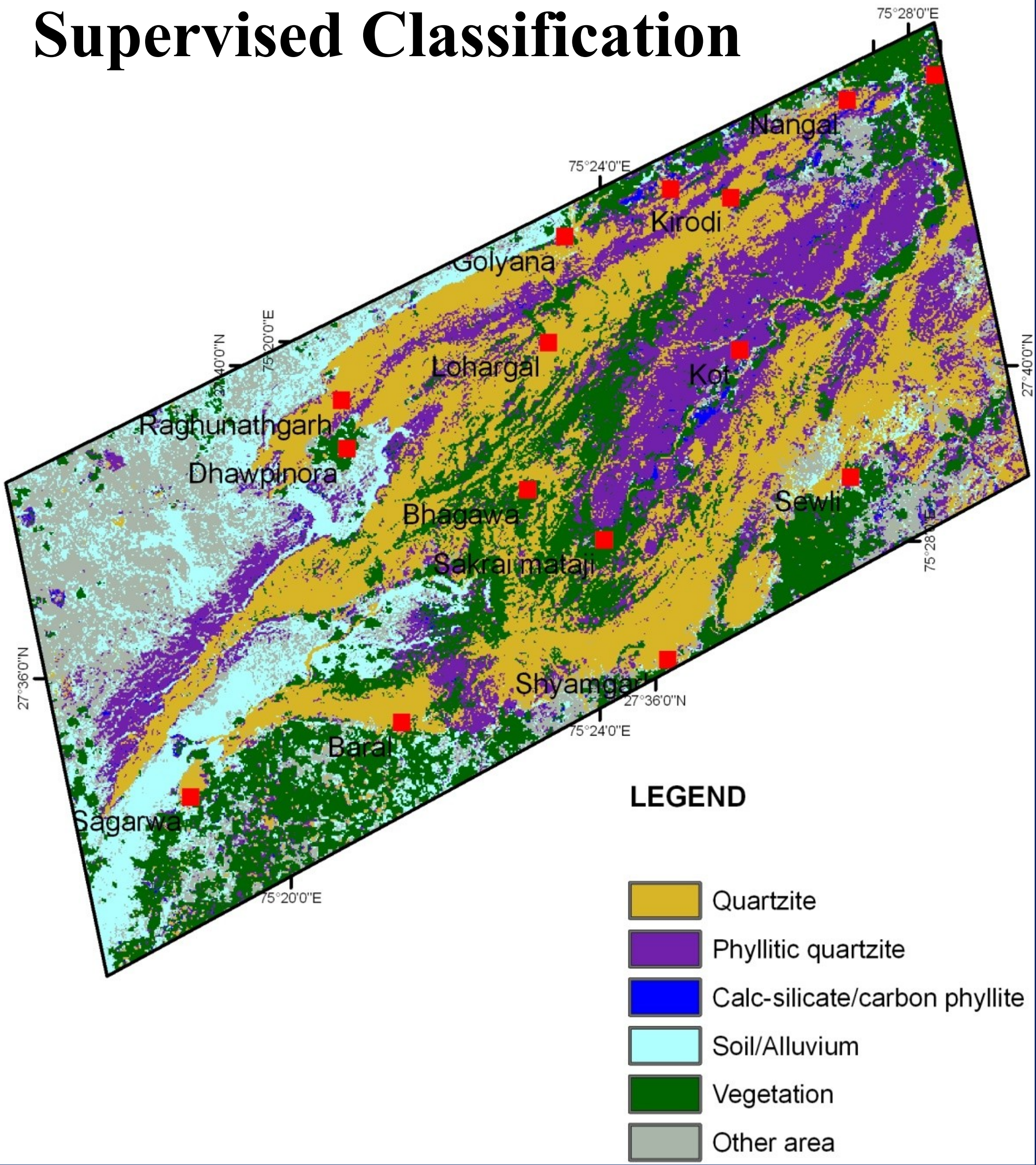
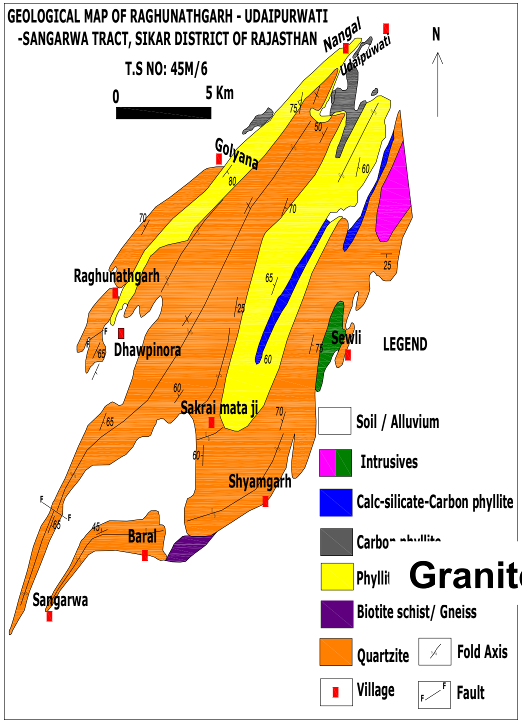


Fig No: 2.6



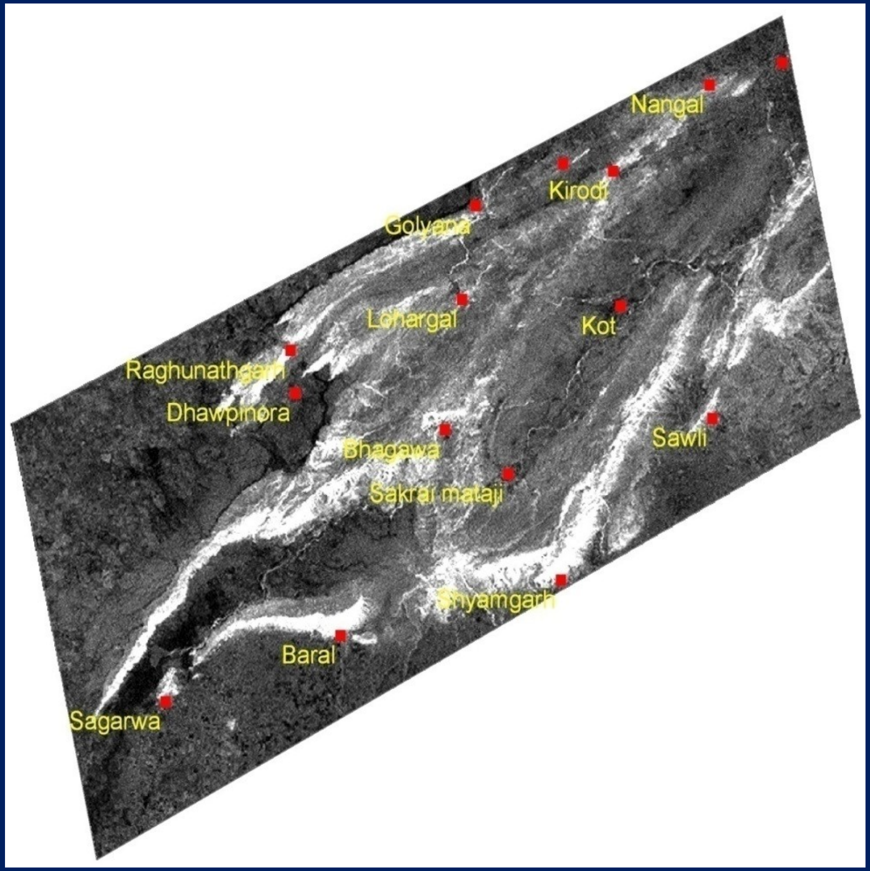
Granite/ Amphibolite

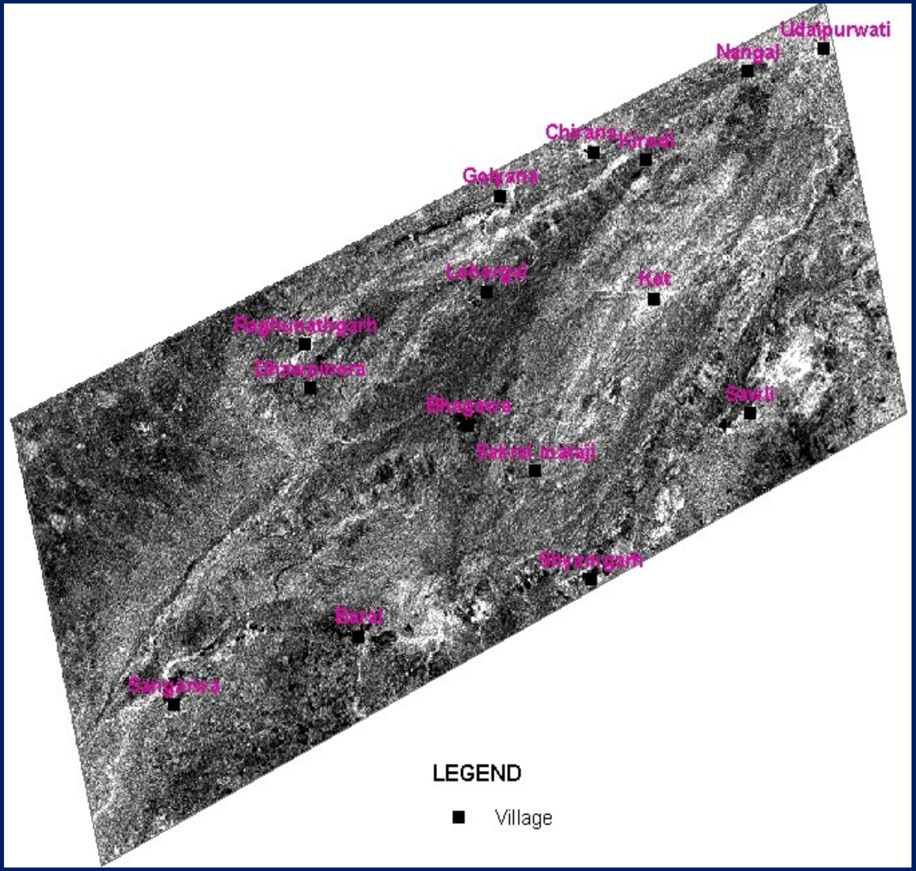
Fig No: 1.6.3A

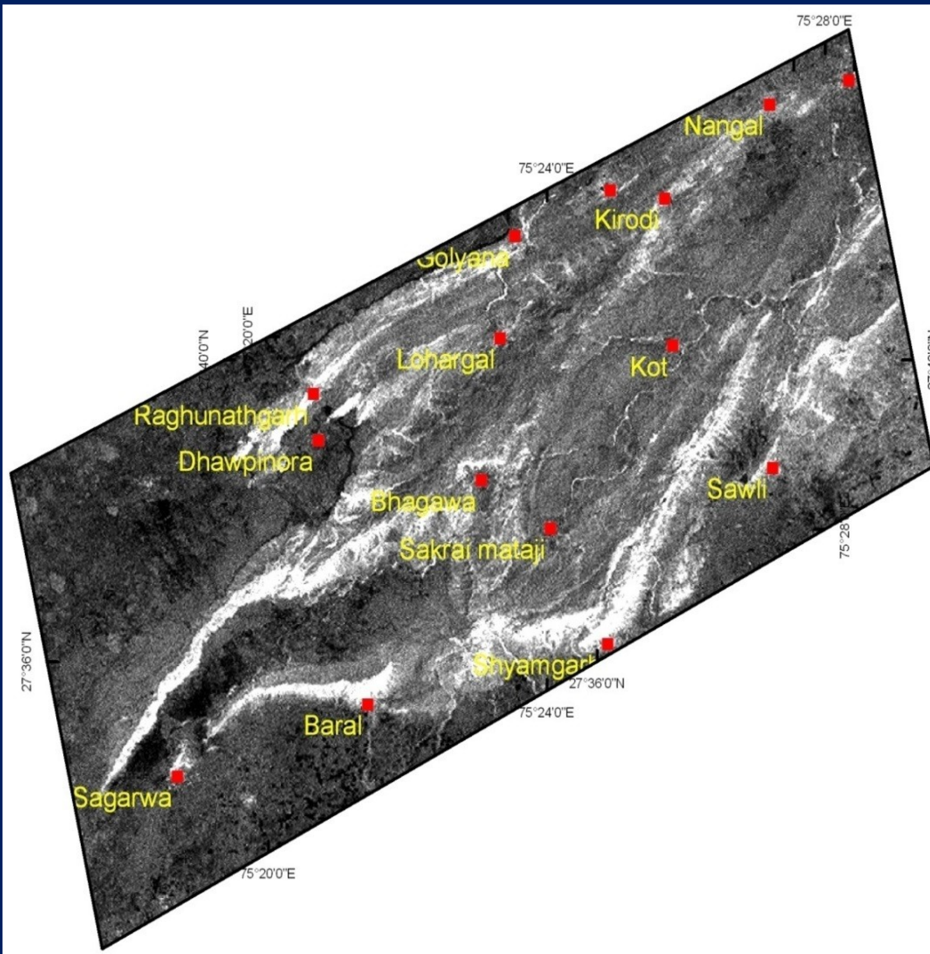
- Crosta technique is applied to find lithological variations. In this technique, principal component analysis (PCA) of 4, 5 and average of 4 & 5 have been used and data were stacked to get a composite image.
- This PCA technique is designed to remove or reduce the redundancy in the multispectral data.
- PCA4 enhances hydroxyl mineral for alteration zones by bright colour.

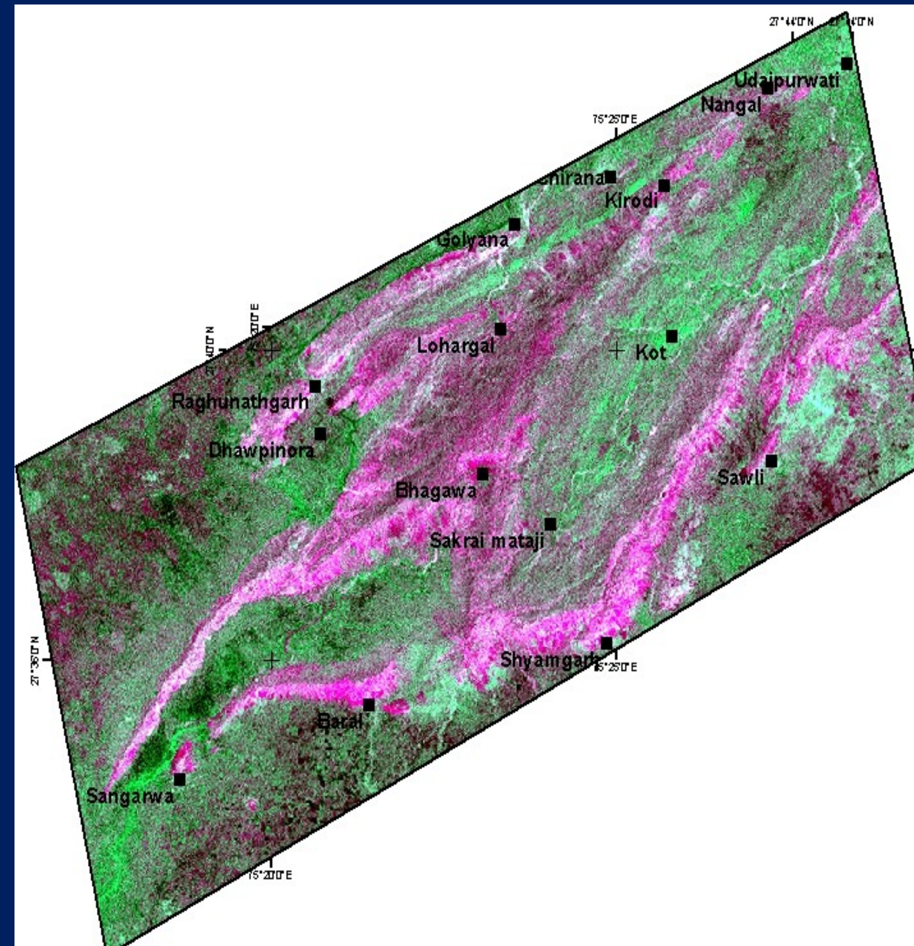
- PCA5 enhances iron oxide mineral for alteration zones showing bright colour.
- This technique was adopted to find the alteration zones but it in the study area failed because of the quartzite rock that contains silica ranging from 76% to 96%.
- But this technique was of immense help to modify the boundary between quartzite and phyllitic quartzite.

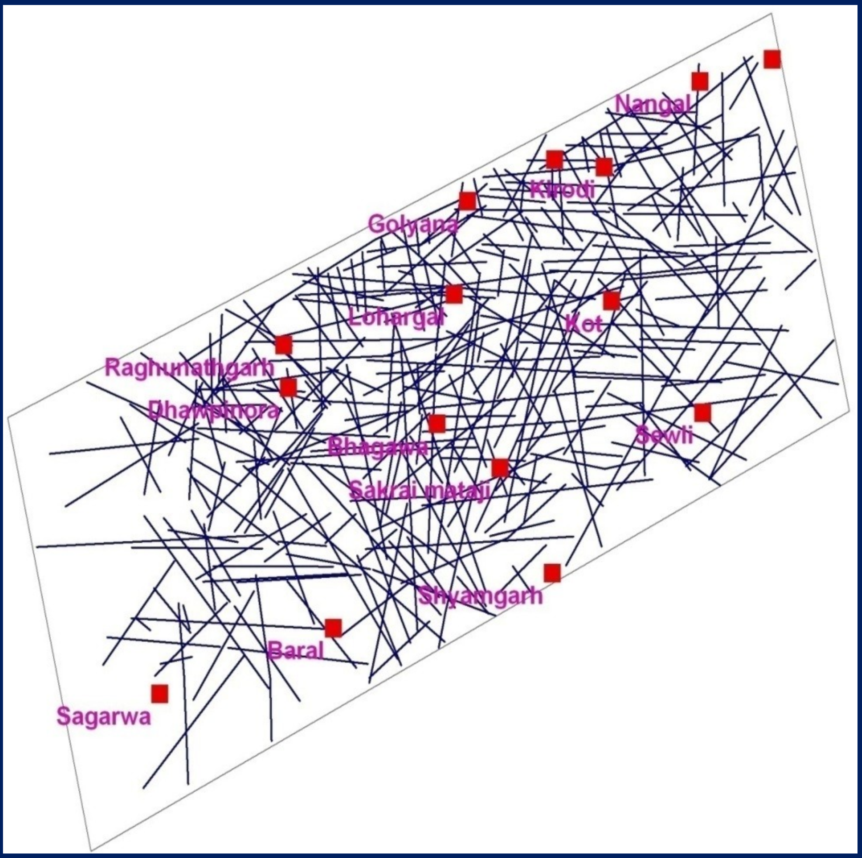
Crosta Analysis:
PCA4, PCA5 and Average of PCA4 and PCA5

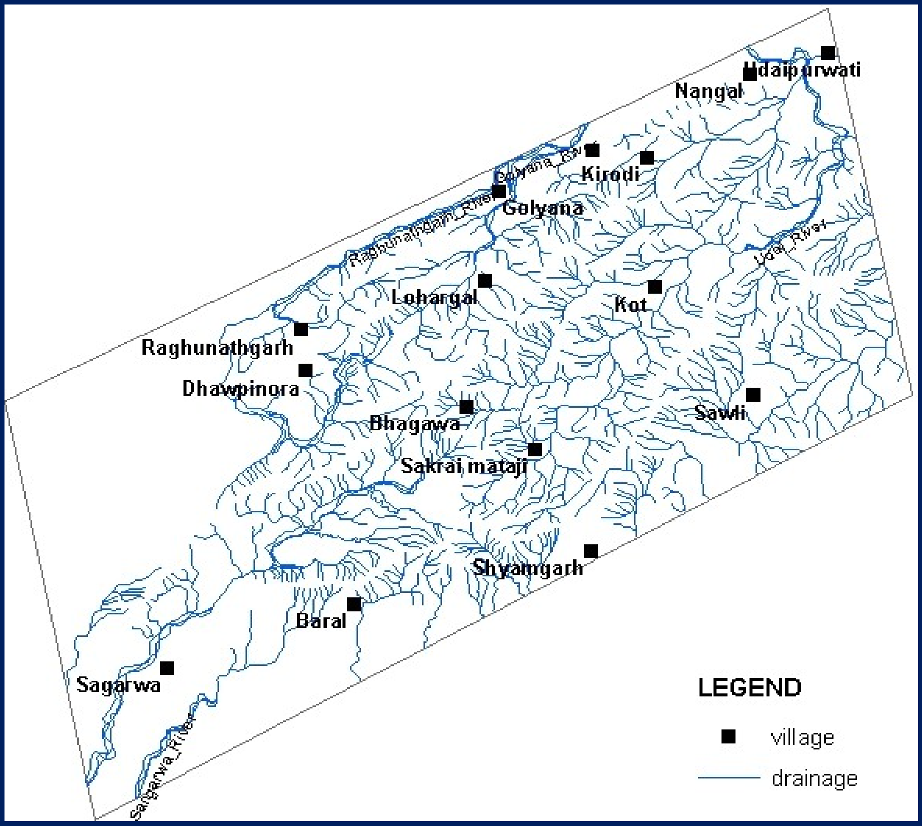


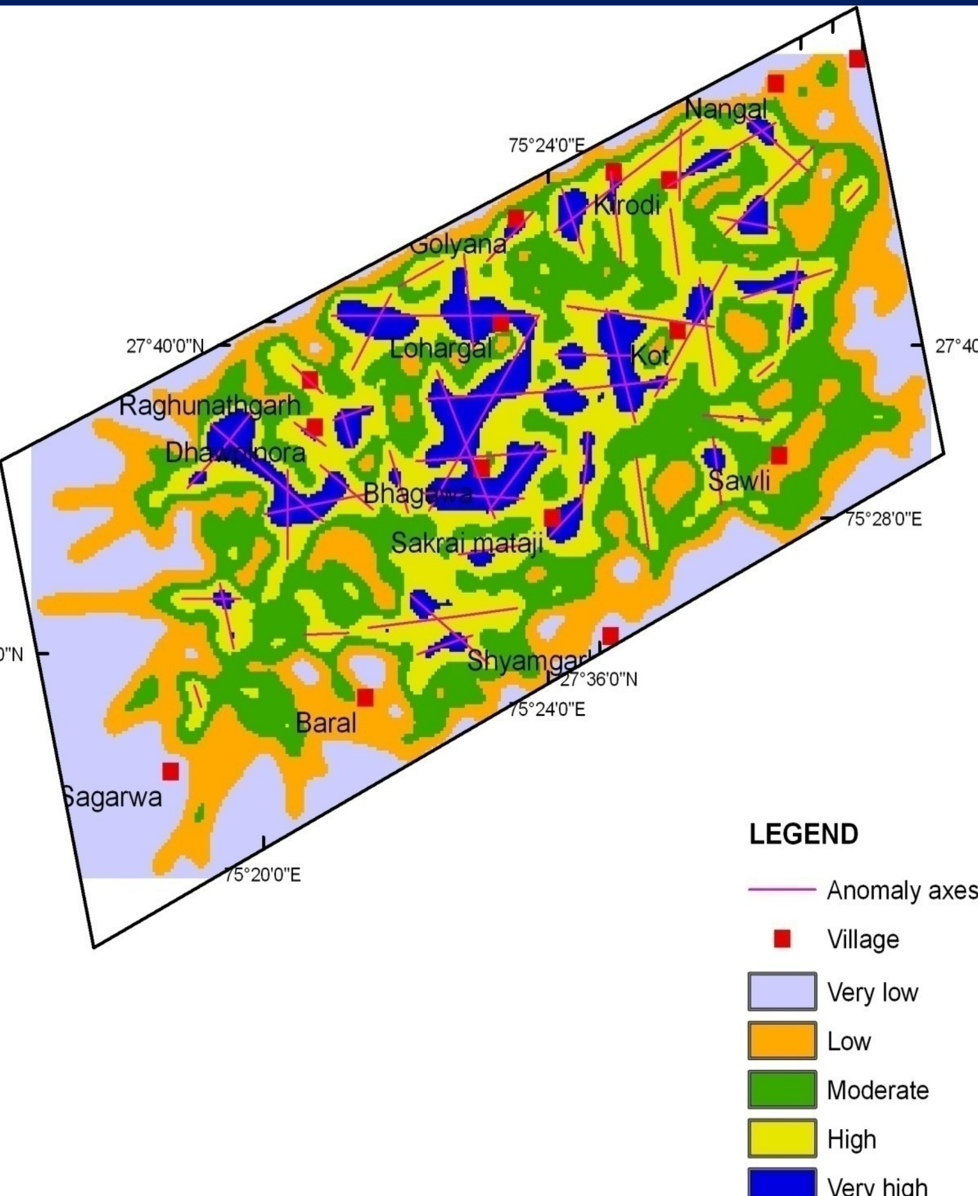



75°28'0"E
Nangal
75°24'0"E
Kirodi
Golyana
Lohargal
Kot
27°40'0"N
Raghunathgarh
Dhawpinora
Bhagawa
Sawli
Sakrai mataji
75°28
27°36'0"N
Shyamgarh
27°36'0"N
75°24'0"E
Baral
Sagarwa
75°20'0"E

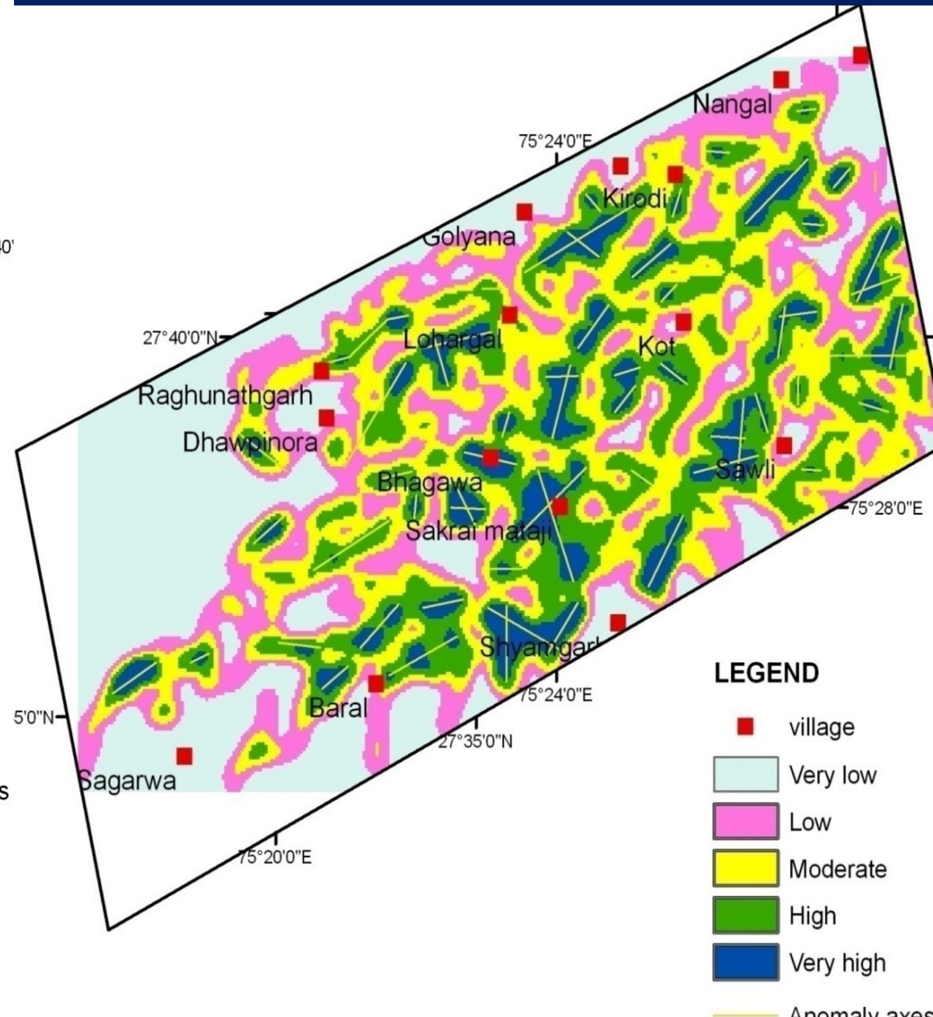

Udaipurwati
Nangal
Kirodi
Golyana
Lohargal
Kot
Raghunathgarh
Dhawpinora
Bhagawa
Sawli
Sakrai mataji
Shyamgarh
Baral
Sangarwa


Nangal
Kirodi
Golyana
Lohargal
Kot
Raghunathgarh
Dhawpinora
Bhagawa
Sewli
Sakrai mataji
Shyamgarh
Baral
Sagarwa

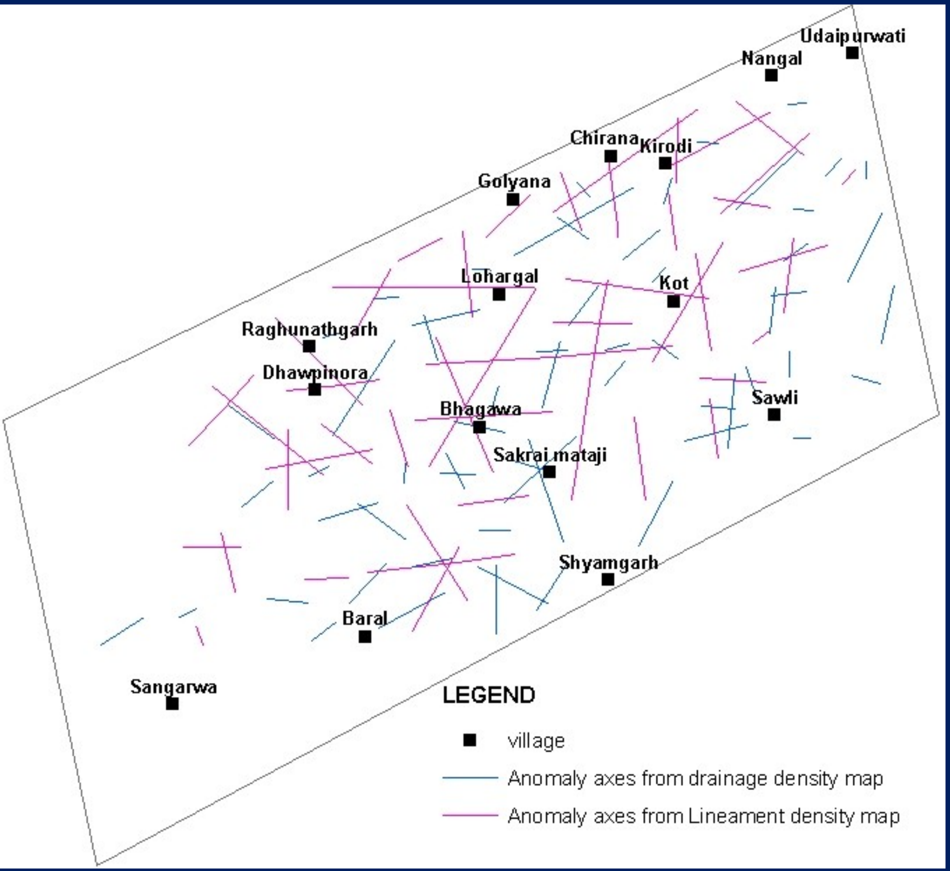

Udaipurwati
Nangal
Kirodi
Golyana
Raghunathgarh_River
Lohargal
Kot
Raghunathgarh
Dhawpinora
Bhagawa
Sawli
Sakrai mataji
Shyamgarh
Baral
Sagarwa
Sagarwa_River
LEGEND
village
drainage

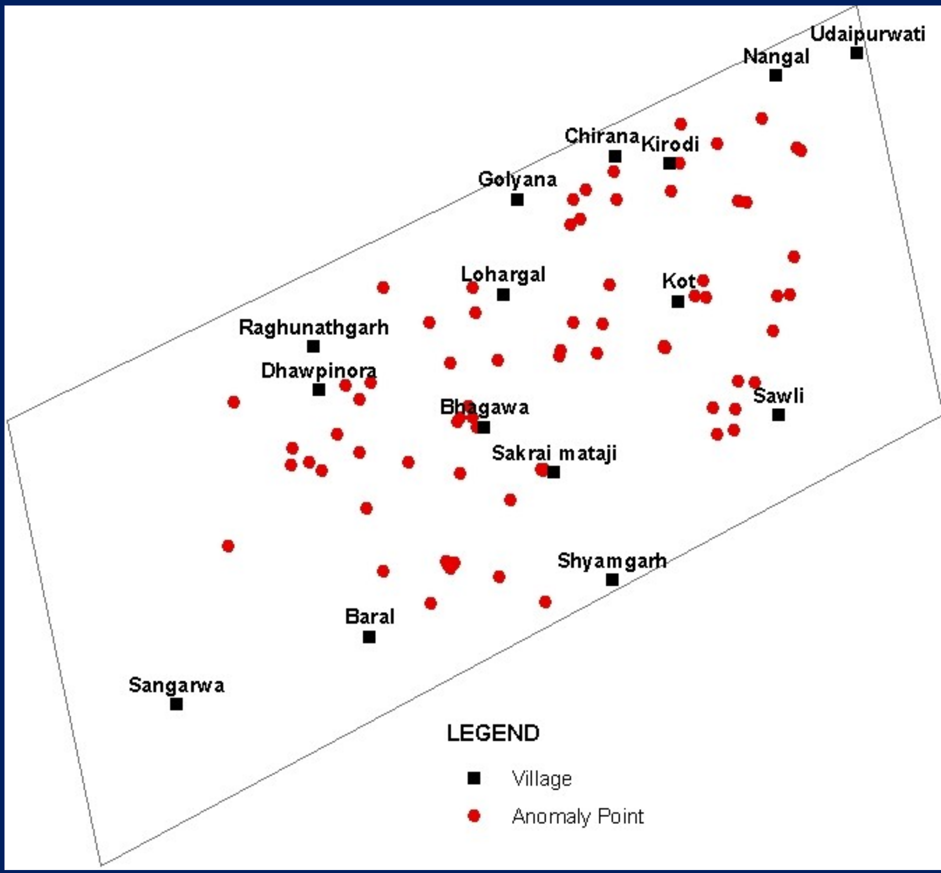


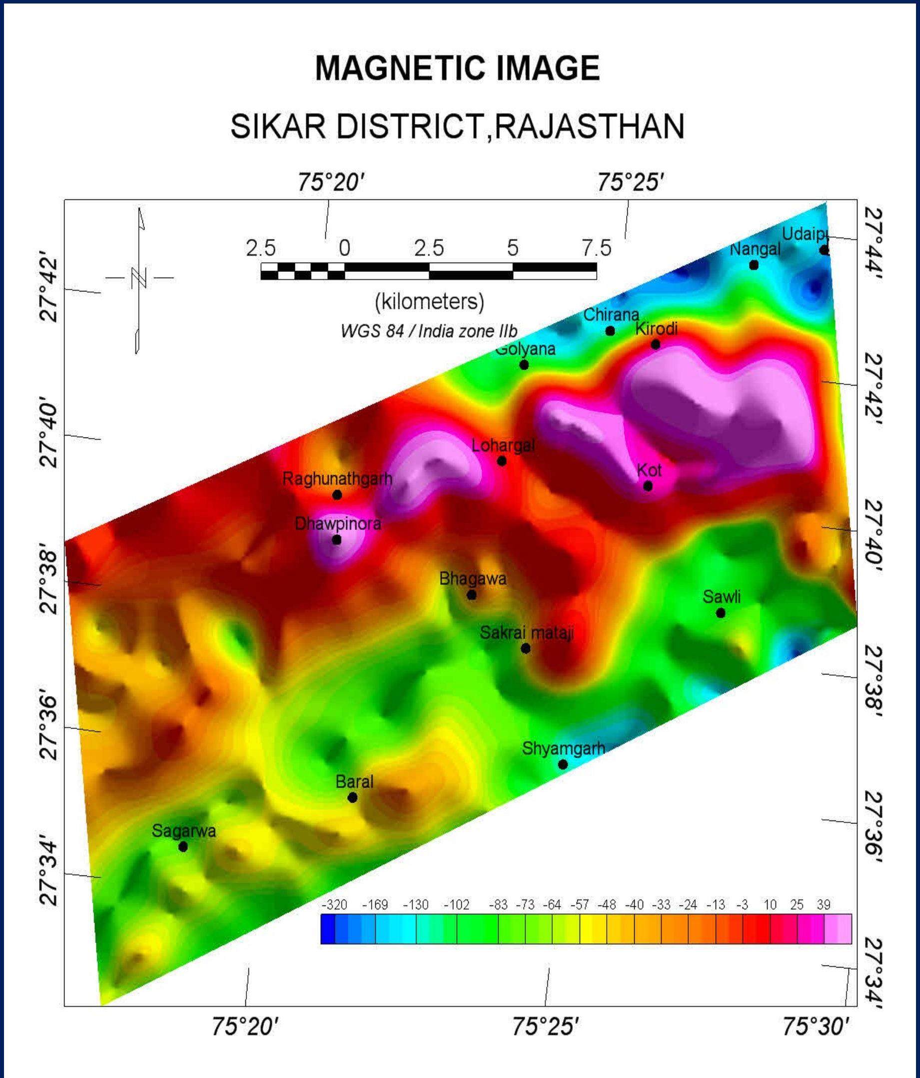
Nangal
75°24'0"E
Kirodi
Golyana
27°40'0"N
Lohargal
Kot
27°40'
Raghunathgarh
Sawli
75°28'0"E
Sakrai mataji
27°36'0"N
75°24'0"E
Baral
75°20'0"E
LEGEND
Anomaly axes
Village
Very low
Low
Moderate
High
Very high

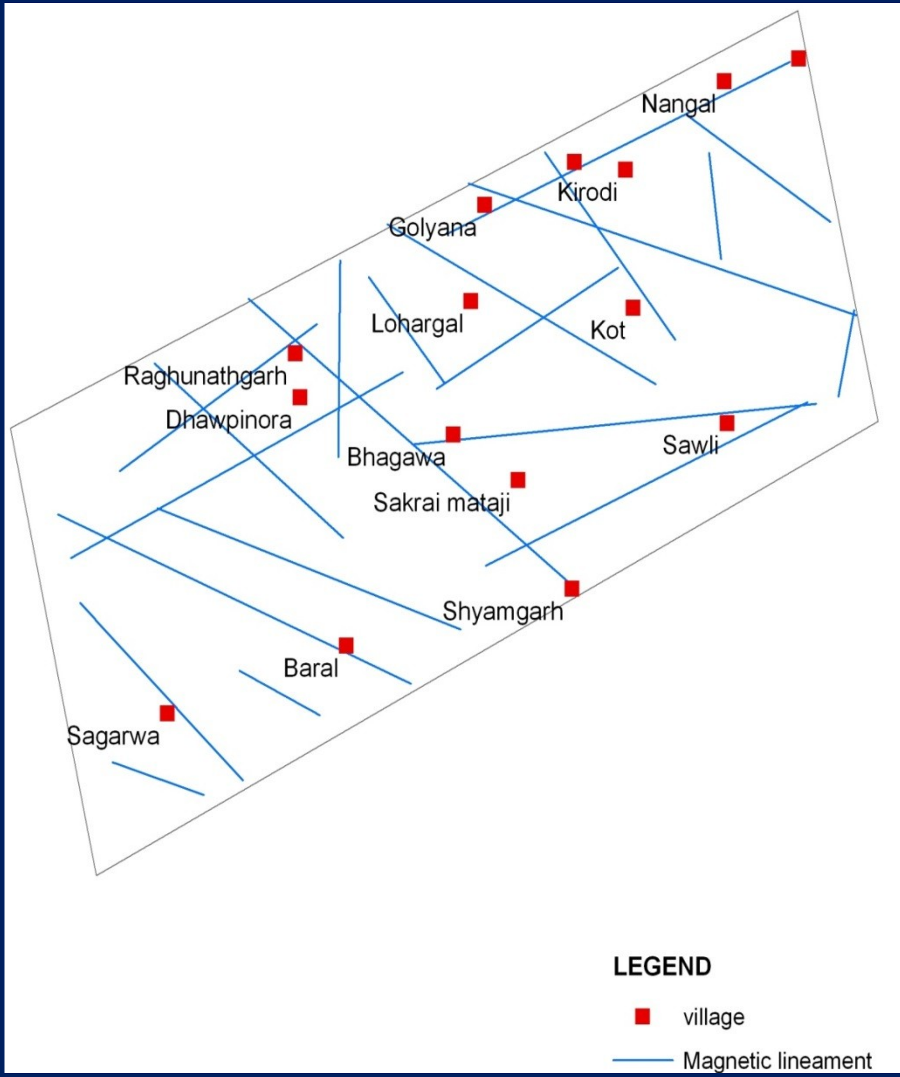


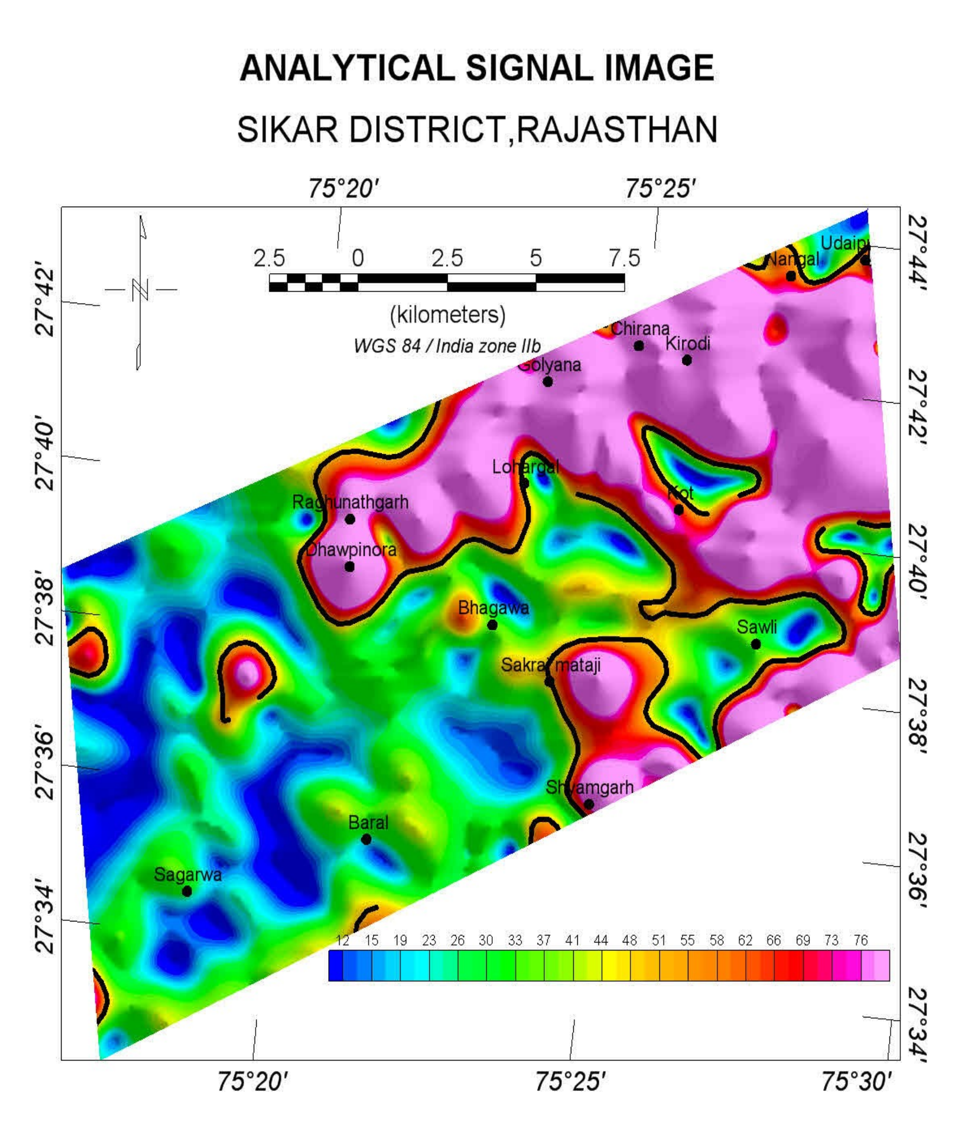
Nangal
75°24'0"E
Kirodi
Golyana
27°40'0"N
Lohargal
Kot
Raghunathgarh
Dhawpinora
Bhagawa
Sawli
75°28'0"E
Sakrai mataji
75°24'0"E
Baral
27°35'0"N
Sagarwa
75°20'0"E
LEGEND
village
Very low
Low
Moderate
High
Very high
Anomaly axes

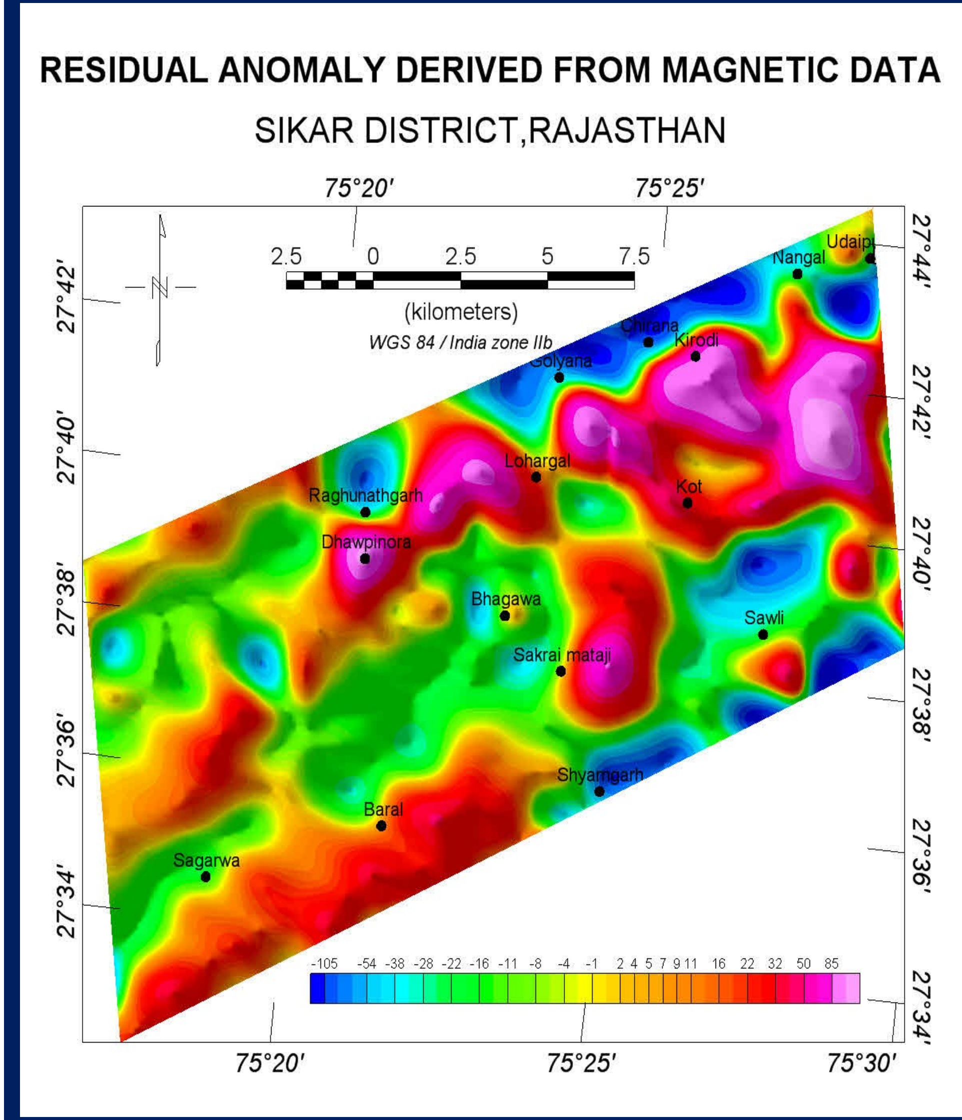

Udaipurwati
Nangal
Chirana
Kirodi
Golyana
Lohargal
Kot
Raghunathgarh
Dhawpinora
Sawli
Bhagawa
Sakrai mataji
Shyamgarh
Baral
Sangarwa
LEGEND
village
Anomaly axes from drainage density map
Anomaly axes from Lineament density map


Udaipurwati
Nangal
Chirana
Kirodi
Golyana
Lohargal
Kot
Raghunathgarh
Dhawpinora
Sawli
Bhagawa
Sakrai mataji
Shyamgarh
Baral
Sangarwa
LEGEND
Village
Anomaly Point


MAGNETIC IMAGE
SIKAR DISTRICT,RAJASTHAN
75°20'
75°25'
75°30'
27°44'
27°42'
27°40'
27°38'
27°36'
27°34'
2.5 0 2.5 5 7.5
(kilometers)
WGS 84 / India zone IIb
Udaipu
Nangal
Chirana
Kirodi
Golyana
Lohargal
Raghunathgarh
Kot
Dhawpinora
Bhagawa
Sawli
Sakrai mataji
Shyamgarh
Baral
Sagarwa
-320 -169 -130 -102 -83 -73 -64 -57 -48 -40 -33 -24 -13 -3 10 25 39

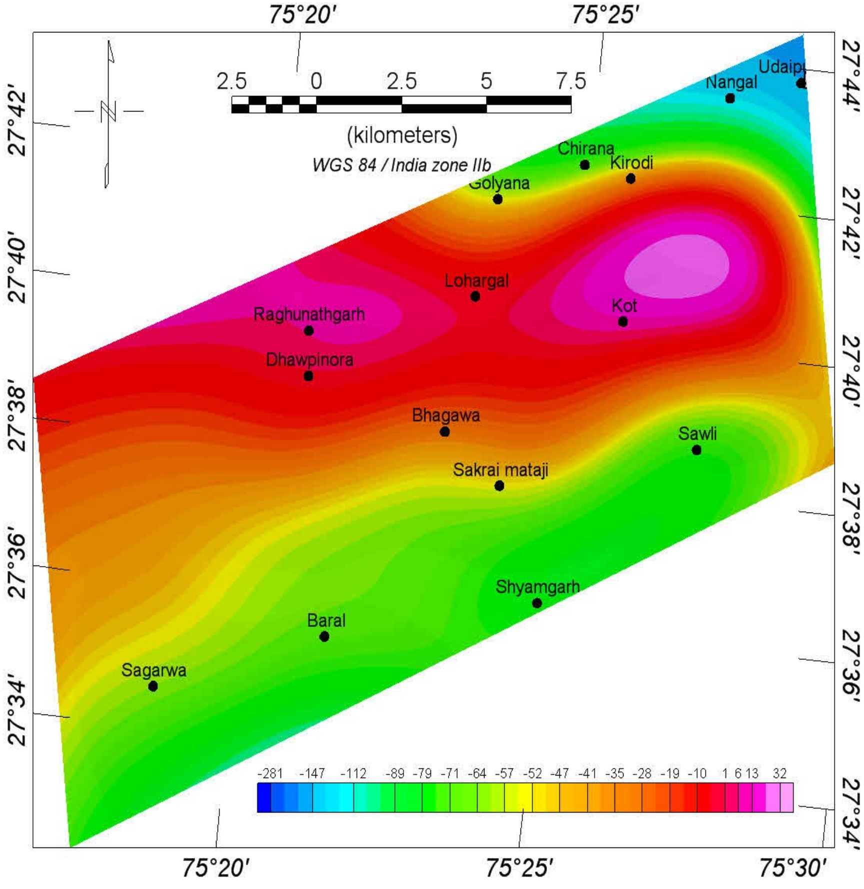

Nangal
Kirodi
Golyana
Lohargal
Kot
Raghunathgarh
Dhawpinora
Bhagawa
Sawli
Sakrai mataji
Shyamgarh
Baral
Sagarwa
LEGEND
village
Magnetic lineament


ANALYTICAL SIGNAL IMAGE
SIKAR DISTRICT,RAJASTHAN
75°20′
75°25′
75°30′
27°34′
27°36′
27°38′
27°40′
27°42′
27°44′
2.5 0 2.5 5 7.5
(kilometers)
WGS 84 / India zone IIb
Udaipur
Nangal
Chirana
Kirodi
Golyana
Lohargal
Kot
Raghunathgarh
Dhawpinora
Bhagawa
Sawli
Sakrai mataji
Shyamgarh
Baral
Sagarwa
12 15 19 23 26 30 33 37 41 44 48 51 55 58 62 66 69 73 76


RESIDUAL ANOMALY DERIVED FROM MAGNETIC DATA
SIKAR DISTRICT,RAJASTHAN
75°20′
75°25′
75°30′
27°34′
27°36′
27°38′
27°40′
27°42′
27°44′
2.5 0 2.5 5 7.5
(kilometers)
WGS 84 / India zone IIb
Udaipur
Nangal
Chirana
Kirodi
Golyana
Lohargal
Kot
Raghunathgarh
Dhawpinora
Bhagawa
Sawli
Sakrai mataji
Shyamgarh
Baral
Sagarwa
-105 -54 -38 -28 -22 -16 -11 -8 -4 -1 2 4 5 7 9 11 16 22 32 50 85

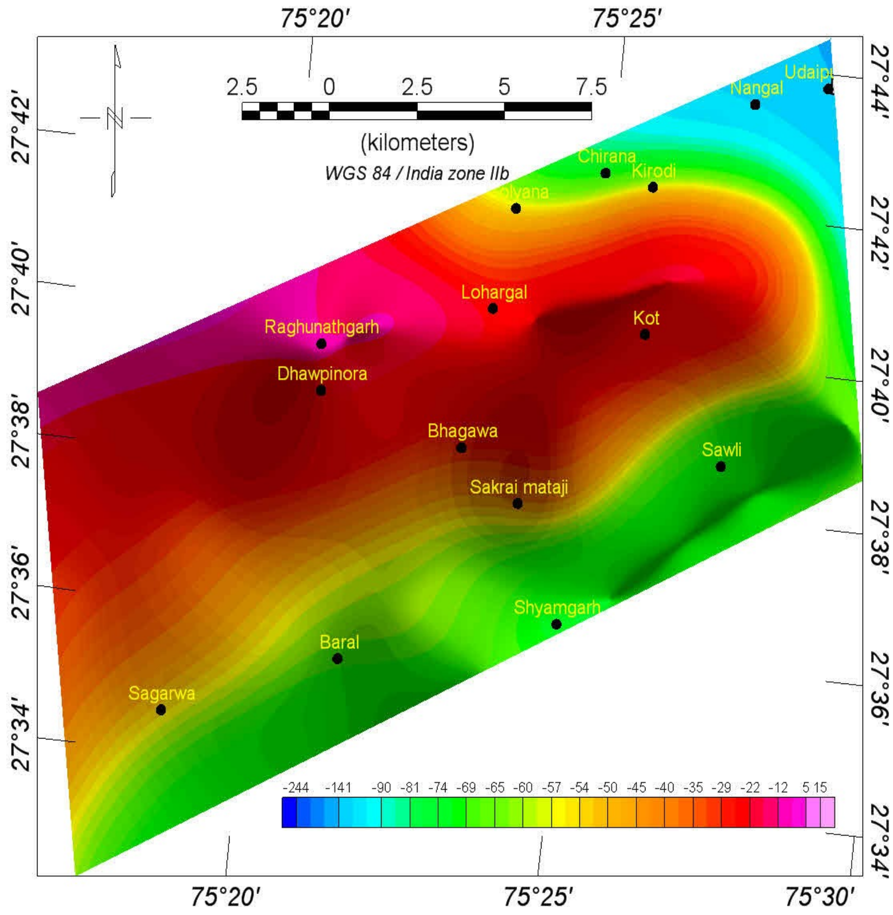
REGIONAL ANOMALY DERIVED FROM MAGNETIC DATA

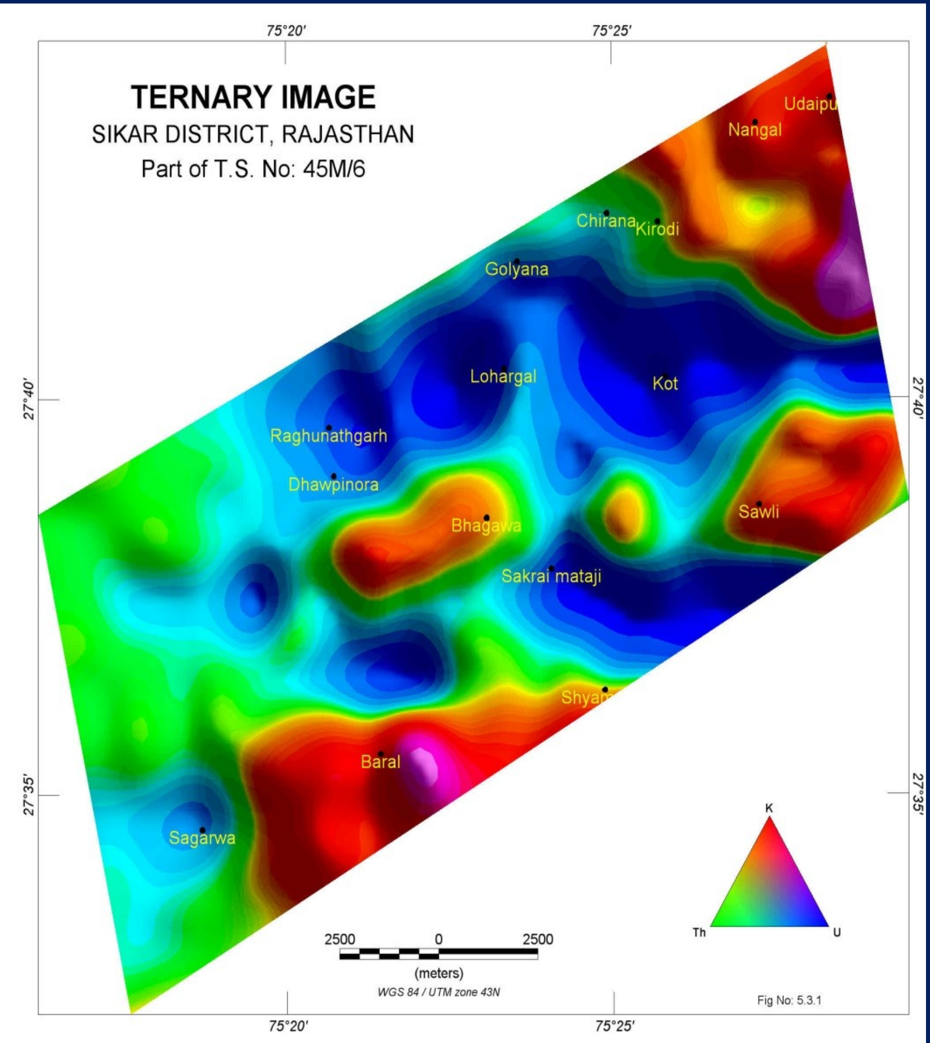
SIKAR DISTRICT,RAJASTHAN

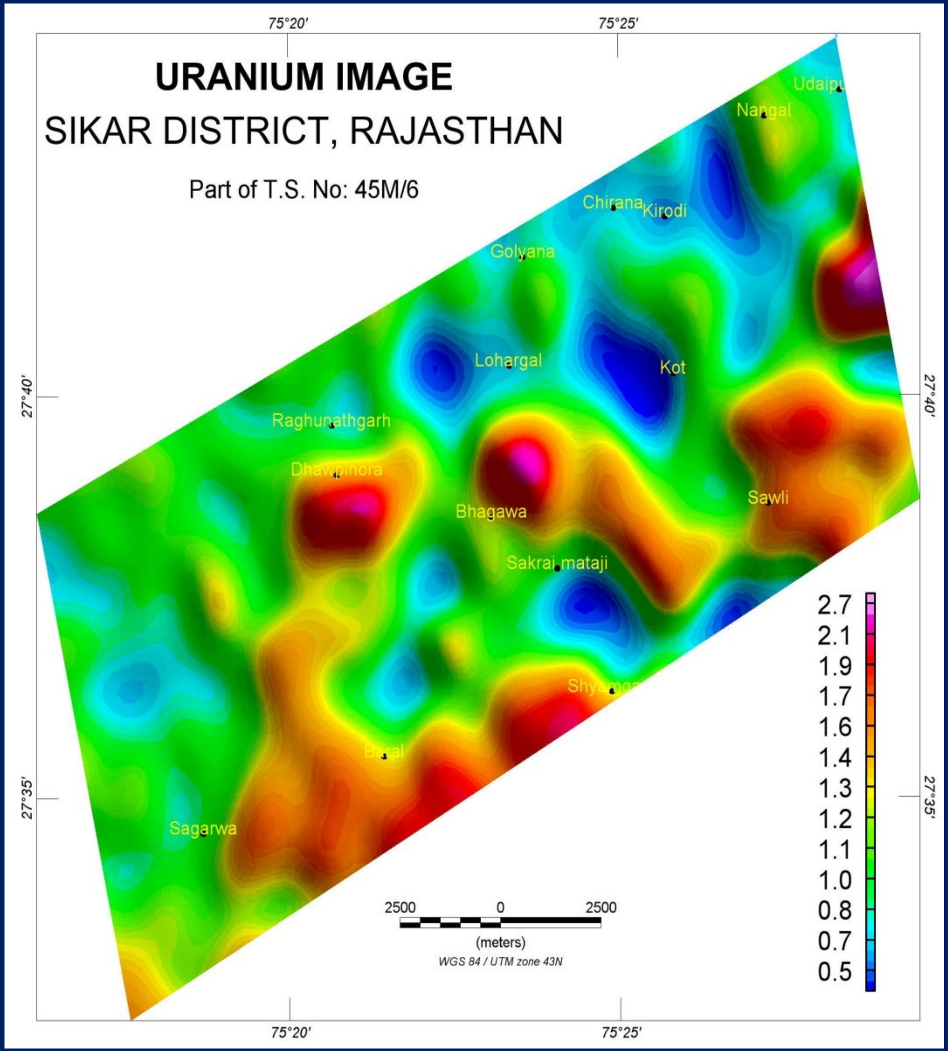


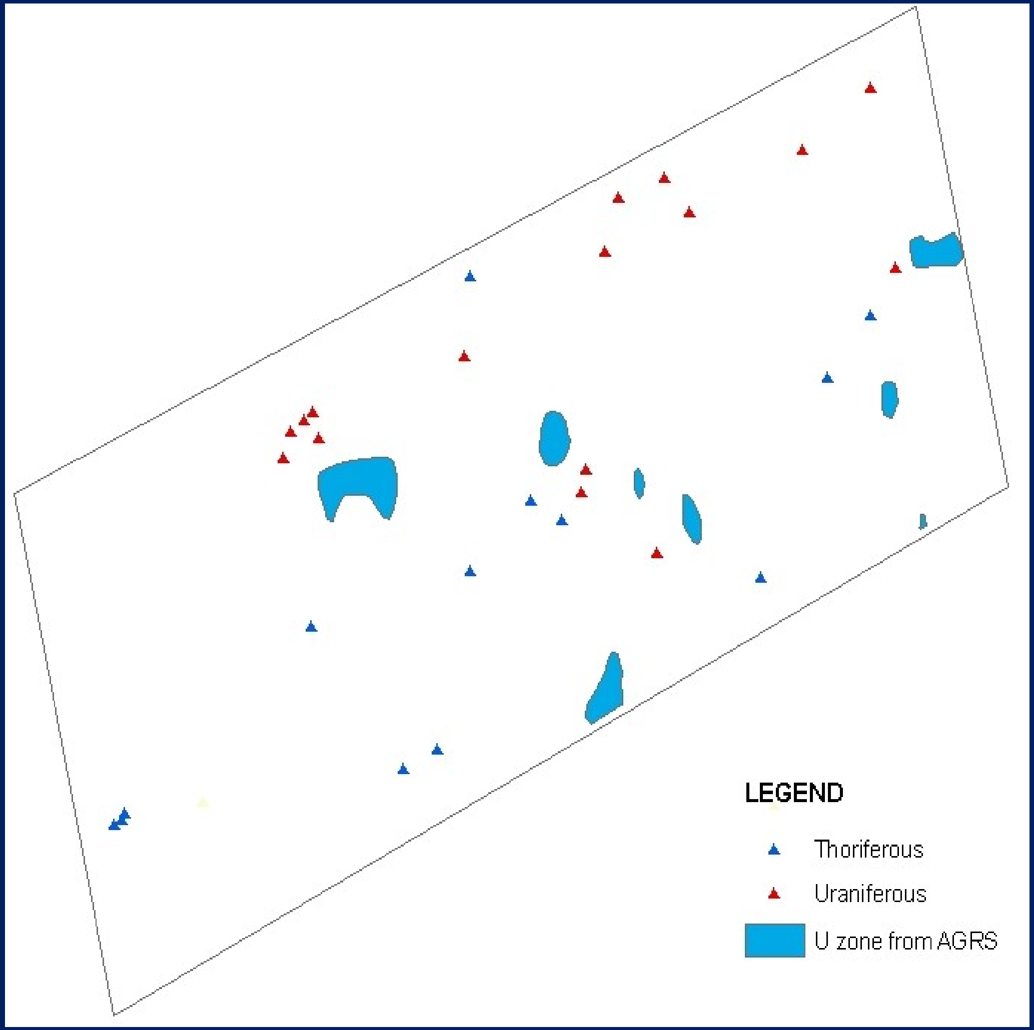
UPWARD CONTINUATION IMAGE

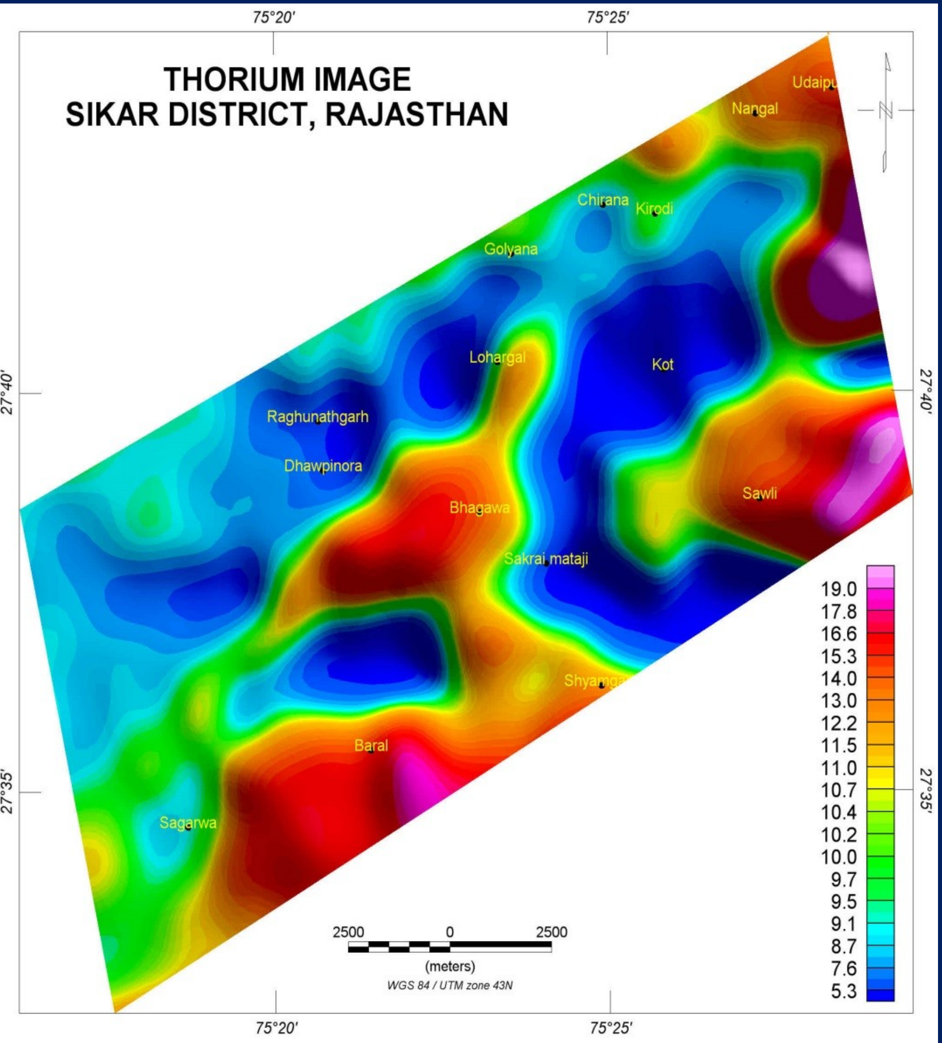
SIKAR DISTRICT,RAJASTHAN

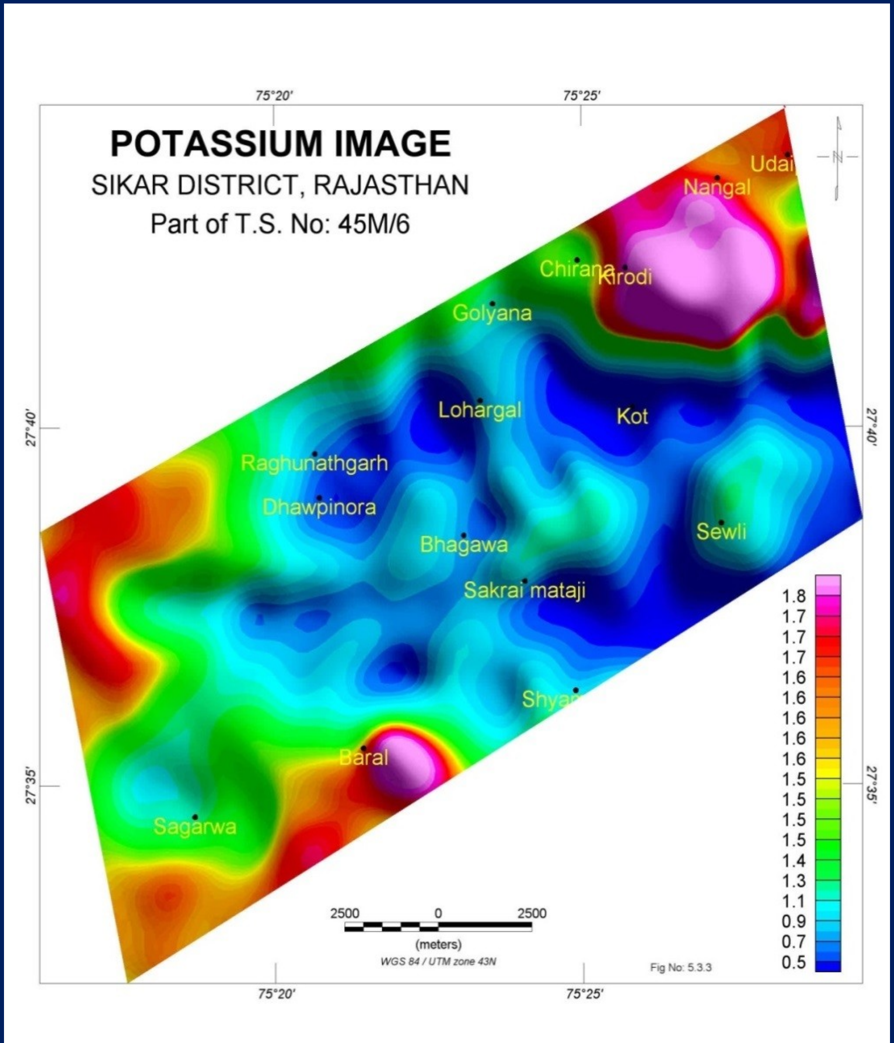


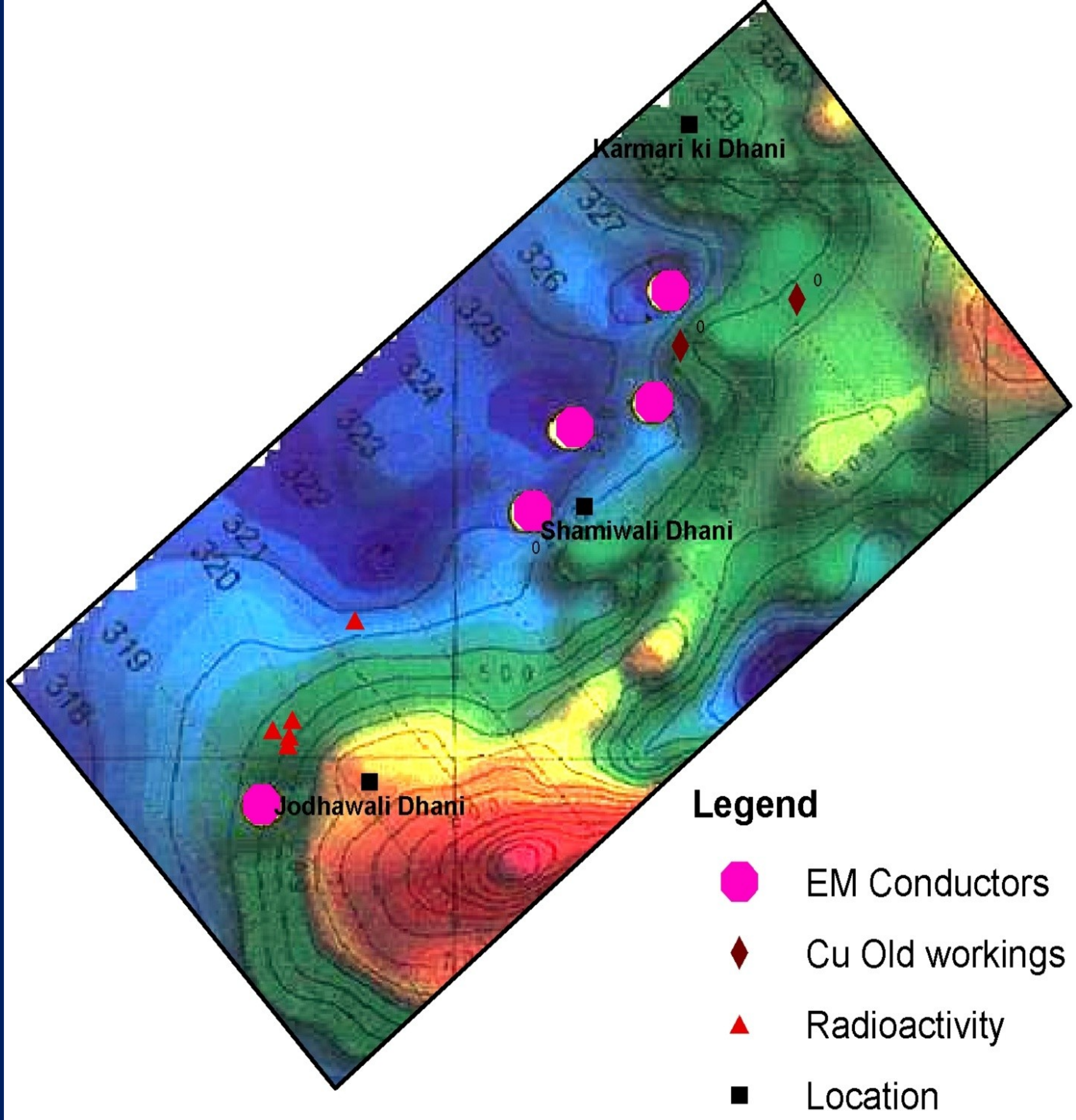

TERNARY IMAGE
SIKAR DISTRICT, RAJASTHAN
Part of T.S. No: 45M/6
75°20'
75°25'
27°40'
27°35'
Udaipu
Nangal
Chirana
Kirodi
Golyana
Lohargal
Kot
Raghunathgarh
Dhawpinora
Bhagawa
Sawli
Sakrai mataji
Shyam
Baral
Sagarwa
K
Th
U
2500
0
2500
(meters)
WGS 84 / UTM zone 43N
Fig No: 5.3.1

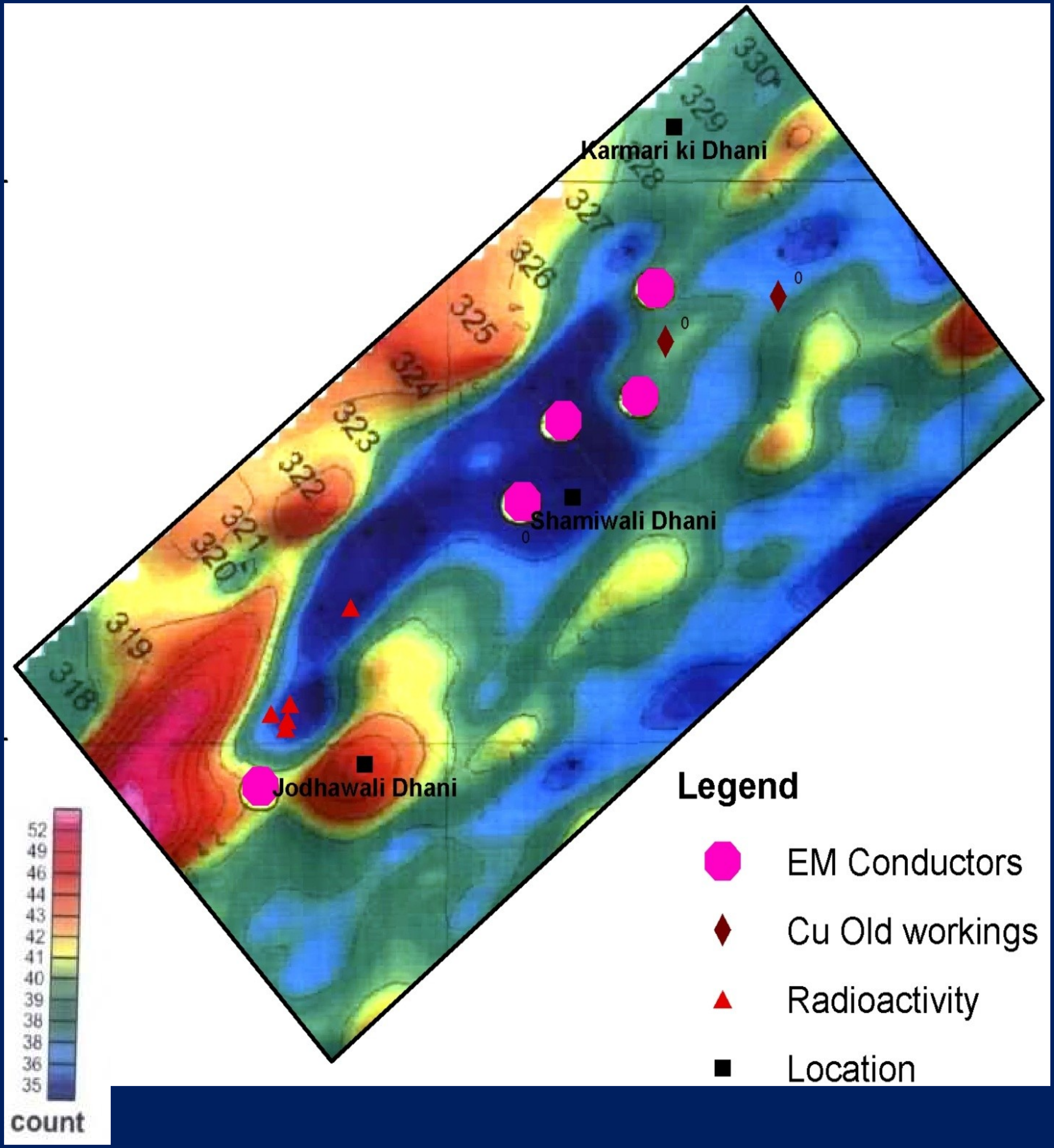

URANIUM IMAGE
SIKAR DISTRICT, RAJASTHAN
Part of T.S. No: 45M/6
75°20'
75°25'
27°40'
27°35'
Udaipu
Nangal
Chirana
Kirodi
Golyana
Lohargal
Kot
Raghunathgarh
Dhawpinora
Bhagawa
Sawli
Sakrai mataji
Shyamga
Baral
Sagarwa
2.7
2.1
1.9
1.7
1.6
1.4
1.3
1.2
1.1
1.0
0.8
0.7
0.5
2500
0
2500
(meters)
WGS 84 / UTM zone 43N


LEGEND
Thoriferous
Uraniferous
U zone from AGRS

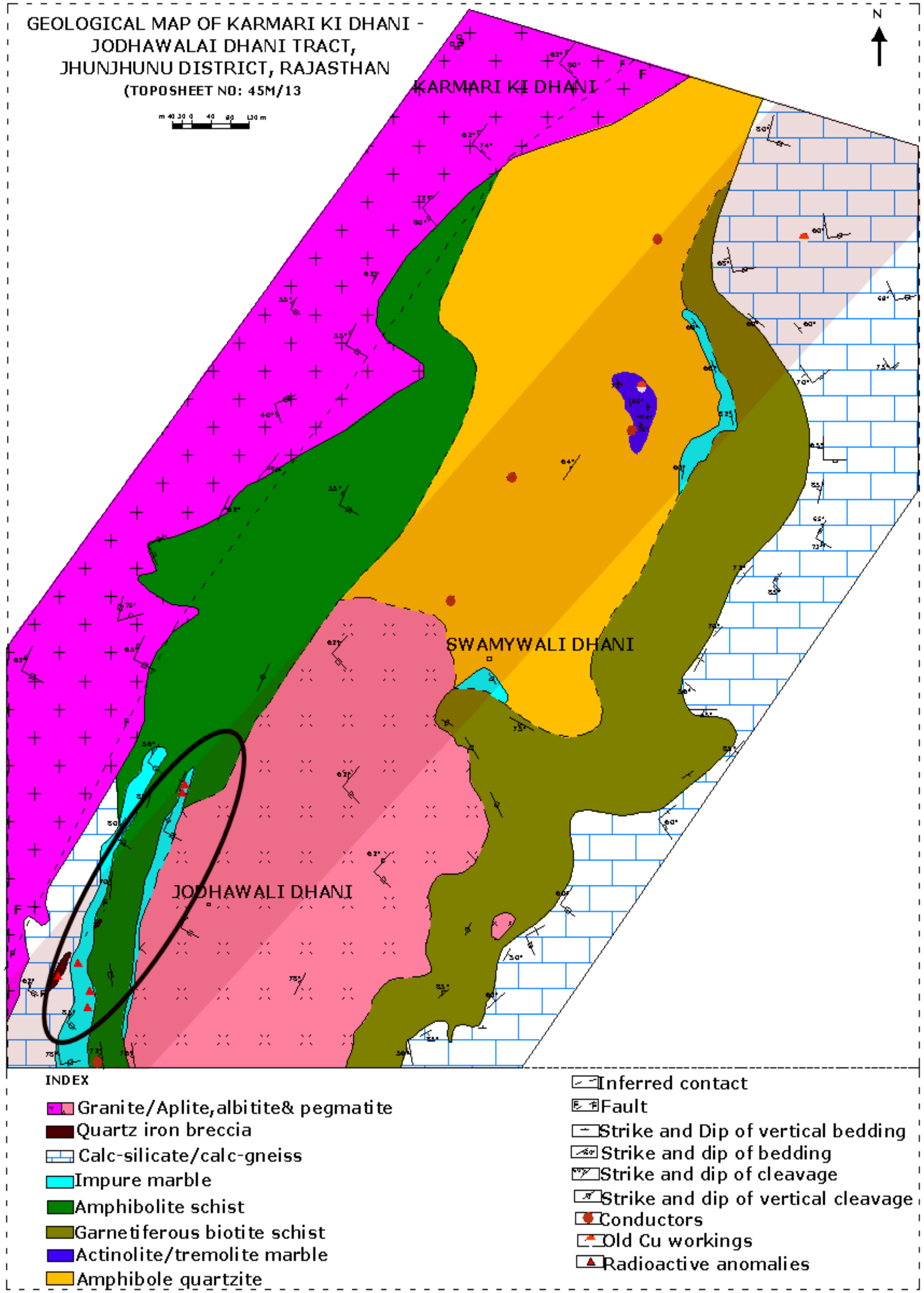

THORIUM IMAGE
SIKAR DISTRICT, RAJASTHAN
75°20'
75°25'
27°40'
27°35'
Udaipu
Nangal
Chirana
Kirodi
Golyana
Lohargal
Kot
Raghunathgarh
Dhawpinora
Bhagawa
Sawli
Sakrai mataji
Shyamga
Baral
Sagarwa
19.0
17.8
16.6
15.3
14.0
13.0
12.2
11.5
11.0
10.7
10.4
10.2
10.0
9.7
9.5
9.1
8.7
7.6
5.3
2500 0 2500
(meters)
WGS 84 / UTM zone 43N


POTASSIUM IMAGE
SIKAR DISTRICT, RAJASTHAN
Part of T.S. No: 45M/6
75°20'
75°25'
27°40'
27°35'
Udai
Nangal
Chirana
Kirodi
Golyana
Lohargal
Kot
Raghunathgarh
Dhawpinora
Bhagawa
Sewli
Sakrai mataji
Shya
Baral
Sagarwa
1.8
1.7
1.7
1.7
1.6
1.6
1.6
1.6
1.6
1.5
1.5
1.5
1.5
1.4
1.3
1.1
0.9
0.7
0.5
2500 0 2500
(meters)
WGS 84 / UTM zone 43N
Fig No: 5.3.3


Karmari ki Dhani
Shamiwali Dhani
Jodhawali Dhani
330
329
327
326
325
324
323
322
321
320
319
318
Legend
EM Conductors
Cu Old workings
Radioactivity
Location



330
329
Karmari ki Dhani
328
327
326
325
324
323
322
321
320
319
318
Shamiwali Dhani
Jodhawali Dhani
52
49
46
44
43
42
41
40
39
38
38
36
35
count
Legend
EM Conductors
Cu Old workings
Radioactivity
Location

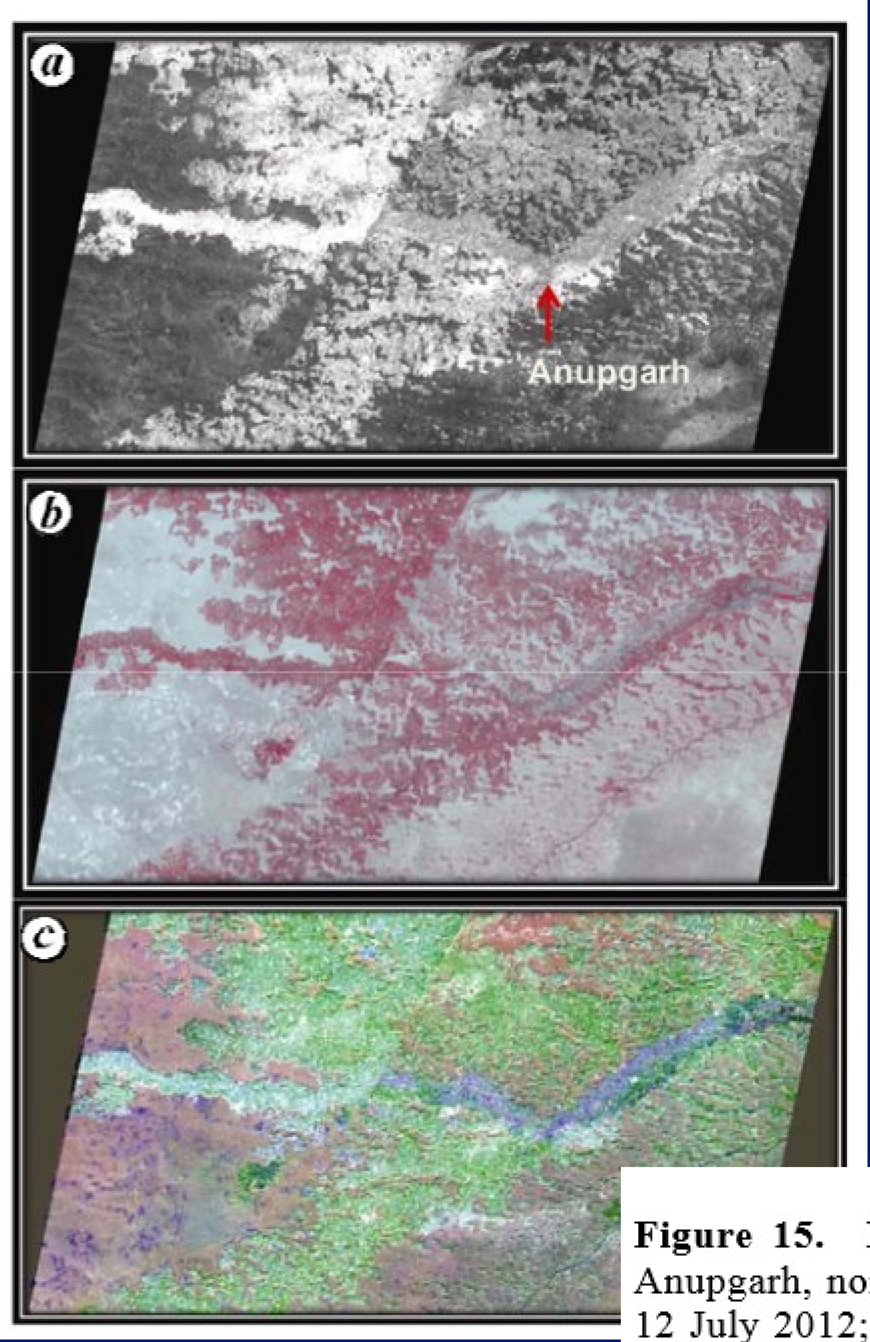

GEOLOGICAL MAP OF KARMARI KI DHANI - JODHAWALAI DHANI TRACT, JHUNJHUNU DISTRICT, RAJASTHAN
(TOPOSHEET NO: 45M/13)
N
KARMARI KI DHANI
SWAMYWALI DHANI
JODHAWALI DHANI
INDEX
Granite/Aplite,albitite& pegmatite
Quartz iron breccia
Calc-silicate/calc-gneiss
Impure marble
Amphibolite schist
Garnetiferous biotite schist
Actinolite/tremolite marble
Amphibole quartzite
Inferred contact
Fault
Strike and Dip of vertical bedding
Strike and dip of bedding
Strike and dip of cleavage
Strike and dip of vertical cleavage
Conductors
Old Cu workings
Radioactive anomalies

Microwave Remote Sensing in Mineral Exploration

- Imaging radars provide information that is fundamentally different from sensors that operate in the visible and infrared portions of the electromagnetic spectrum.
- One of the unique potentials demonstrated by spaceborne radar images is their penetration capability through shallow sand cover in arid regions and detecting subsurface geological and archaeological features, in particular buried river channels and imprints of archaeological sites occurring in the adjoining areas.

- The capability of the L-band (wavelength 24.5 cm) to penetrate 1–2 m of loose sand and return information about geologic and geomorphologic features covered by sand.
- The benefit of radar images to study bedrock features beneath few meters of loose sand.

- Ancient drainage pattern cut in the bedrock is not visible in the optical images because of the sand cover.
- The buried palaeo drainage network appears as dark features due to smoother channel fillings.
- It is also identified due to contrasting brightness of hard substrate of the adjoining region



The analysis of SAR data covering parts of Thar Desert in western Rajasthan led to identification of previously unknown buried channels, relict valleys and shallow, sand-covered limestone areas.

Figure 15. Parts of the palaeochannel of the lost Sarasvati around Anupgarh, northern Rajasthan as seen on (*a*) RISAT SAR acquired on 12 July 2012; (*b*) Landsat ETM FCC and (*c*) FCC of RISAT SAR and Landsat ETM merged product.

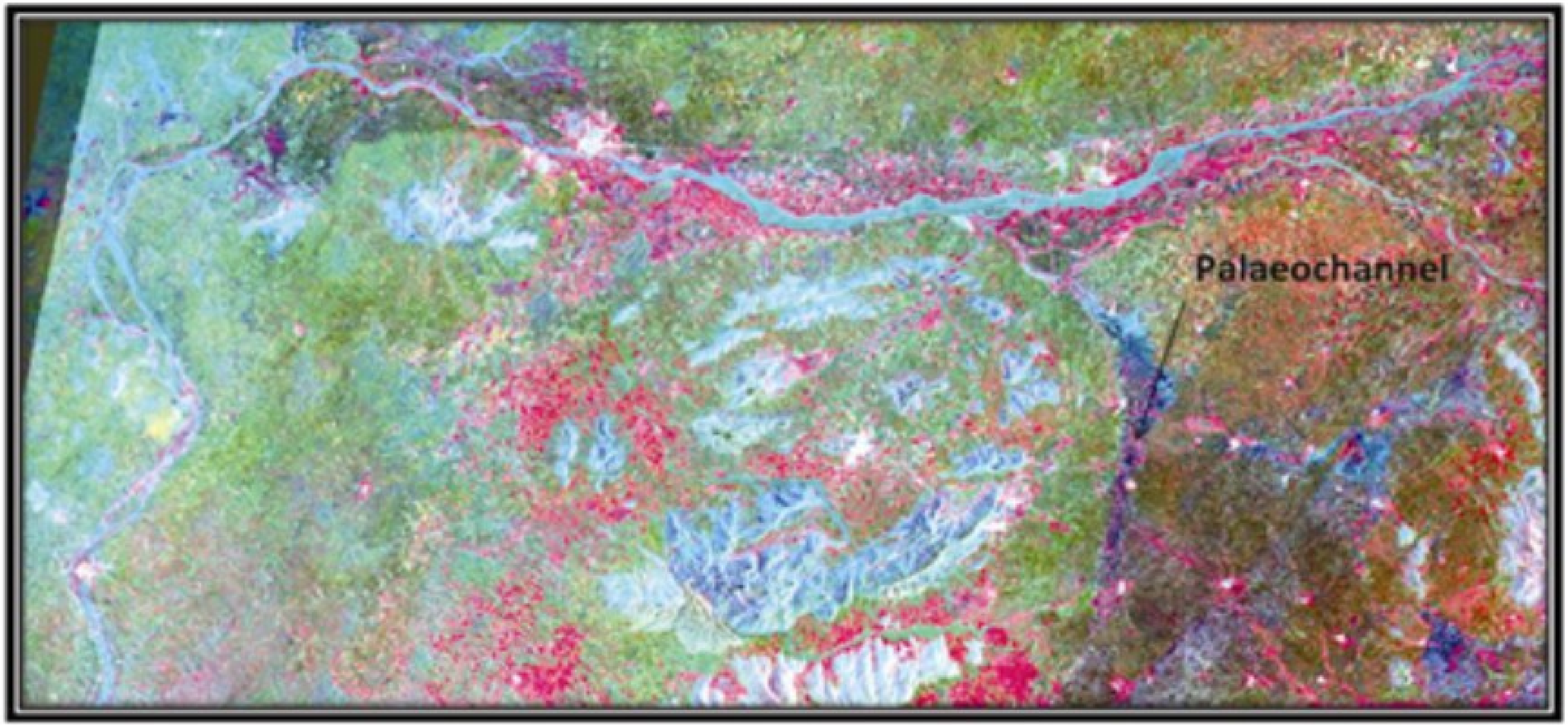


Figure 16. Palaeochannel detected on RISAT SAR and Landsat ETM merged FCC covering parts of Barmer, Jalor and Pali districts in the southern region of Luni River.

Landsat Thematic Mapper (TM)

Band 1 (0.45 - 0.52u m): It is capable of differentiating soil and rock surfaces from vegetation and for detecting cultural features.

Band 2 (0.52 - 0.60u m): it is sensitive to water turbidity differences; it highlighted the turbid water in the Lake. Because it covers the green reflectance peak from leaf surfaces, it has separated vegetation (forest, croplands with standing crops) from soil. In this band barren lands urban areas and roads and highways have appeared as brighter (lighter) tone, but forest, vegetation, bare croplands, croplands with standing crops have appeared as dark (black) tone.

Band 3 (0.63 - 0.69u m): senses in a strong chlorophyll absorption region and strong reflectance region for most soils. It has discriminated vegetation and soil. But it couldn�t separated water and forest. Forest land and water both have appeared as dark tone. This band has highlighted barren lands, urban areas, street pattern in the urban area and highways. It has also separated croplands with standing crops from bare croplands with stubble.

Band 4 (0.76 - 0.90u m): To distinguish vegetation varieties and conditions. Because water is a strong absorber of near IR, this band has delineated water bodies (lakes and sinkholes), distinguished between dry and moist soils (barren land and croplands). In this band croplands and grasslands have showed higher reflectance (brighter tone) than the forest. This band has also separated croplands from bare croplands.

Since standing crops (vegetation) has higher reflectance in the near IR region, they have appeared as brighter tone and due to presence of moisture content in the bare croplands, they have appeared as darker tone. In the band 4 barren lands, urban areas and highways have not been highlighted and they appeared as dark tone. Band 4 is useful for crop identification and emphasizes soil-crop and land-water contrast.

Band 5 (1.55 - 1.75um): is sensitive to the turgidity or amount of water in plants. Band 5 has separated forest lands, croplands, water body distinctly. Forests have appeared as comparatively darker tone than the croplands (light gray).Band 5 has separated water body (dark tone) from barren lands, croplands, and grass lands (lighter tone). Since urban area and croplands have responded almost in same spectral reflectance band 5 could not be able to separate these areas.

Band 7 (2.08 -2.35um): has separated land and water sharply. Band 7 has strong water absorption region and strong reflectance region for soil and rock. Urban area, croplands, highways, bare croplands have appeared as bright tone and water body, forest have appeared as dark tone.

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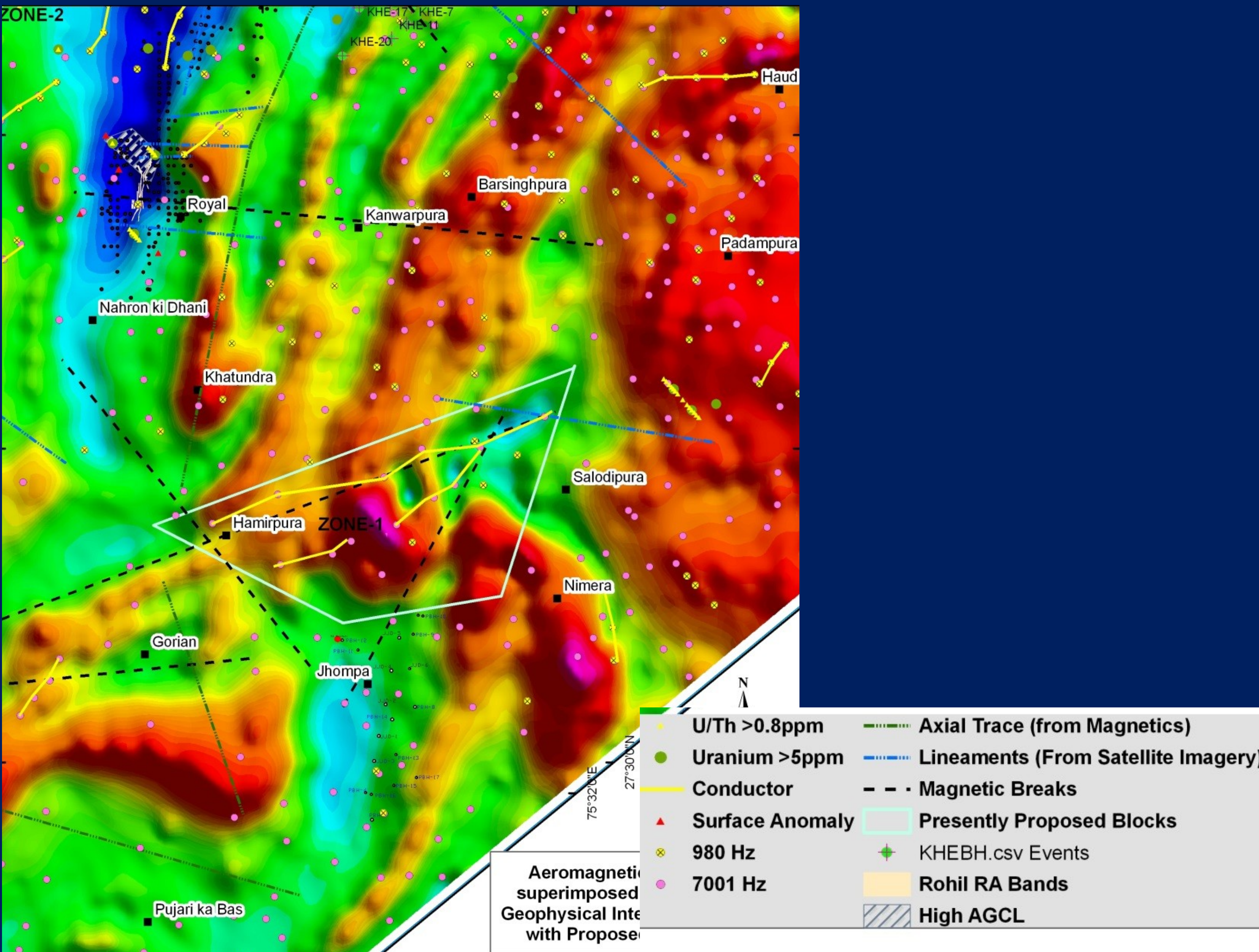
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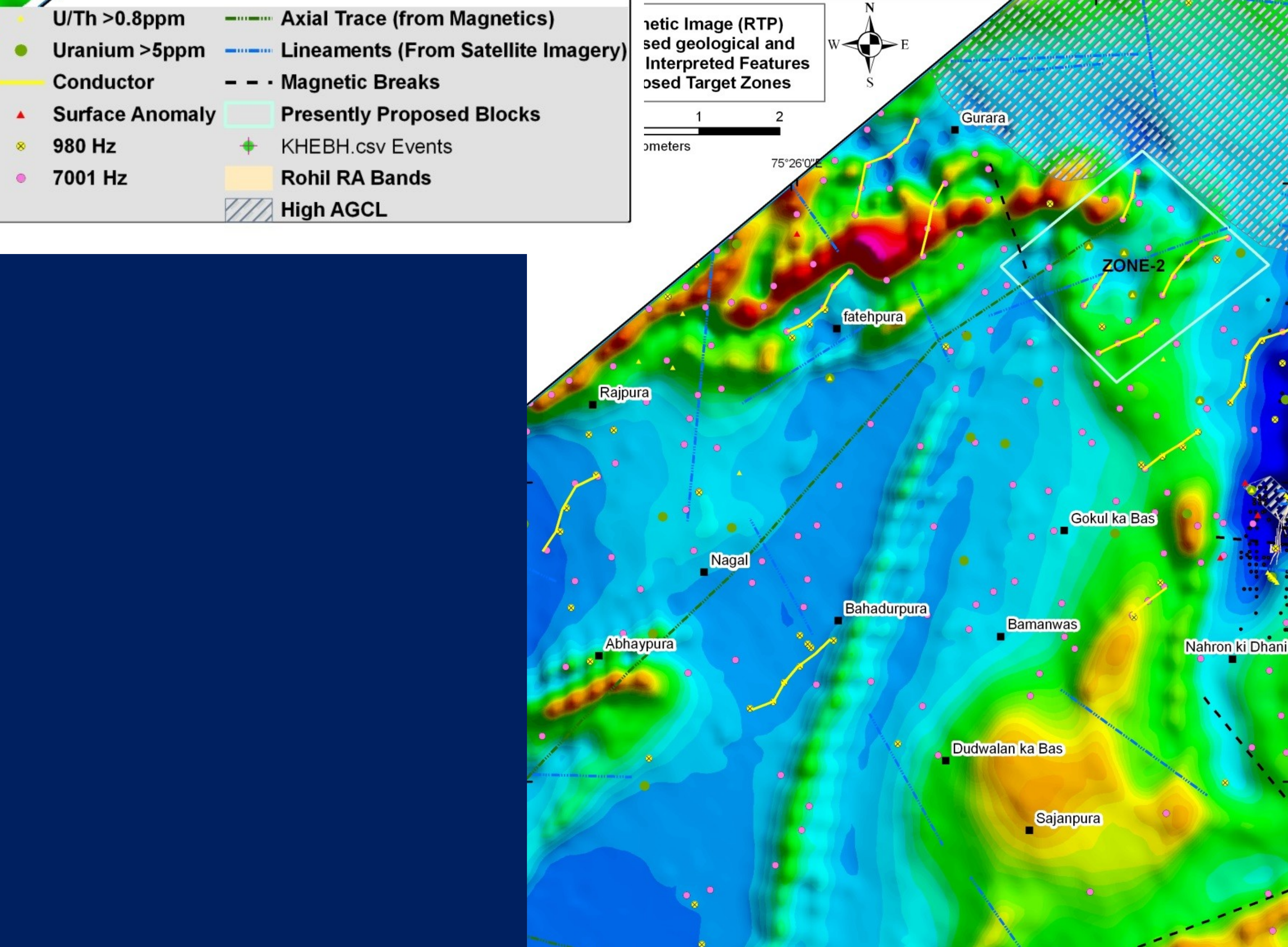
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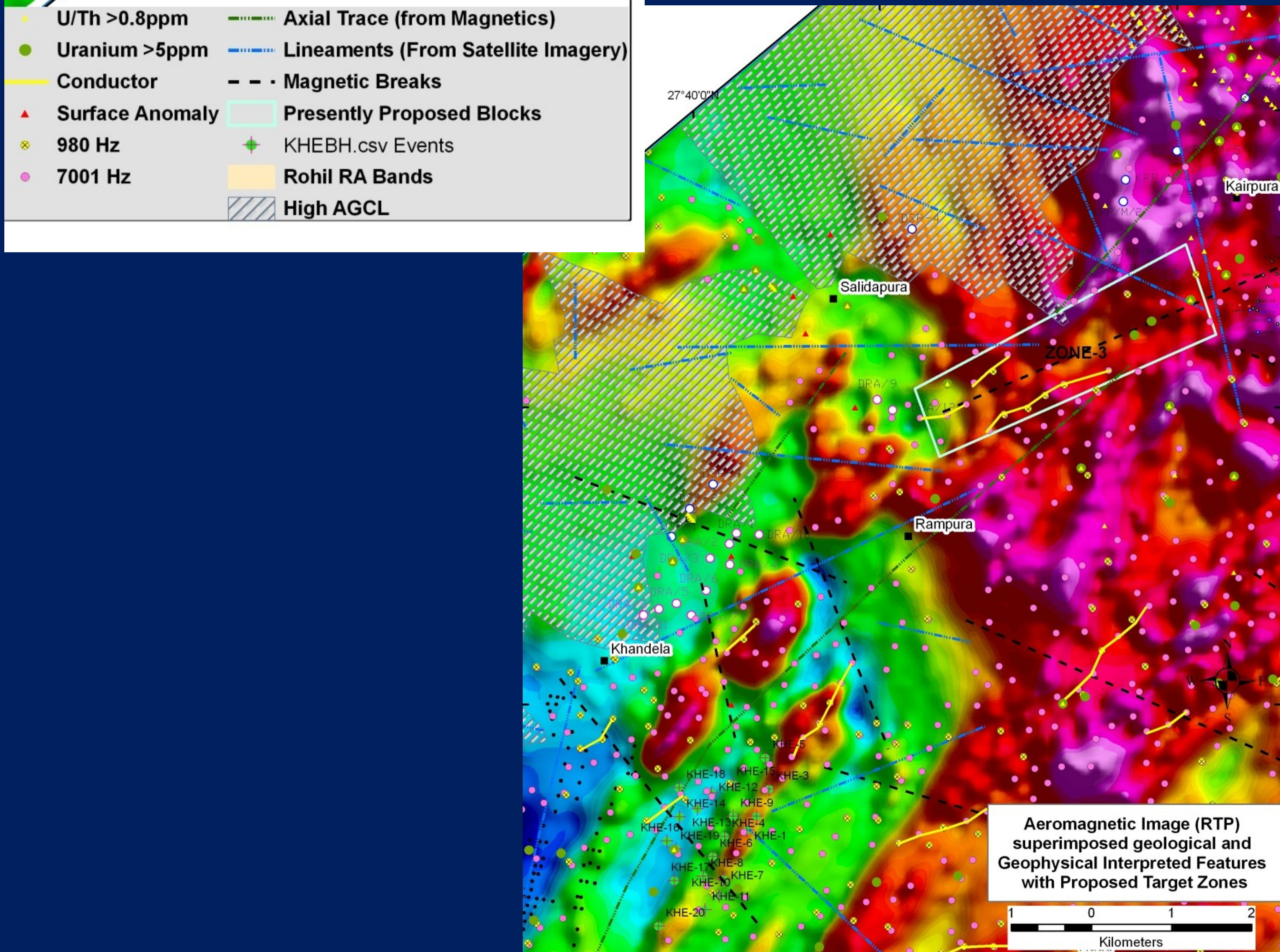
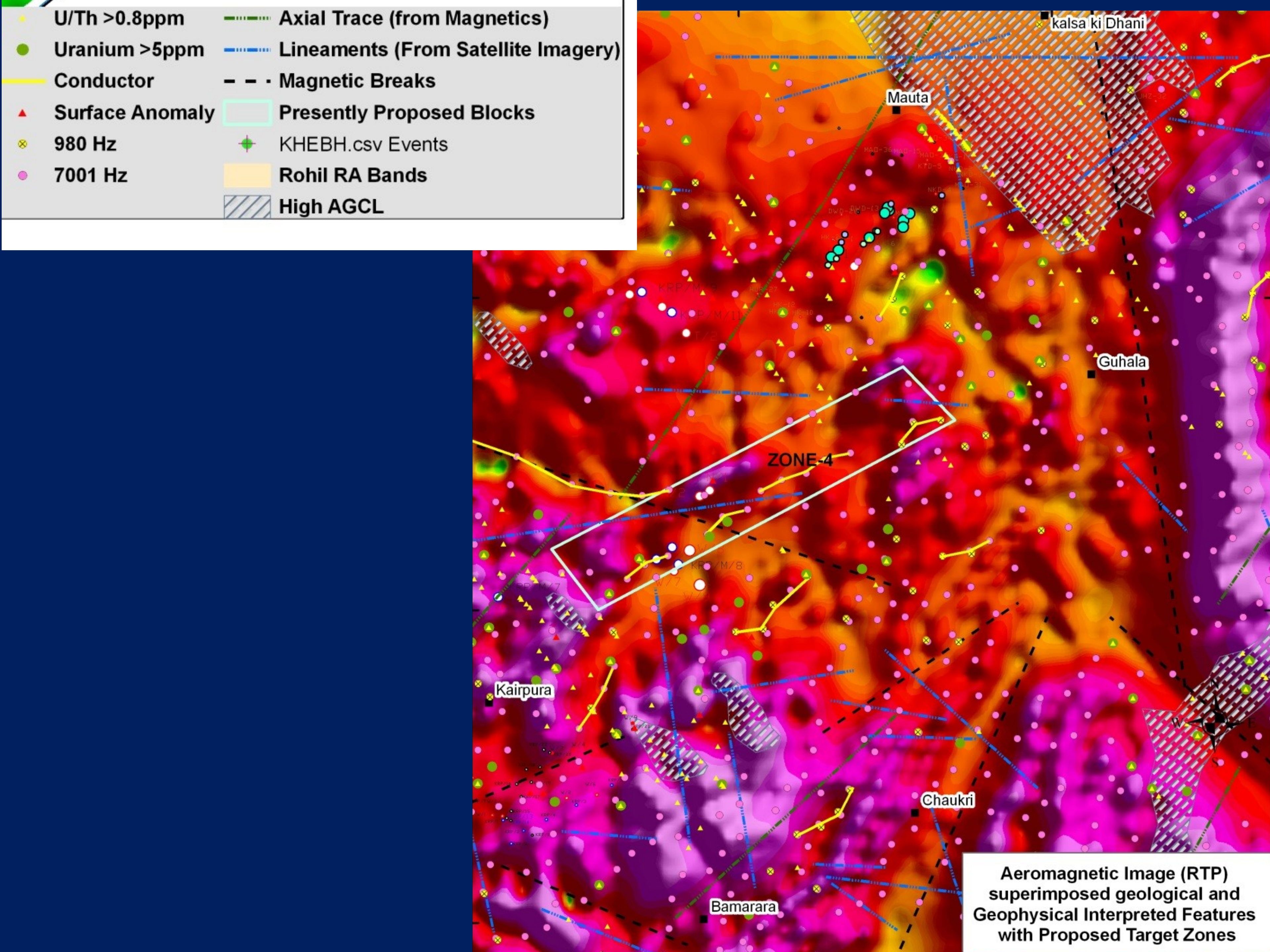


Aeromagnetic Image (RTP) superimposed geological and Geophysical Interpreted Features with Proposed Target Zones



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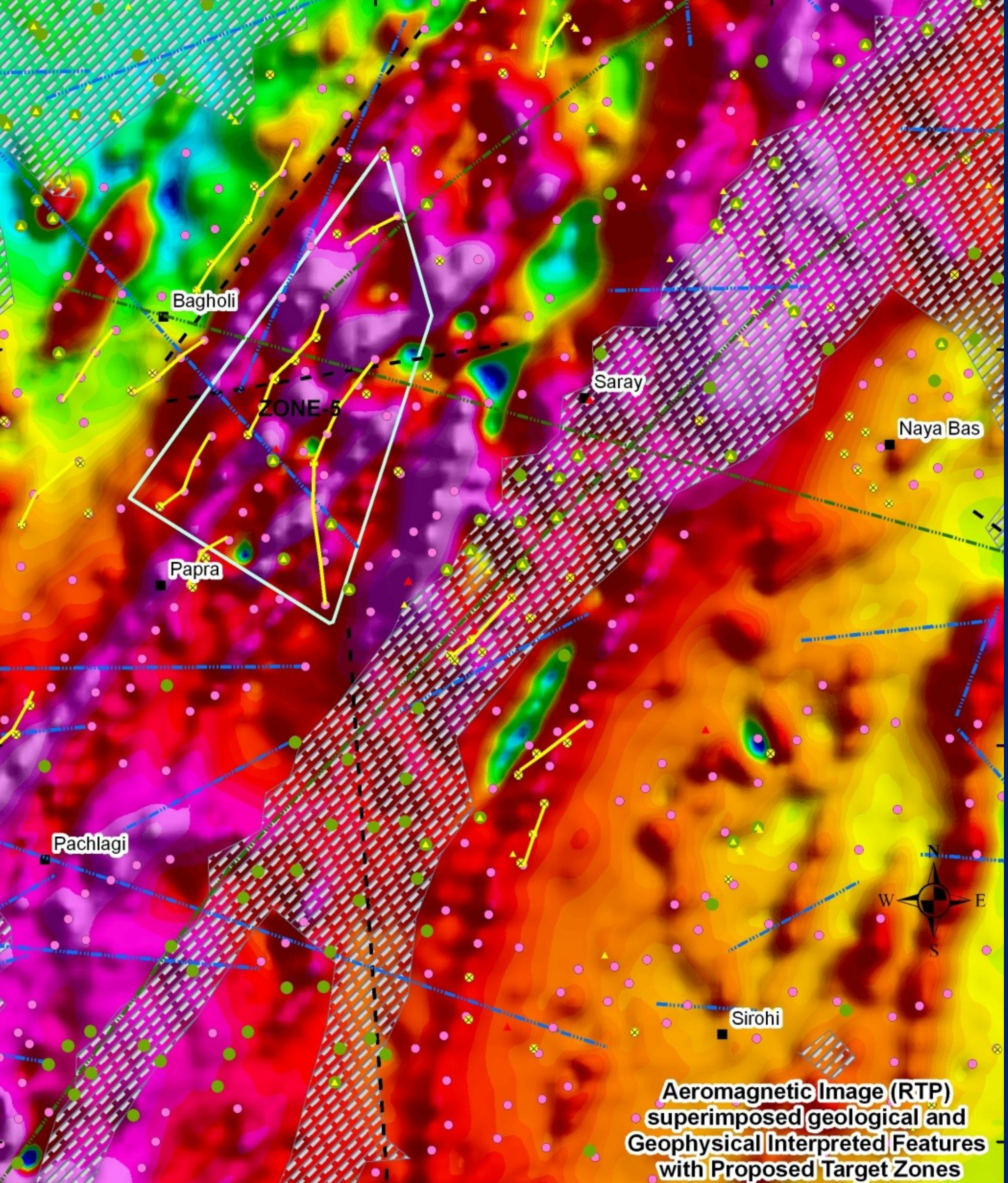
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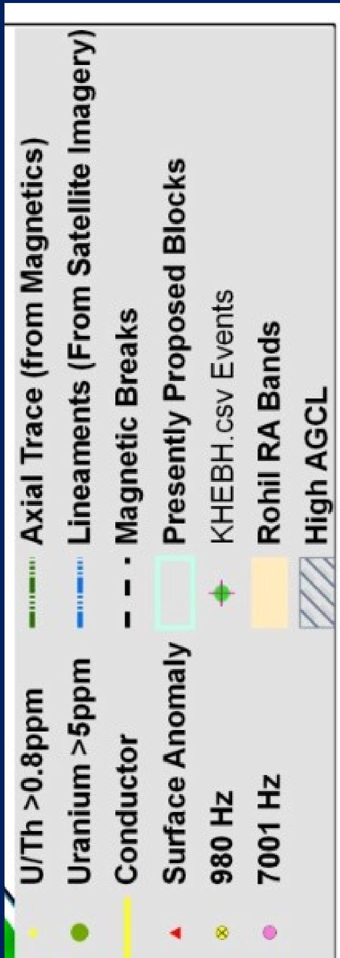
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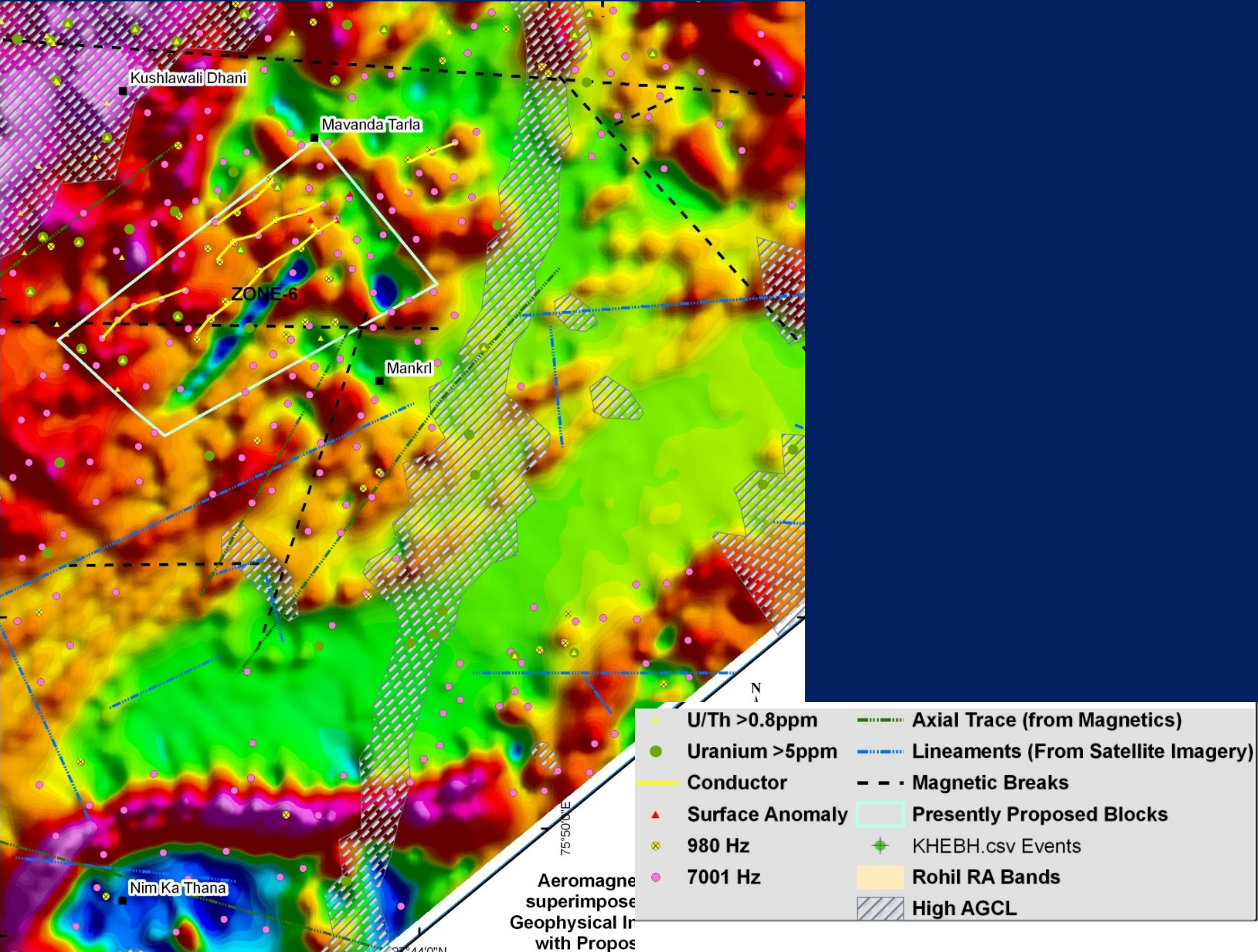

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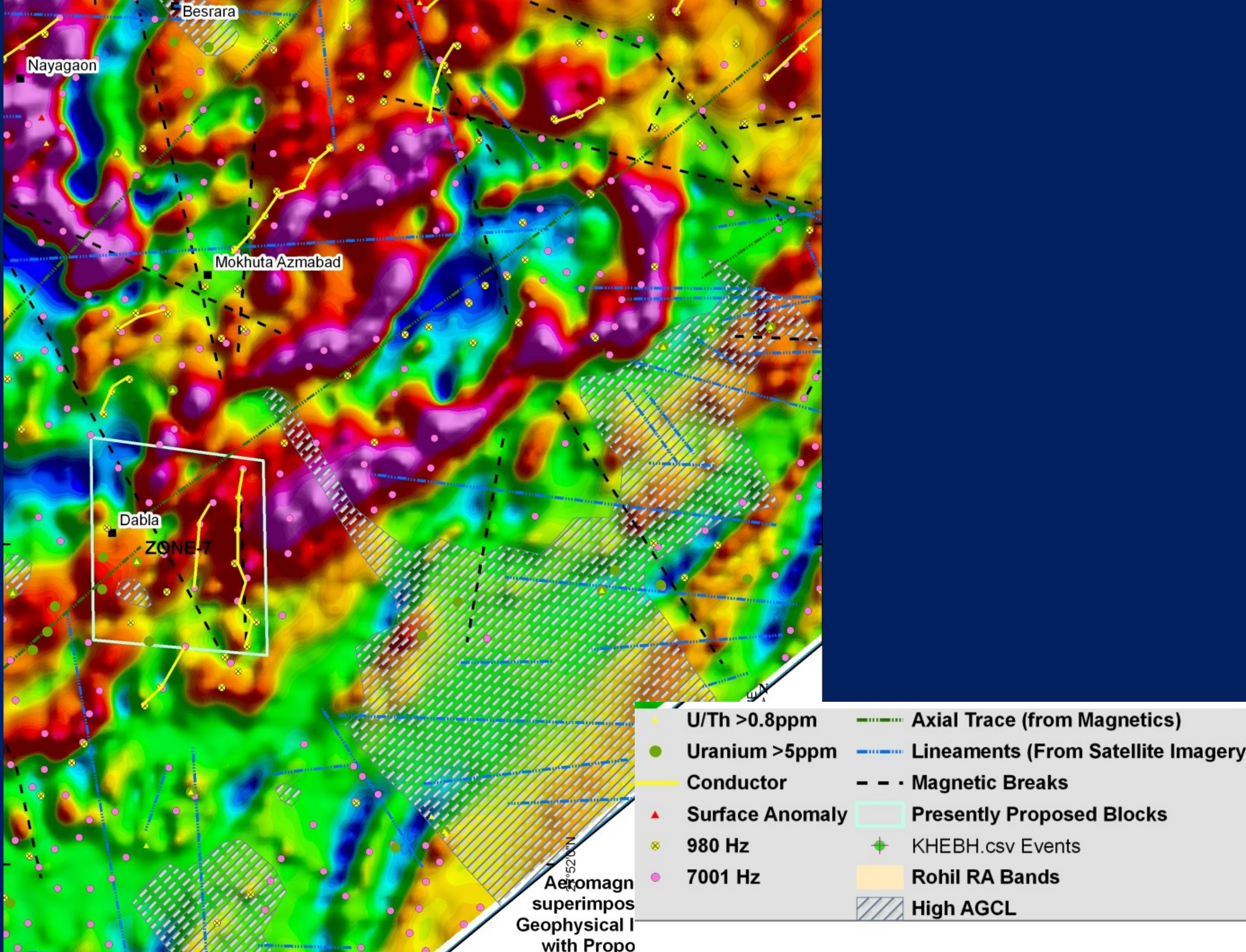
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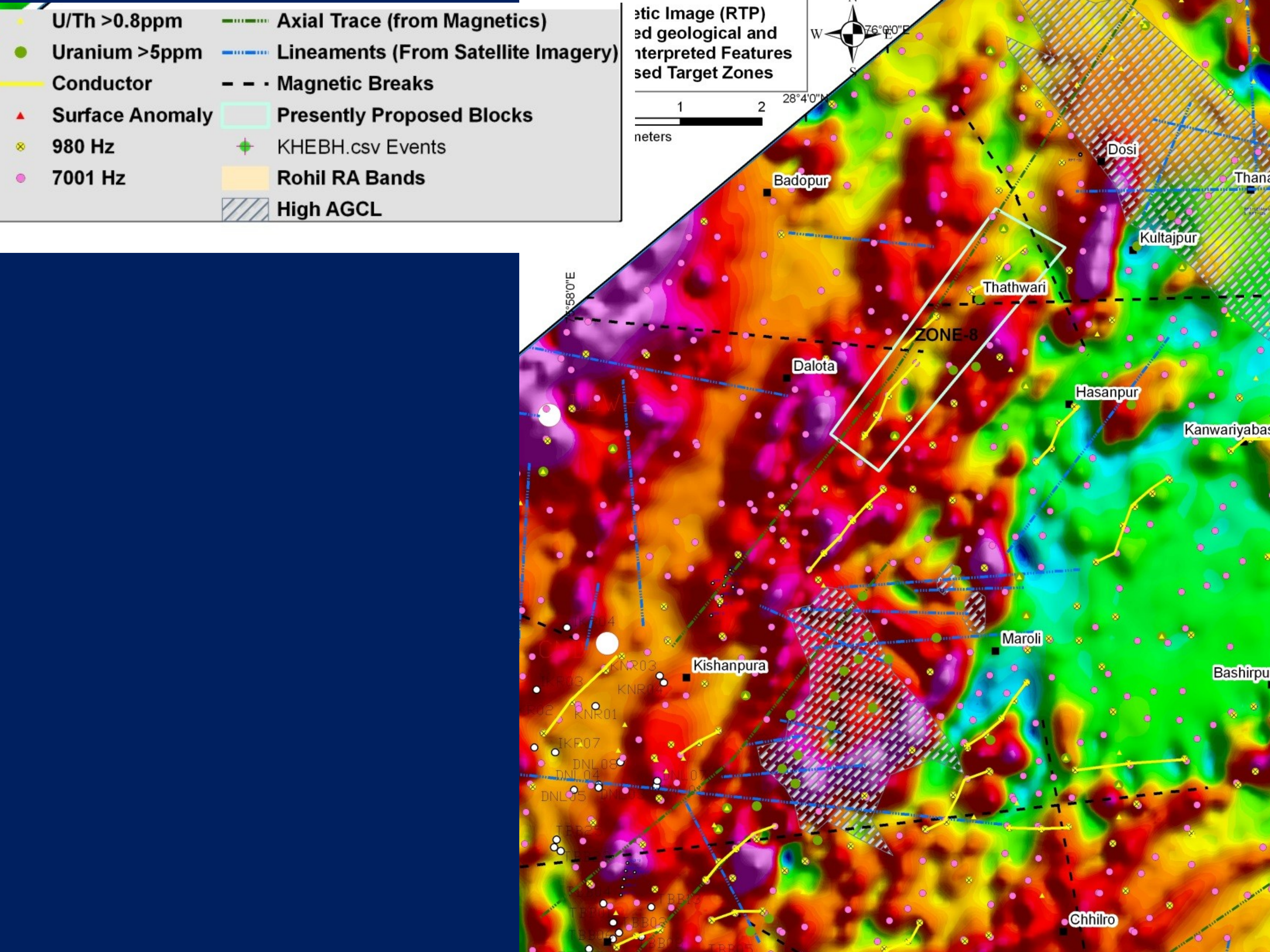
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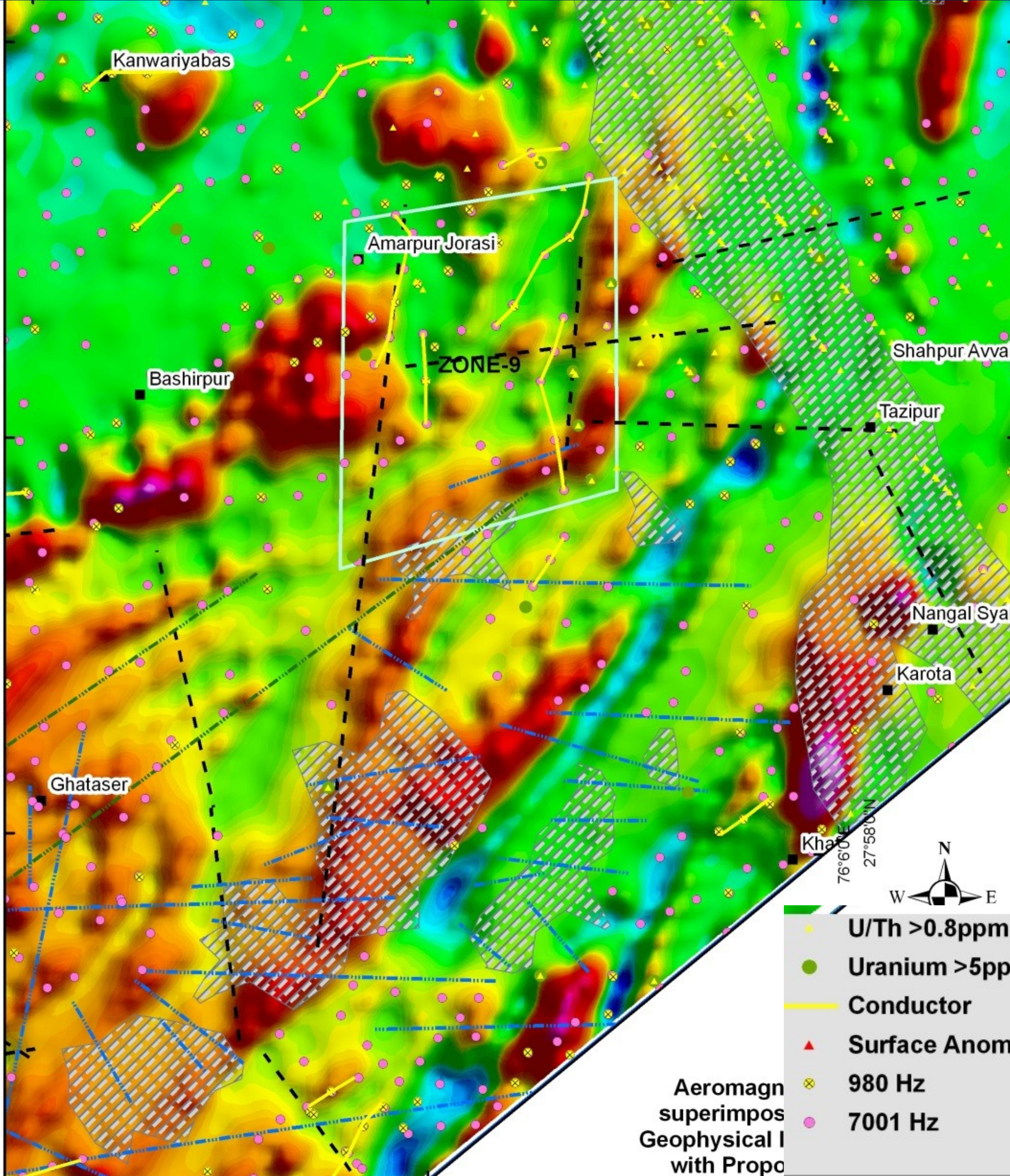

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<table>
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<tr><th colspan="2">Magnetic Image</th><th rowspan="2">Satellite Image</th><th rowspan="2">AGRS</th><th rowspan="2">Ground</th></tr>
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</table>

Zone	Presence of conductors	Lineaments (inferred from)			Uranium Anomaly		Other favourable criteria, if any
		Magnetic Image		Satellite Image	AGRS	Ground	
		Break/ Fault	Axial trace				
1	✓	✓	6	✓	6	6	
2	✓	6	✓	✓	✓	6	
3	✓	✓	6	✓	✓	6	
4	✓	✓	6	✓	✓	✓	RA wells
5	✓	✓	✓	✓	✓	✓	
6	✓	✓	6	6	✓	✓	
7	✓	✓	✓	6	✓	6	
8	✓	✓	✓	6	✓	6	
9	✓	✓	✓	✓	✓	6	

Terrain Character	Igneous	Sedimentary	Metamorphic
Size & Dimension	Small to Medium	Larger	Moderate
Display of Terrain	Un -Controlled	Perfectly controlled	Moderate Either controlled/uncontrolled
Elevation	Varies point to point without any regularity	Varies uniformly and gradually	Moderate
Topography	Peak & Cliff	No Peaks-Cliffs	Moderate
Orientation/ Terrain	No trend/ orientation	Perfect trend/orientation	Moderate
Surface Smoothness	Rugged	Smooth	Smooth & Rugged

- **Thermal remote sensing** we measure the radiations 'emitted' from the surface of the target, as opposed to optical remote sensing where we measure the radiations 'reflected' by the target under consideration.
- It is a well known fact that all natural targets reflect as well as emit radiations.
- It is operating on 3-5 V and 8-14 μm
- Block body is a hypothetical, ideal radiator that totally absorbs and reemits all incident energy upon it.

- The ***thermal inertia*** of a rock is the measure of a surface's ability to absorb heat during the day and release it at night, and it has been used to determine the mineralogy of rocks present.
- The resistance of a material to temperature change, indicated by the time dependent variations in temperature during a full heating/cooling cycle.
- It is a measure of the response of a material to temperature change. It increases with an increase of conductivity, capacity, desity.
- The rock either to absorb or to reflect light depending on the rock's color.

- Materials with high thermal inertia have more uniform surface temperature through out the day and knight.
- Thermal Conductivity (K): It is a measure of rate at which heat passes through a materials.

Eg. Heat passes through the metal is faster than the rock

- Heat Capacity (C): It is how well the material store the heat.

THERMAL DATA OF LANDSAT ETM+

- Landsat ETM+ thermal data is a black and white image having 60m spatial resolution and 10.4 - 12.5 μm of spectral range.
- It was used to map the structural features like fold, fault and fractures / shears on 1:50,000 scales.
- Thermal data gives information about earth features based on the electromagnetic radiation, which is emitted by the earth system.

- Interpretation of this data was done on the basis of tonal and textural variation.
- Fractures can be mapped on the basis of cool linear anomalies.
- Lineaments mapped from the FCC and PAN can be modified with the help of thermal image.

Microwave Remote Sensing in Mineral Exploration

- Imaging radars provide information that is fundamentally different from sensors that operate in the visible and infrared portions of the electromagnetic spectrum.
- One of the unique potentials demonstrated by spaceborne radar images is their penetration capability through shallow sand cover in arid regions and detecting subsurface geological and archaeological features, in particular buried river channels and imprints of archaeological sites occurring in the adjoining areas.

- The capability of the L-band (wavelength 24.5 cm) to penetrate 1–2 m of loose sand and return information about geologic and geomorphologic features covered by sand.
- The benefit of radar images to study bedrock features beneath few meters of loose sand.

- The radar energy has penetrated through the shallow sand cover and subsurface igneous dykes have acted as subsurface rough surfaces and provided high backscatter to be detected by the radar sensor.
- Ancient drainage pattern cut in the bedrock is not visible in the optical images because of the sand cover.
- The buried palaeo drainage network appears as dark features due to smoother channel fillings.
- It is also identified due to contrasting brightness of hard substrate of the adjoining region

Imaging Spectroscopy.

- Spectrometers are used in the laboratory, in the field, in aircraft (looking both down at the Earth, and up into space), and on satellites.
- Reflectance and emittance spectroscopy of natural surfaces are sensitive to specific chemical bonds in materials, whether solid, liquid or gas.
- Spectroscopy has the advantage of being sensitive to both crystalline and amorphous materials.
- Spectroscopy's historical disadvantage is that it is too sensitive to small changes in the chemistry and/or structure of a material.
- The variations in material composition often causes shifts in the position and shape of absorption bands in the spectrum.
- Thus, with the vast variety of chemistry typically encountered in the real world, spectral signatures can be quite complex and sometimes unintelligible.

- **With the advances in computer and detector technology, the new field of imaging spectroscopy is developing**

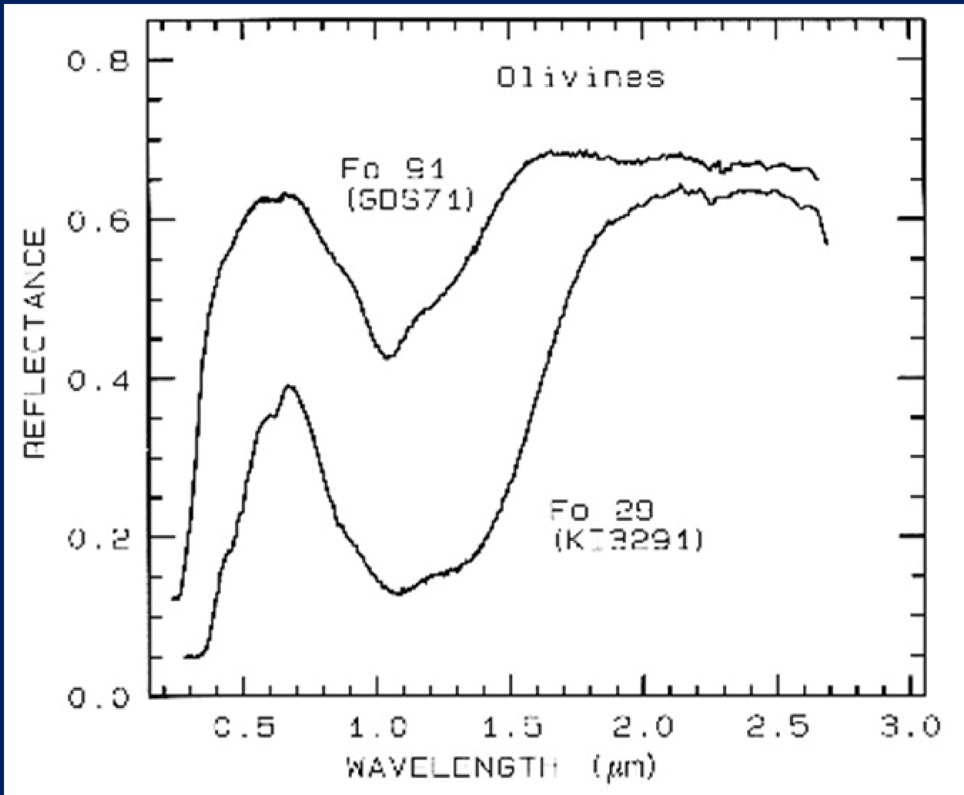
- **Imaging spectroscopy is a new technique for obtaining a spectrum in each position of a large array of spatial positions so that any one spectral wavelength can be used to make a recognizable image.**

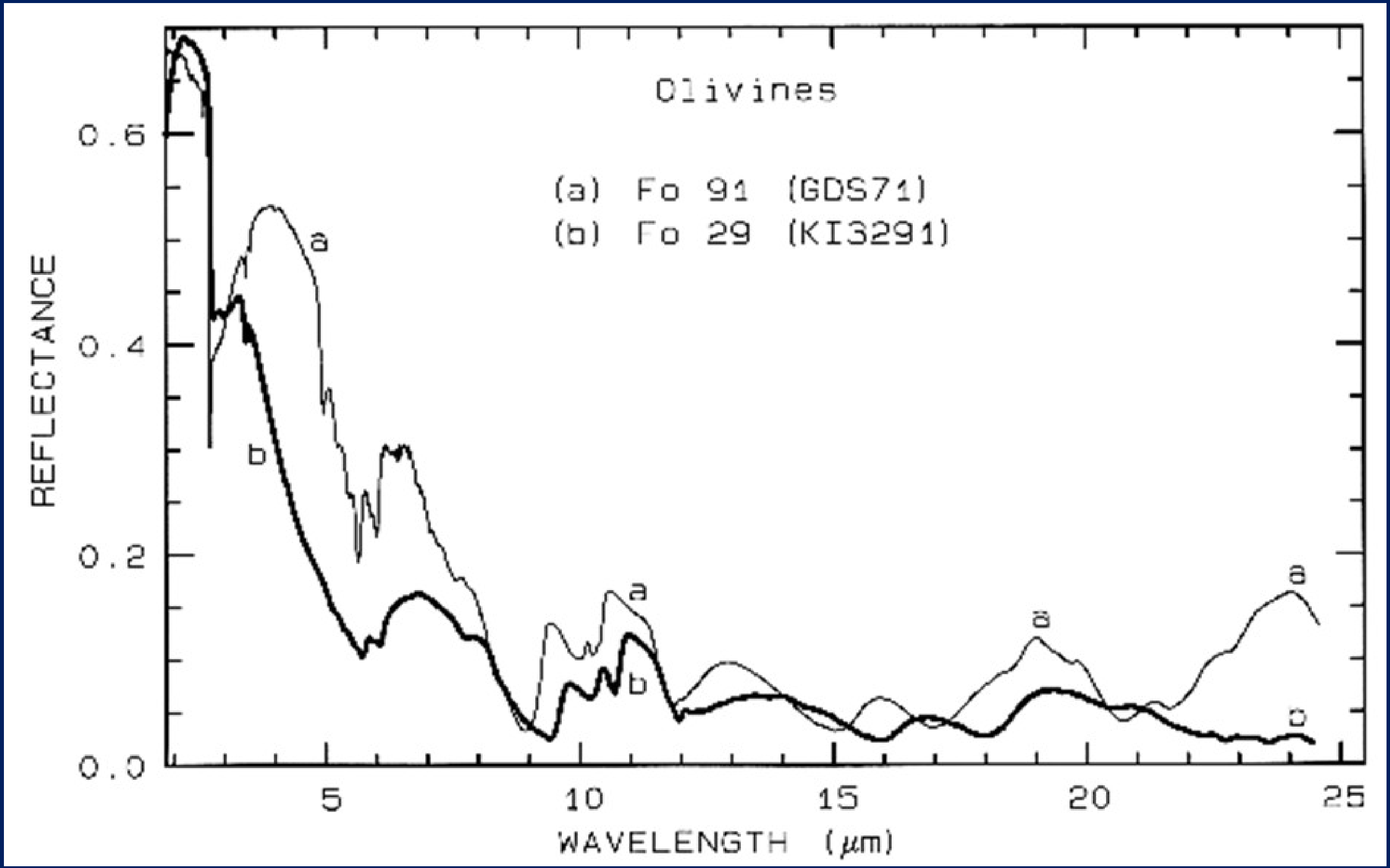
- **Imaging spectroscopy has many names in the remote sensing community, including imaging spectrometry, hyperspectral, and ultraspectral imaging. Spectroscopy is the study of electromagnetic radiation.**

- Spectrometry is derived from spectro-photometry, the measure of photons as a function of wavelength, a term used for years in astronomy.

- Hyper means excessive, but no imaging spectrometer in use can hardly be considered hyper-spectral, after all, a couple of hundred channels stakes in comparison to truly high resolution spectrometer with millions of channels.

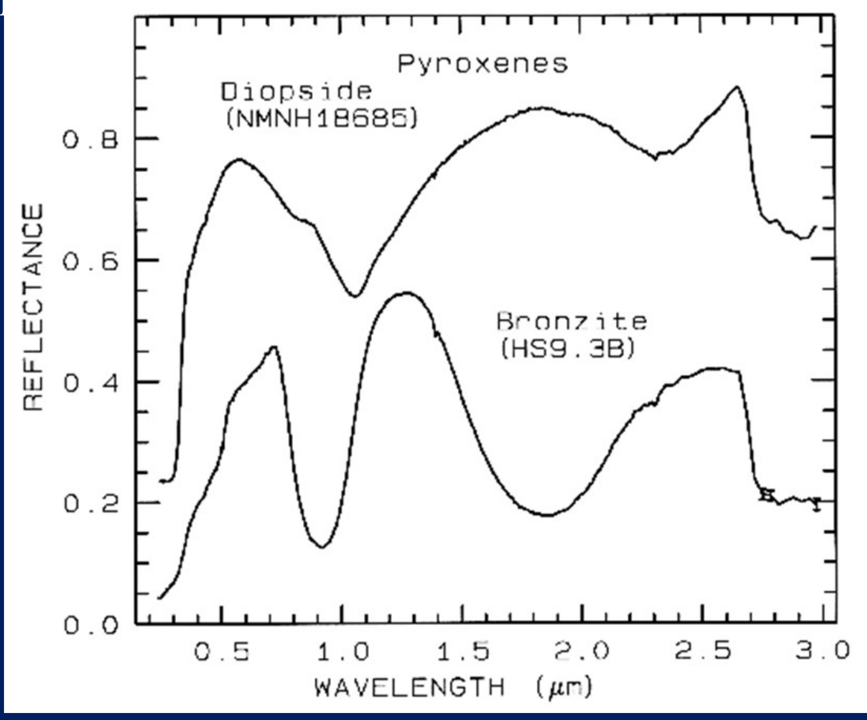
- Reflectance spectra of **two olivines** showing the change in band position and shape with composition.
- The 1-μm absorption band is due to a crystal field absorption of Fe^{2+}. "Fo" stands for forsterite (Mg_2SiO_4) in the forsterite - fayalite ($Fe_2^{2+}SiO_4$) olivine solid solution series.
- The Fo 29 sample (KI3291) has an FeO content of 53.65%, while the Fo 91 sample (GDS 71) has an FeO content of 7.93%. The mean grain size is 30 and 25 μm respectively.
- The 1-μm band position varies from about 1.08 μm at Fo 10 to 1.05 μm at Fo 90

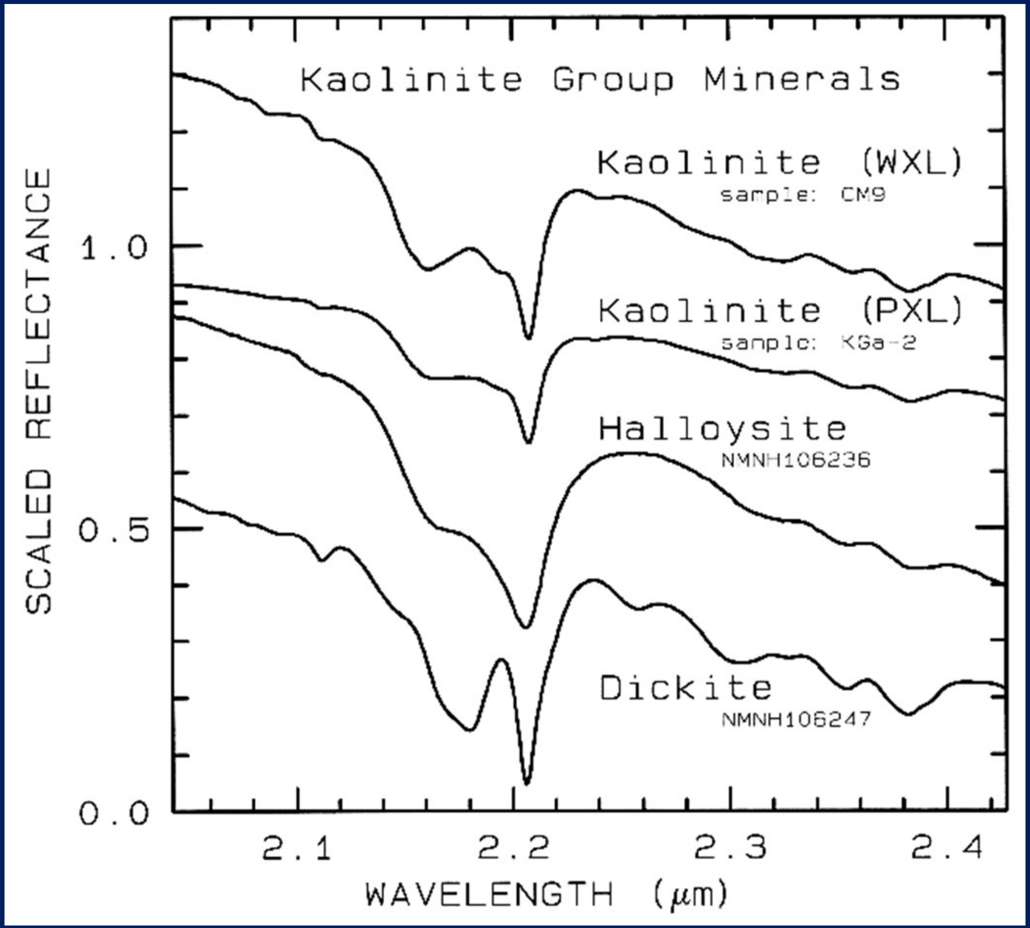




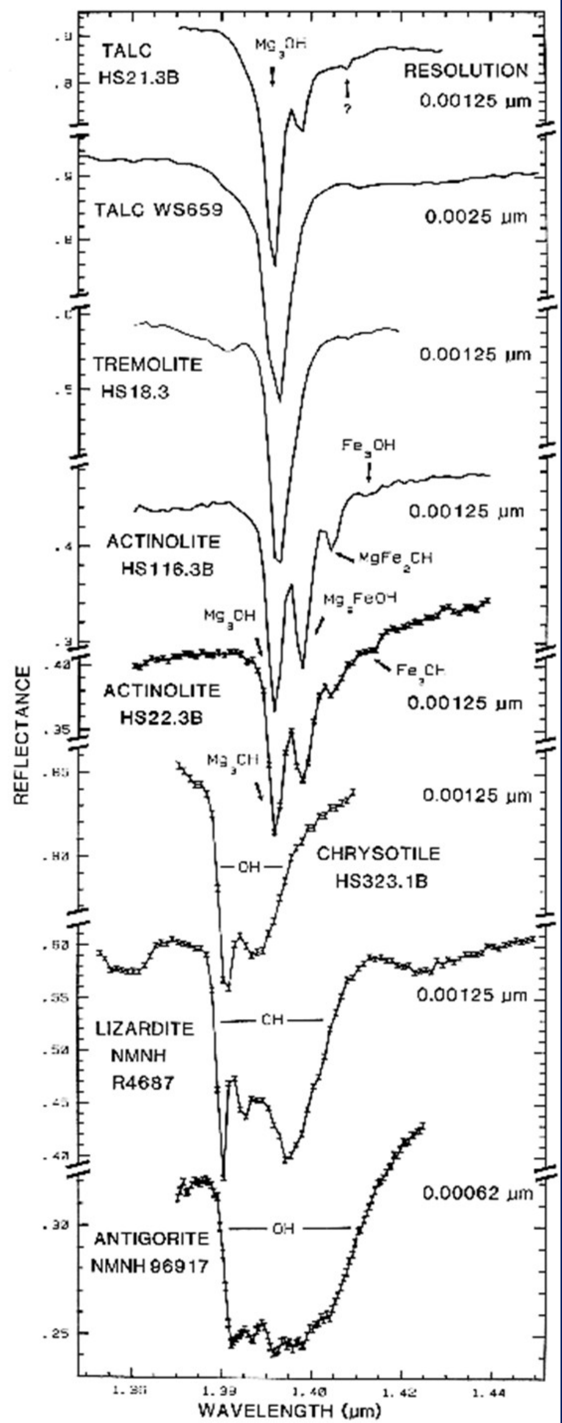
For Mid-infrared wavelengths. Note the shifts in the spectral features due to the change in composition.

- Reflectance spectra of two pyroxenes showing the change in **Fe^{2+}** -absorption band position and shape with composition.
- Diopside, sample NMNH18685, is $CaMgSi_2O_6$, but some Fe^{2+} substitutes for Mg. Bronzite, sample HS9.3B, is $(Mg,Fe)SiO_3$ with mostly Mg.
- The 1-µm versus the 2-µm band position of a pyroxene describes the pyroxene composition.





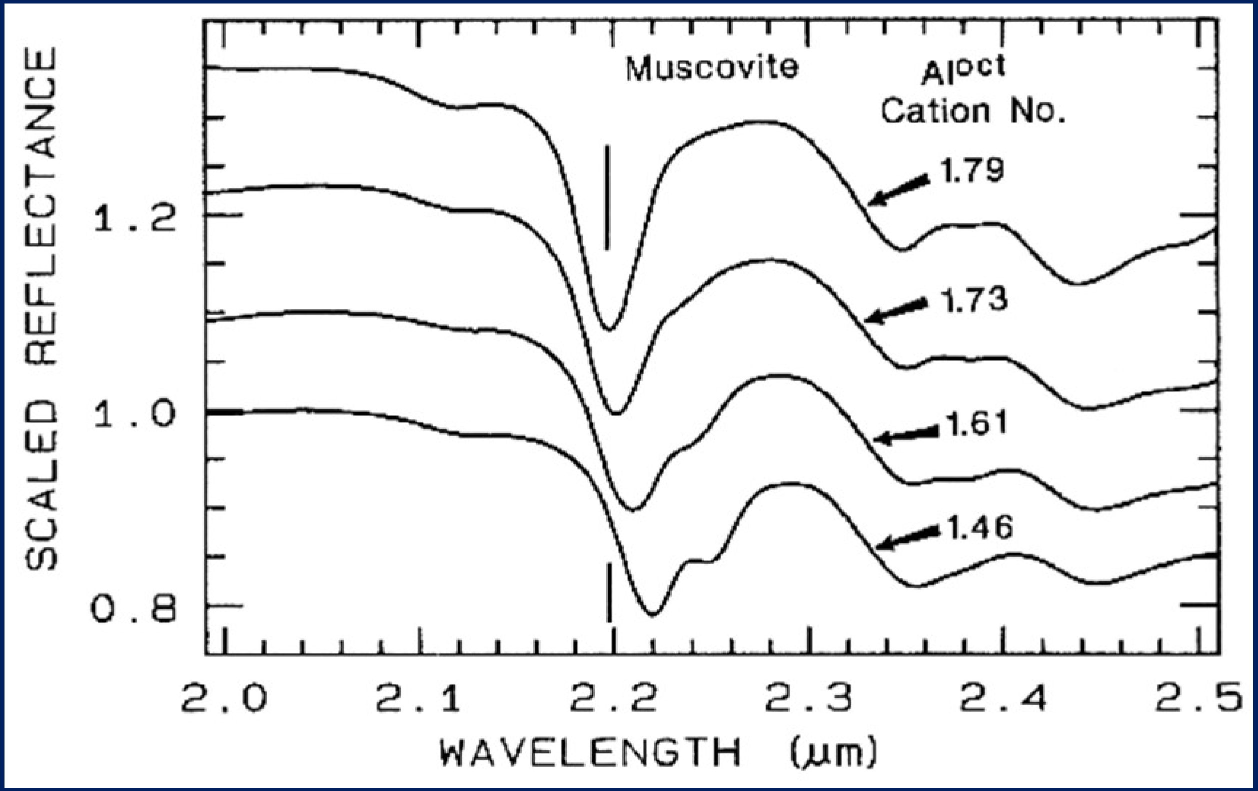
- Subtle spectral differences in the kaolinite group minerals near 2.2-µm.
- Kaolinite CM9 is well crystallized (WXL) while KGa-2 is poorly crystallized (PXL).
- Spectral bandwidth is 1.9 nm and sampling is 0.95 nm. Each spectrum was scaled to 0.7 at 2.1 µm then offset up or down so that the curves to not overlap.
- Original reflectances were between 0.5 and 0.8.



High spectral resolution reflectance spectra of the first overtone of OH in talc, tremolite, actinolite, crysotile, lizardite, and antigorite.

The three sharp absorption bands in talc, tremolite and actinolite are caused by Mg and Fe ions associated with the hydroxyls, causing small band shifts.

The Fe:Fe+Mg ratio can be estimated. In chrysotile, lizardite and antigorite, the absorptions change with small structural differences even though the composition is constant



Reflectance spectra of muscovite showing band shifts due to changing aluminum composition.

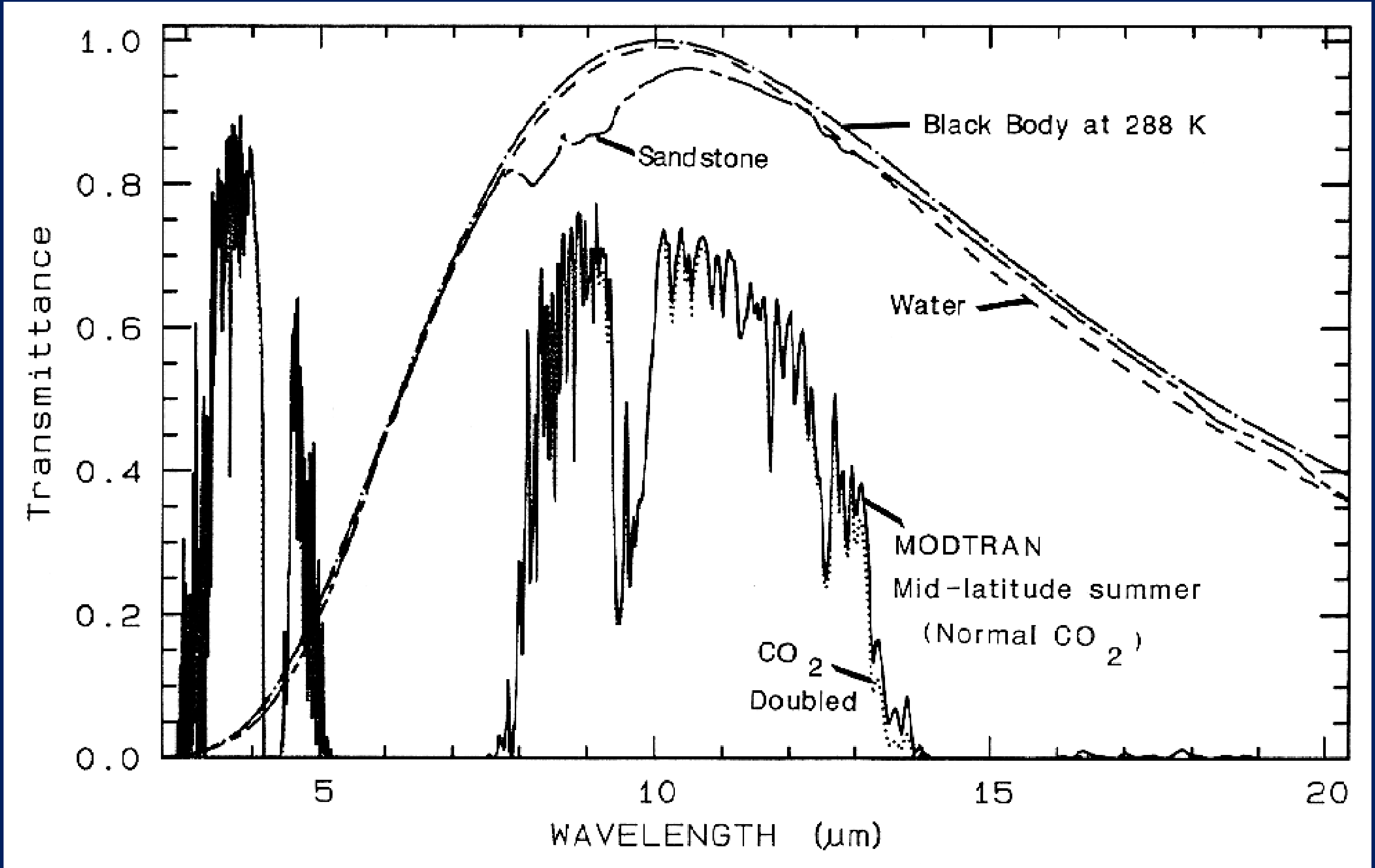
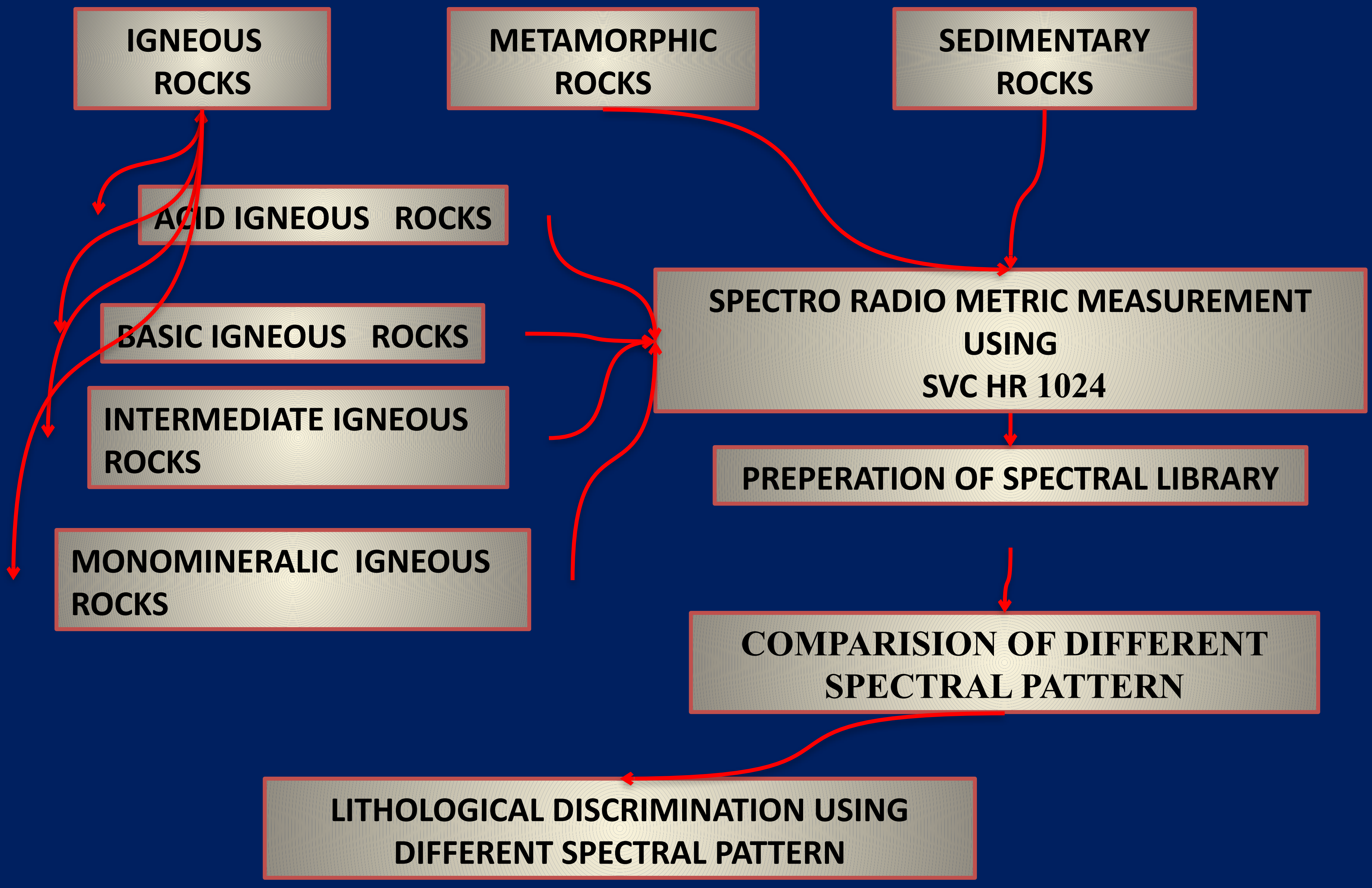


Figure 3b. Atmospheric transmittance, mid-infrared is compared to scaled grey-body spectra. Most of the absorption is due to water.

Carbon dioxide has a strong 15-µm band, and the dotted line shows the increased absorption due to doubling CO_2. Also shown is the black-body emission at 288 K and the grey-body emission from water and a sandstone scaled to fit on this transmittance scale. The water and sandstone curves were computed from reflectance data using: 1 - reflectance times a black-body at 288 Kelvin.

METHODOLOGY



Interpretation

- The interpretation of magnetic data obtained in ground or airborne surveys made qualitatively and quantitatively, the later involving mathematical procedure.
- Magnetic anomalies are mainly attribute to the changes in the susceptibility and/or the remnant magnetism of rocks and minerals.
- The qualitative study yields information about the bodies causing the anomalies in the areas such as strike trends, faults etc.
- The quantitative analysis deals with individual anomalies and deduce the shape, size and depth of the causative bodies.
- The **quantitative** method of interpretations are half-anomaly width relation, Peters's slope method, upward and downward continuation method, derivative methods, RTP etc.

Qualitative study

- By visual inspection one may obtain information such as strike of the causative bodies from the trend of the contour.
- The intensity of the anomaly suggest whether one is dealing with strongly magnetic bodies weaker anomalies denoting structural features in the subsurface.
- If the anomaly is localized and the contours are crowded, the causative bodies may be inferred as shallow depth.
- Abrupt change in the contour pattern suggest the existence of fault.

- In mining field, it is very helpful to locate certain igneous body in the form of dyke, plugs and laccolith and other structural feature such as contact zones may also be noted.
- In oil exploration, the magnetic anomaly map show the margins of sedimentary basins.
- It also gives information about the deeper part of the basin with sediment thickness.

Application:

- It is used to map the sub surface geological structures.
- Geological mapping
- It is used to map the topographic features of the basement that might influence the structure of the overlying sediments
- Ground water exploitation are made more successful through knowledge of fracture system in crystalline rocks and bed rock aquifer under alluvial cover.
- It is used to map the volcanic areas which generally has large susceptibility and often remnants.

- It has an important role in mineral exploration because many mineral deposits are associated with magnetite concentration.
- Kimberlitic pipe are often directly detected by magnetic surveys at close sample spacing.
- Application in archeological survey.
- It has a great advantage in the exploration of massive sulphide ore.
- In oil exploration, it gives information from which one can determine the depth to basement and thus locate and define the extent of sedimentary basin.

Magnetic	Gravity
Elevation makes no differences	It cause serious affects
Topography will not make any differences	It will make great difference
Interpretation is more complicated	Less
Vector (both direction & intensity)	Scalar
Anomaly due to magnetization of rock	It is due to density variation
Elements of magnetization has attractive and repulsive	All the elements of mass attractive only
It measures total component	It measures only vertical component

Gravity: Field Procedure

- Precious location and elevation of the each stations is very important in this gravity prospecting.
- Elevation of each station locations should be obtained accurate to 0.05m.
- 1m error in elevation will cause 0.33mgal in gravity value.
- Locations of each point should not more than 20-25m along the north and south directions.
- The error of 50m either in north or south direction will cause 0.02mgals.

- Leveling instruments or DGPS must be used to get the elevation values.
- For mining exploration, the survey area in general not very large and stations should be carried out very close intervals.
- For long narrow type of ore body, survey should be taken up across the mineralization.
- For the ore body of 100m length, traverse should be made on 10m interval to get the accurate picture of the ore body.
- In case of massive irregular ore bodies, a regular grid pattern with spacing of one third of expected depth of mineralization may be adopted.
- The layout should be planned by taking into the account of nature of topography, available aerial photographic study and existence of road and the transport facilities.

- During the survey, the instrument is kept directly on tripod over the stations marked by the surveyor.
- Leveling of the instrument has to be done using the screws at the bottom.
- After one or two hours of survey, the instrument should brought back the base station to check the drift of the instrument.
- Even the best instruments are susceptible to creep because of the springs or torsion fibres. It is mainly depends on temperature change, mechanical jolts and other factors like shocks during the transport.
- Drift curve is generated by plotting the gravity values with respect to time.
- Some times the reading at one place may be repeated to three to four times when the base station is far away from the survey area.

Interpretation

- Gravity anomaly map generally indicates lateral changes in density of the subsurface rock formations. The variations of density in vertical direction is depth wise change in rocks formation.
- The depth of the ore body can not be predicted directly from the data obtained in surface measurement.
- The geological and geophysical interpretation of a gravity data is more of an art than a science.
- Knowledge and experience of the interpreter plays an important role in these interpretations.
- To interpret the gravity data both physical and geological knowledge must be required. Besides, other type of geophysical data also help to solve the problem

Interpretation

- Interpretation of gravity data properly begins at the very early stage of survey planning and survey must be designed with desired goal really in the mind.
- The critical factors of survey design are the accuracy and spatial distributions. (limiting the survey area for accuracy). These things can be done with prior knowledge of the area and buried sources.
- The accuracy of the gravity data for geological intepretations depends both on the accuracy of the gravity observation themselves and on the accuracy of the other quantities namely station location, elevation, density of the near surface rocks that must be used to reduce the gravity observations to form a suitable interpretaions.

Interpretation

- Generally, the first step in interpretation is the removal of regional field to isolate the residual anomalies. Because, in gravity survey, residual anomalies are prime interest.

Regional and Residual

- Regional and Residual separation may be performed by graphically by sketching in a linear and curvi-linear field by eye. Such method is biased by the interpreter however it is based on the prior knowledge only.
- Other than Graphical, several analytical and graphical methods are available to isolate the Residual from Regional.
- The noise free anomalies contain two components called Regional and Residuals. Due to their deep seated origin, the regional components are broad and have a uniform varying gradient in contrast.

Regional and Residual

- Regional anomalies are sharp and narrow
- Both regional and residual can be separately interpreted for a possible geological information. However, residuals area always analyzed more systematically then the regionals.

- **Interpretation of EM data**
- EM survey gives the information about the geometrical disposition and conductivities of the causative bodies and the nature of the overburden.
- Qualitative interpretation of data in lateral exploration may often enough.
- Quantitative determination as estimations of depth, shape, dip etc of the indicating ore body interpretation.
- Interpretation should be carried out based on the loop orientation and by keeping the instrument in mind.
- Modeling will be very useful for different geometrical types of ore bodies.
- Horizontal loop will give better information about the vertical body similarly vertical loop will give much information about horizontal body.

- **Effective Depth of E.M Surveys**
- The depth to which an E.M method is effective depends on the resistivity of the ground, the frequency employed and the separation transmitting loop and the receiving coil.
- The resistivity of the ground and the frequency of the current employed in a system should be taken together for consideration to evaluate the effective depth of penetration.
- The higher the resistivity of the ground, the greater will be the depth of penetration for a particular frequency. But an increase in frequency will reduce the depth of penetration.
- If the ground if highly insulating, the E.M waves will penetrate large depths.

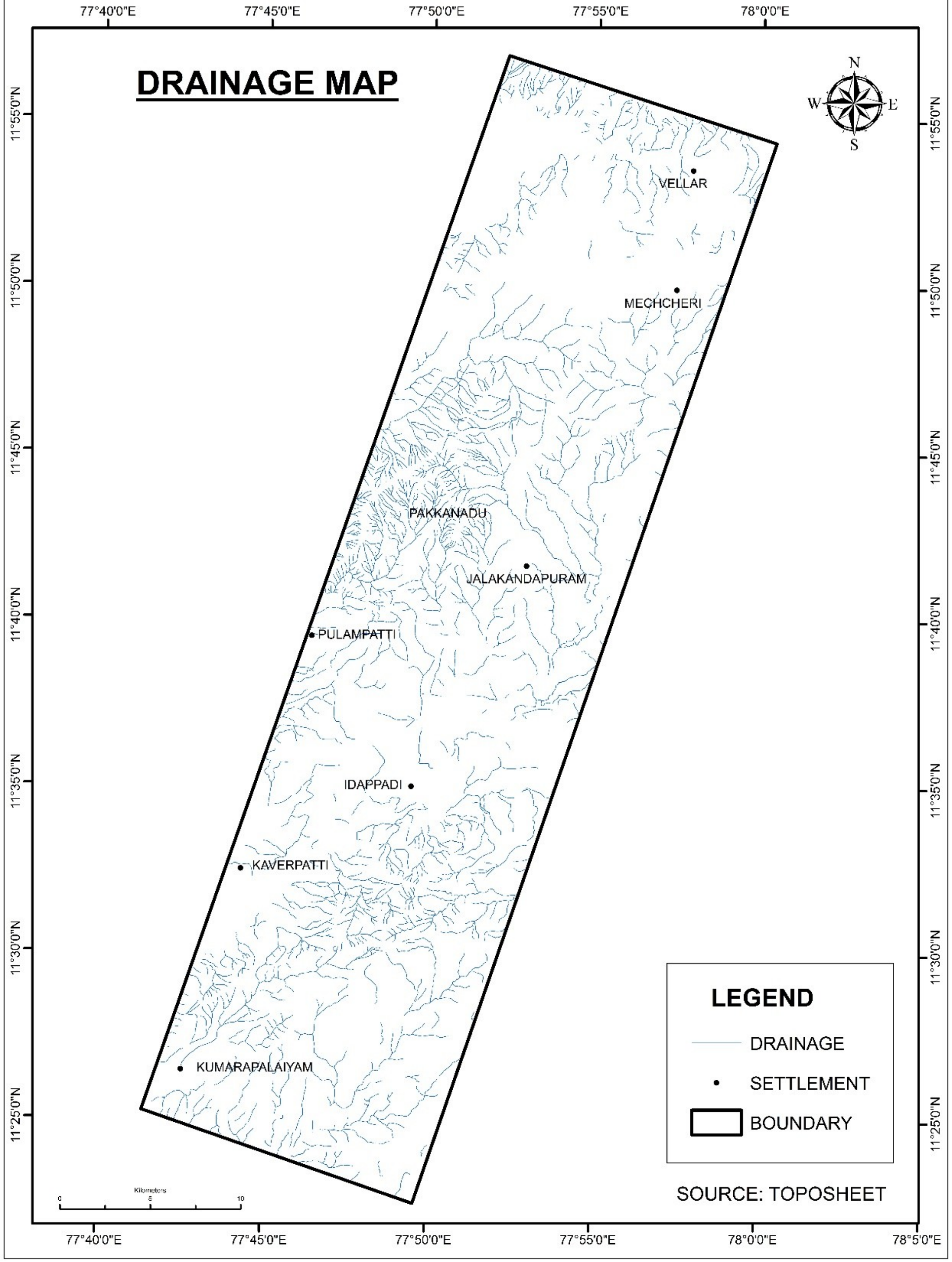
Skin Deth:

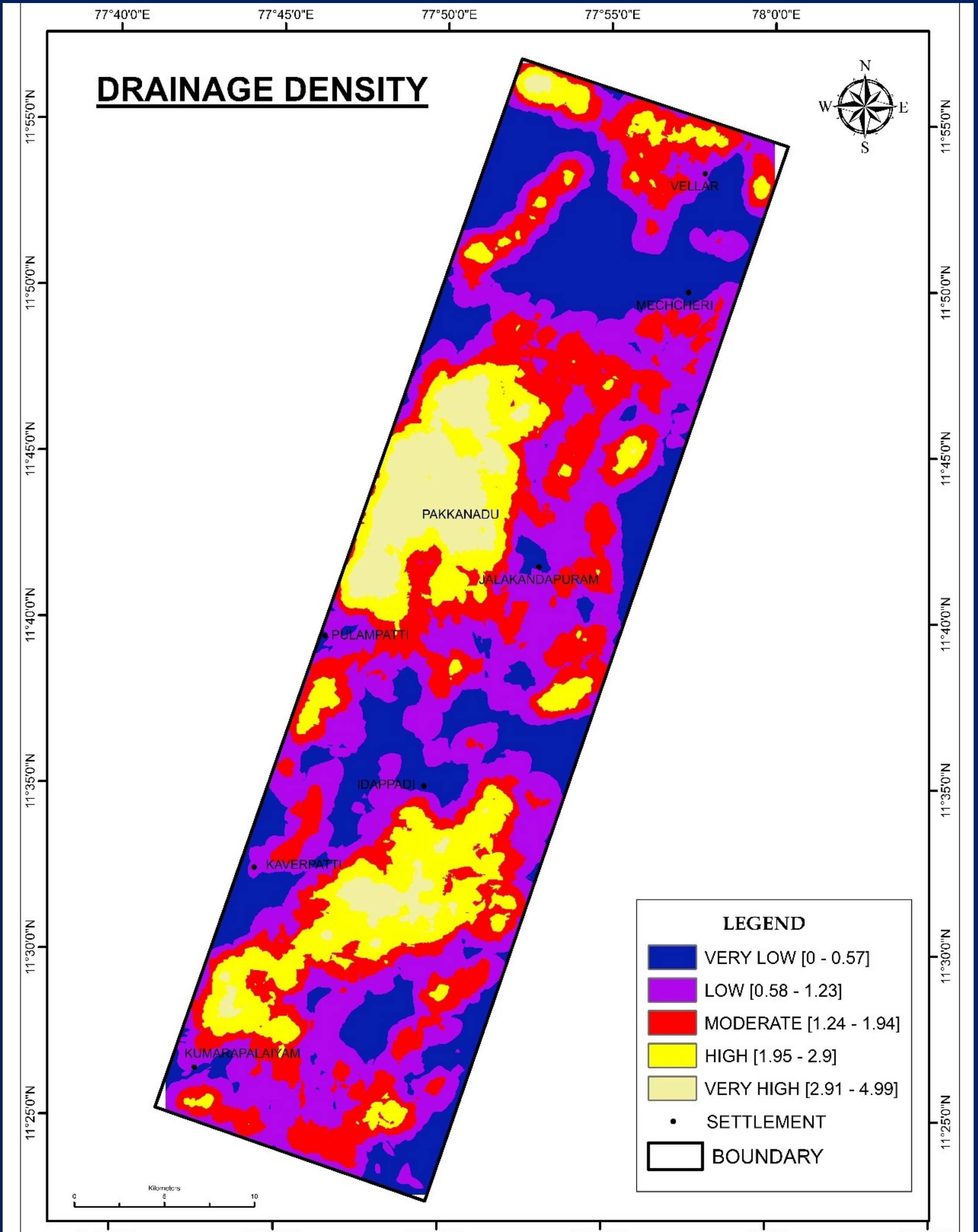
The maximum depth of transmission of EM wave into the subsurface, called Skin Depth (d).

$$d=500 \sqrt{\rho/f}$$

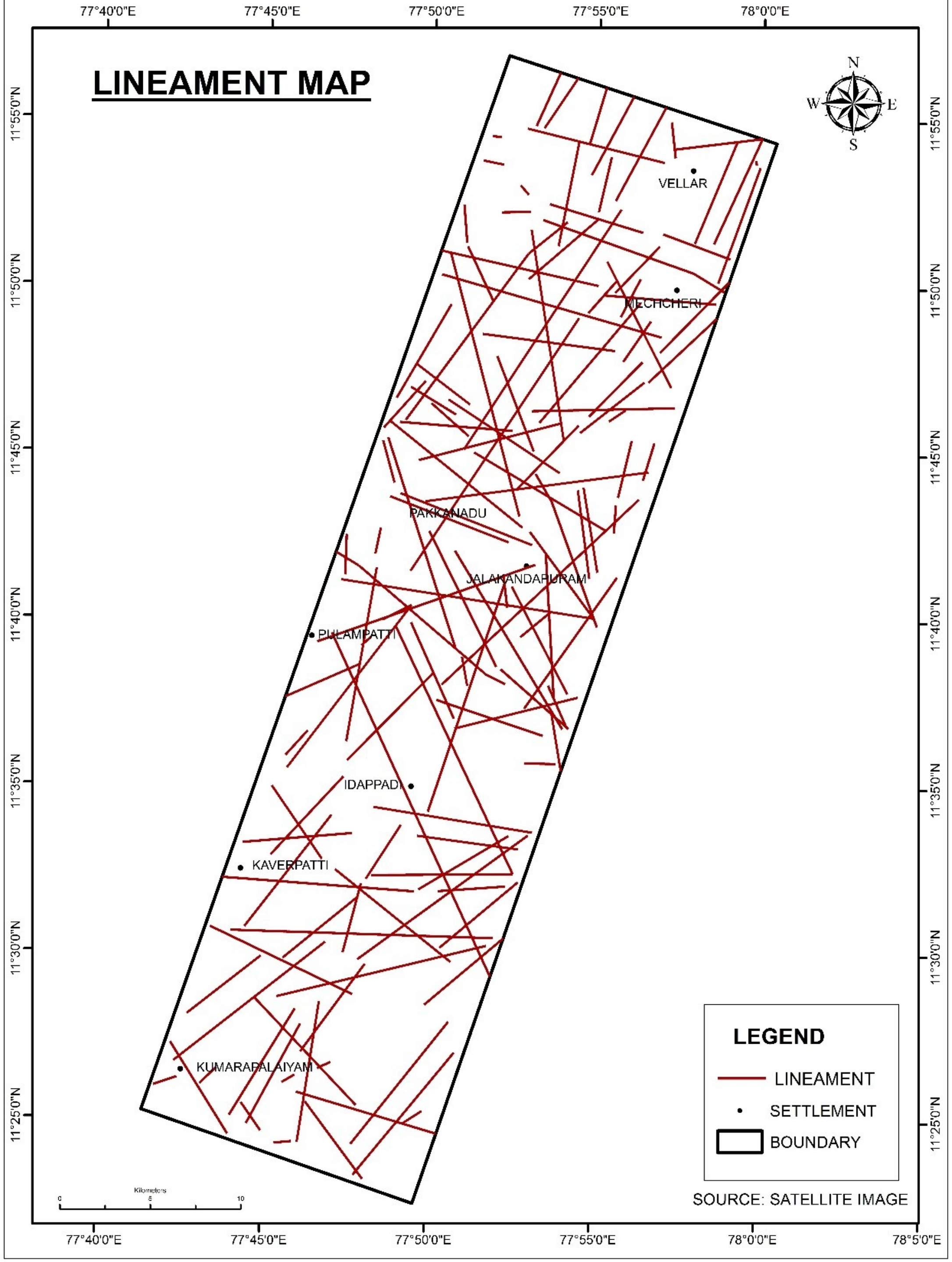
Where d is in meter, ρ the resistivity in ohm.m and 'f' is in Hz or c.p.s.

- Although the depth of penetration of E.M waves may be calculated from formula, the depth of exploration in most of the EM units would probably be only half of the calculated depth of penetration.
- In the horizontal coplanar system has a depth of exploration about one half or two-thirds the distance between transmitting and receiving coils

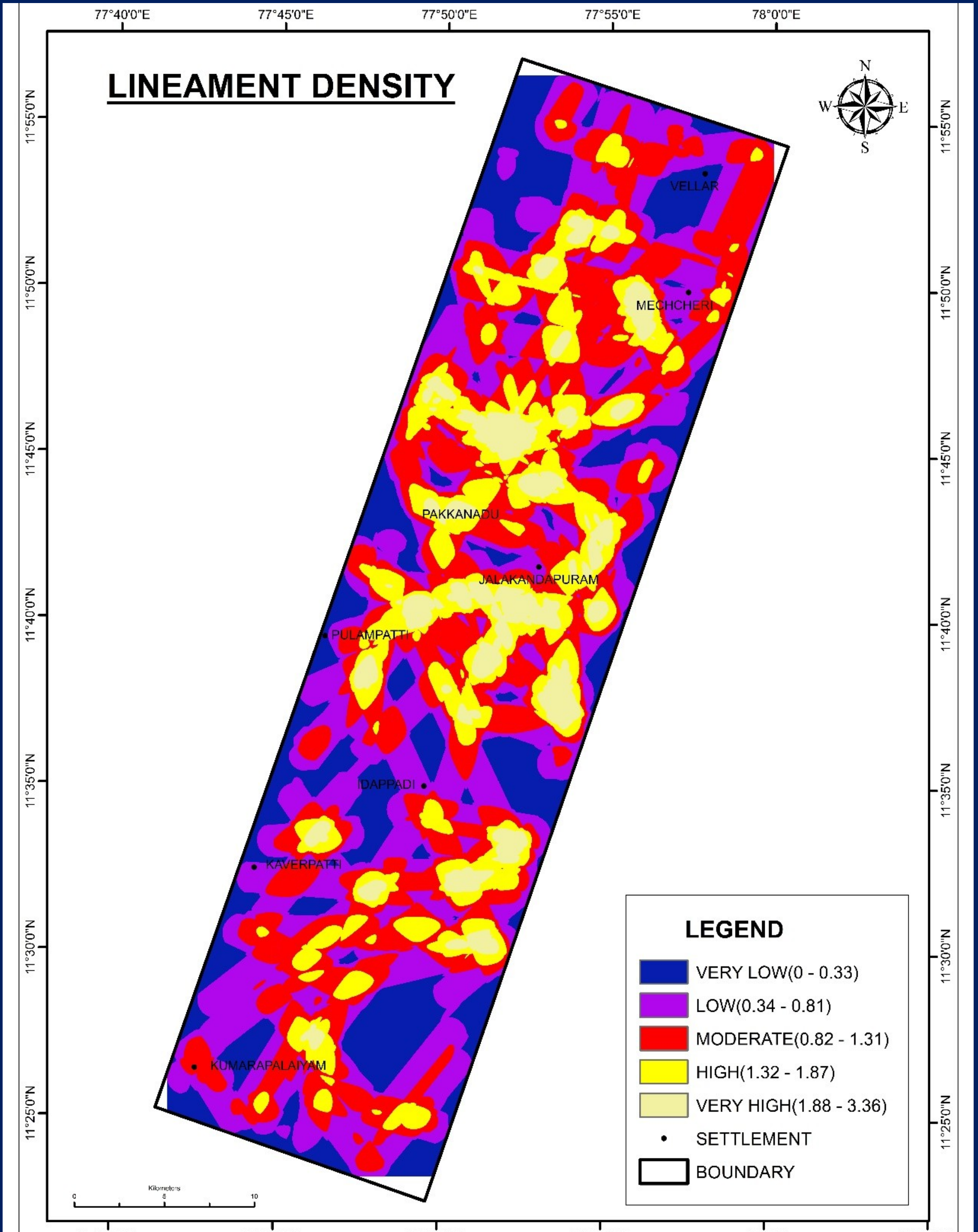

DRAINAGE MAP
77°40'0"E
77°45'0"E
77°50'0"E
77°55'0"E
78°0'0"E
78°5'0"E
11°55'0"N
11°50'0"N
11°45'0"N
11°40'0"N
11°35'0"N
11°30'0"N
11°25'0"N
N
S
E
W
VELLAR
MECHCHERI
PAKKANADU
JALAKANDAPURAM
PULAMPATTI
IDAPPADI
KAVERPATTI
KUMARAPALAIYAM
LEGEND
DRAINAGE
SETTLEMENT
BOUNDARY
SOURCE: TOPOSHEET
Kilometers
0
5
10

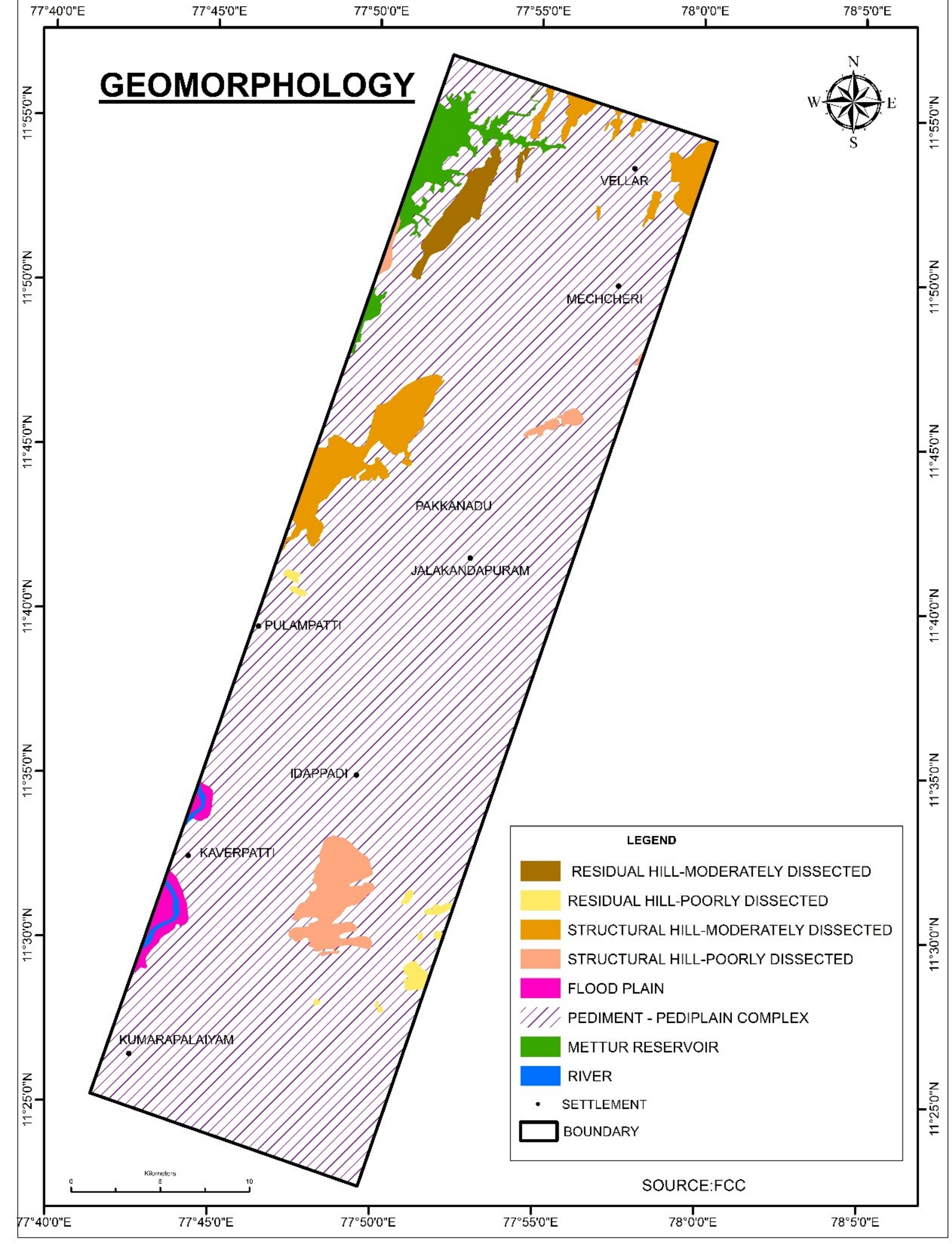


DRAINAGE DENSITY
77°40'0"E
77°45'0"E
77°50'0"E
77°55'0"E
78°0'0"E
11°55'0"N
11°50'0"N
11°45'0"N
11°40'0"N
11°35'0"N
11°30'0"N
11°25'0"N
N
S
E
W
VELLAR
MECHCHERI
PAKKANADU
JALAKANDAPURAM
PULAMPATTI
IDAPPADI
KAVERPATTI
KUMARAPALAIYAM
LEGEND
VERY LOW [0 - 0.57]
LOW [0.58 - 1.23]
MODERATE [1.24 - 1.94]
HIGH [1.95 - 2.9]
VERY HIGH [2.91 - 4.99]
SETTLEMENT
BOUNDARY
Kilometers
0
5
10



LINEAMENT MAP
77°40'0"E
77°45'0"E
77°50'0"E
77°55'0"E
78°0'0"E
78°5'0"E
11°55'0"N
11°50'0"N
11°45'0"N
11°40'0"N
11°35'0"N
11°30'0"N
11°25'0"N
N
S
E
W
VELLAR
MECHCHERI
PAKKANADU
JALAKANDAPURAM
PULAMPATTI
IDAPPADI
KAVERPATTI
KUMARAPALAIYAM
LEGEND
LINEAMENT
SETTLEMENT
BOUNDARY
Kilometers
0
5
10
SOURCE: SATELLITE IMAGE


LINEAMENT DENSITY
77°40'0"E
77°45'0"E
77°50'0"E
77°55'0"E
78°0'0"E
11°55'0"N
11°50'0"N
11°45'0"N
11°40'0"N
11°35'0"N
11°30'0"N
11°25'0"N
N
S
E
W
VELLAR
MECHCHERI
PAKKANADU
JALAKANDAPURAM
PULAMPATTI
IDAPPADI
KAVERPATTI
KUMARAPALAIYAM
LEGEND
VERY LOW(0 - 0.33)
LOW(0.34 - 0.81)
MODERATE(0.82 - 1.31)
HIGH(1.32 - 1.87)
VERY HIGH(1.88 - 3.36)
SETTLEMENT
BOUNDARY



GEOMORPHOLOGY
77°40'0"E
77°45'0"E
77°50'0"E
77°55'0"E
78°0'0"E
78°5'0"E
11°55'0"N
11°50'0"N
11°45'0"N
11°40'0"N
11°35'0"N
11°30'0"N
11°25'0"N
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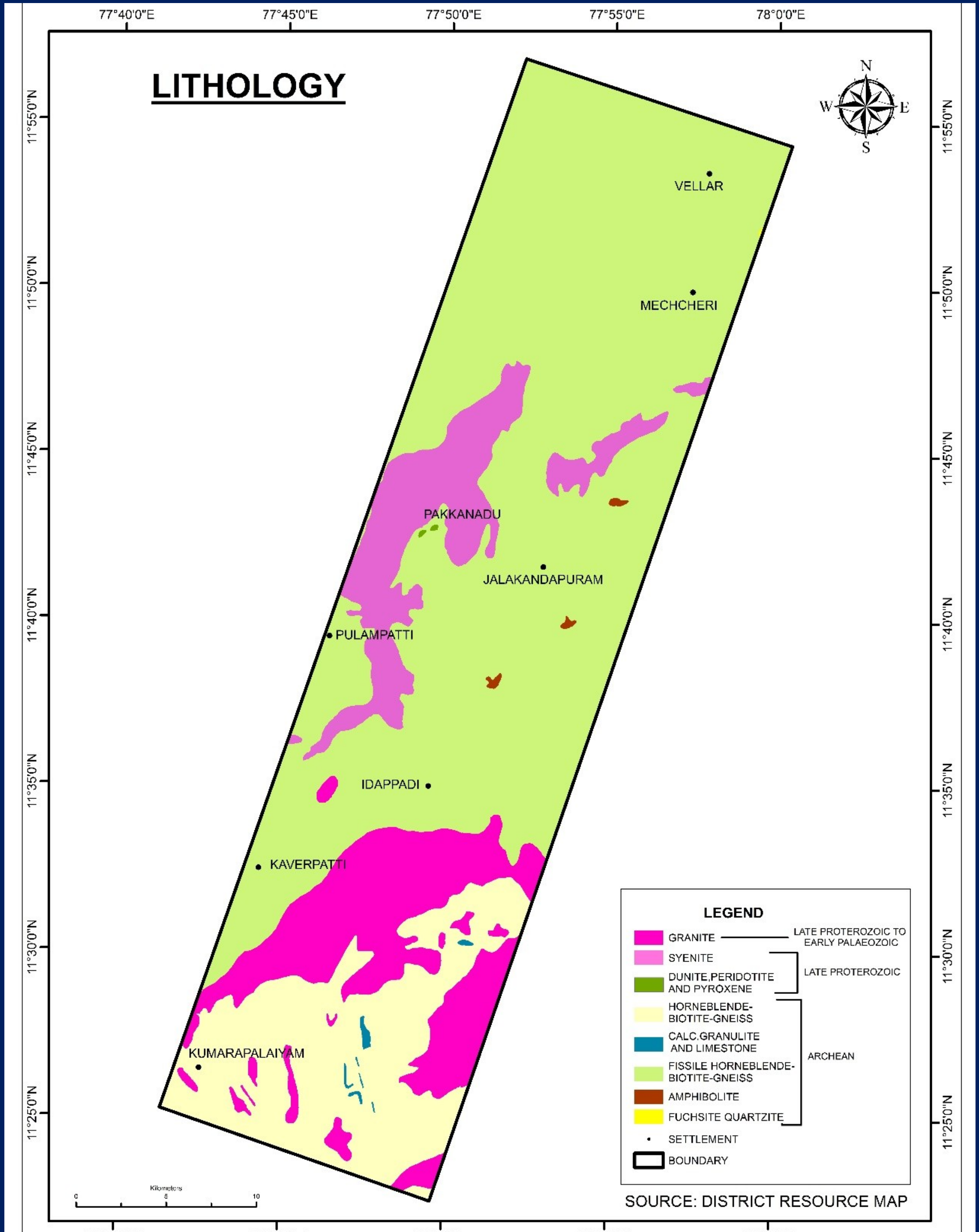
E
W
VELLAR
MECHCHERI
PAKKANADU
JALAKANDAPURAM
PULAMPATTI
IDAPPADI
KAVERPATTI
KUMARAPALAIYAM
LEGEND
RESIDUAL HILL-MODERATELY DISSECTED
RESIDUAL HILL-POORLY DISSECTED
STRUCTURAL HILL-MODERATELY DISSECTED
STRUCTURAL HILL-POORLY DISSECTED
FLOOD PLAIN
PEDIMENT - PEDIPLAIN COMPLEX
METTUR RESERVOIR
RIVER
SETTLEMENT
BOUNDARY
SOURCE:FCC
Kilometers
0
5
10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77°45'0"E
77°50'0"E
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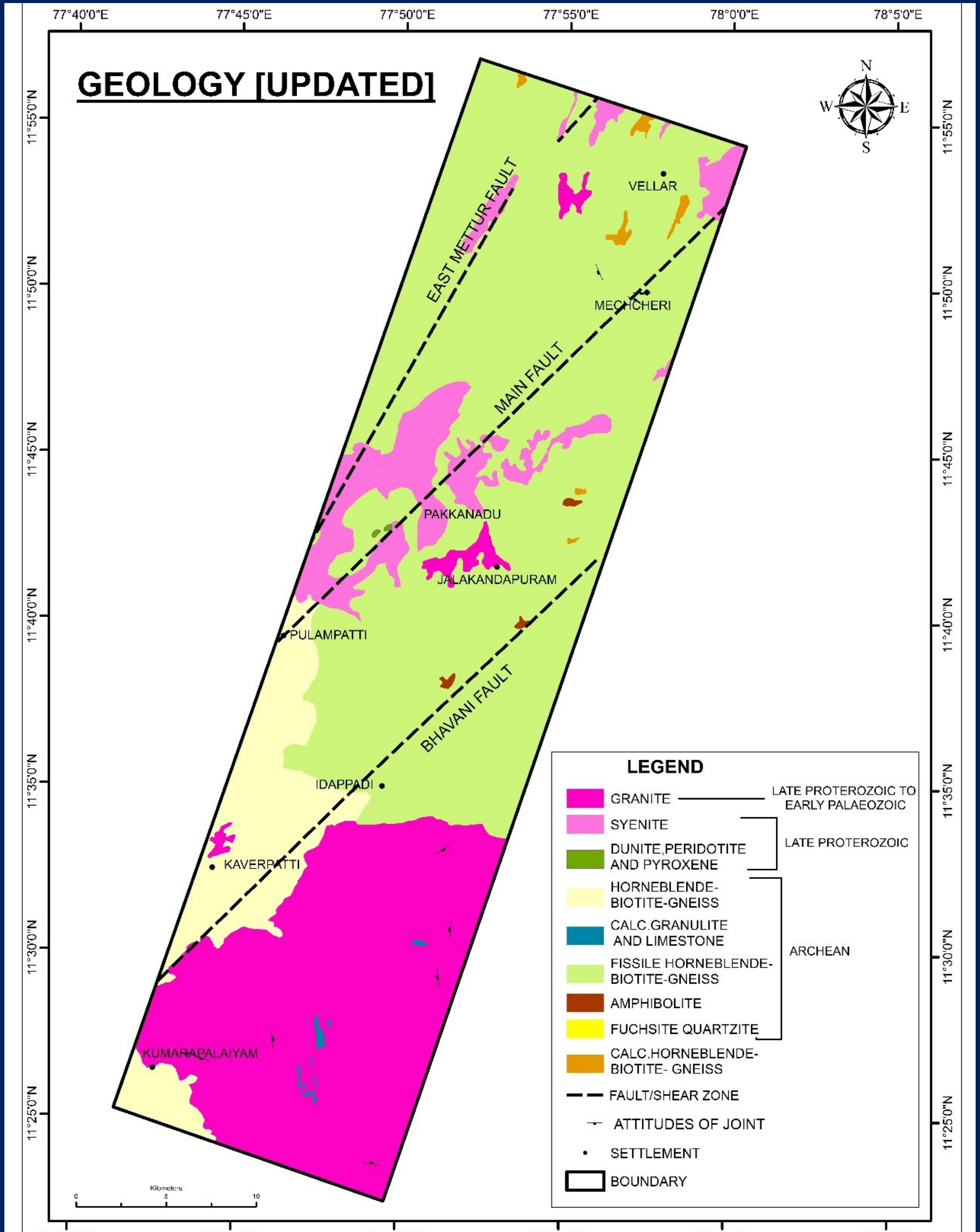
78°0'0"E
11°55'0"N
11°50'0"N
11°45'0"N
11°40'0"N
11°35'0"N
11°30'0"N
11°25'0"N
LITHOLOGY
N
S
E
W
VELLAR
MECHCHERI
PAKKANADU
JALAKANDAPURAM
PULAMPATTI
IDAPPADI
KAVERPATTI
KUMARAPALAIYAM
LEGEND
GRANITE
LATE PROTEROZOIC TO EARLY PALAEOZOIC
SYENITE
DUNITE,PERIDOTITE AND PYROXENE
LATE PROTEROZOIC
HORNEBLENDE-BIOTITE-GNEISS
CALC.GRANULITE AND LIMESTONE
FISSILE HORNEBLENDE-BIOTITE-GNEISS
ARCHEAN
AMPHIBOLITE
FUCHSITE QUARTZITE
SETTLEMENT
BOUNDARY
Kilometers
0
5
10
SOURCE: DISTRICT RESOURCE MAP



GEOLOGY [UPDATED]
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77°50'0"E
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78°0'0"E
78°5'0"E
11°55'0"N
11°50'0"N
11°45'0"N
11°40'0"N
11°35'0"N
11°30'0"N
11°25'0"N
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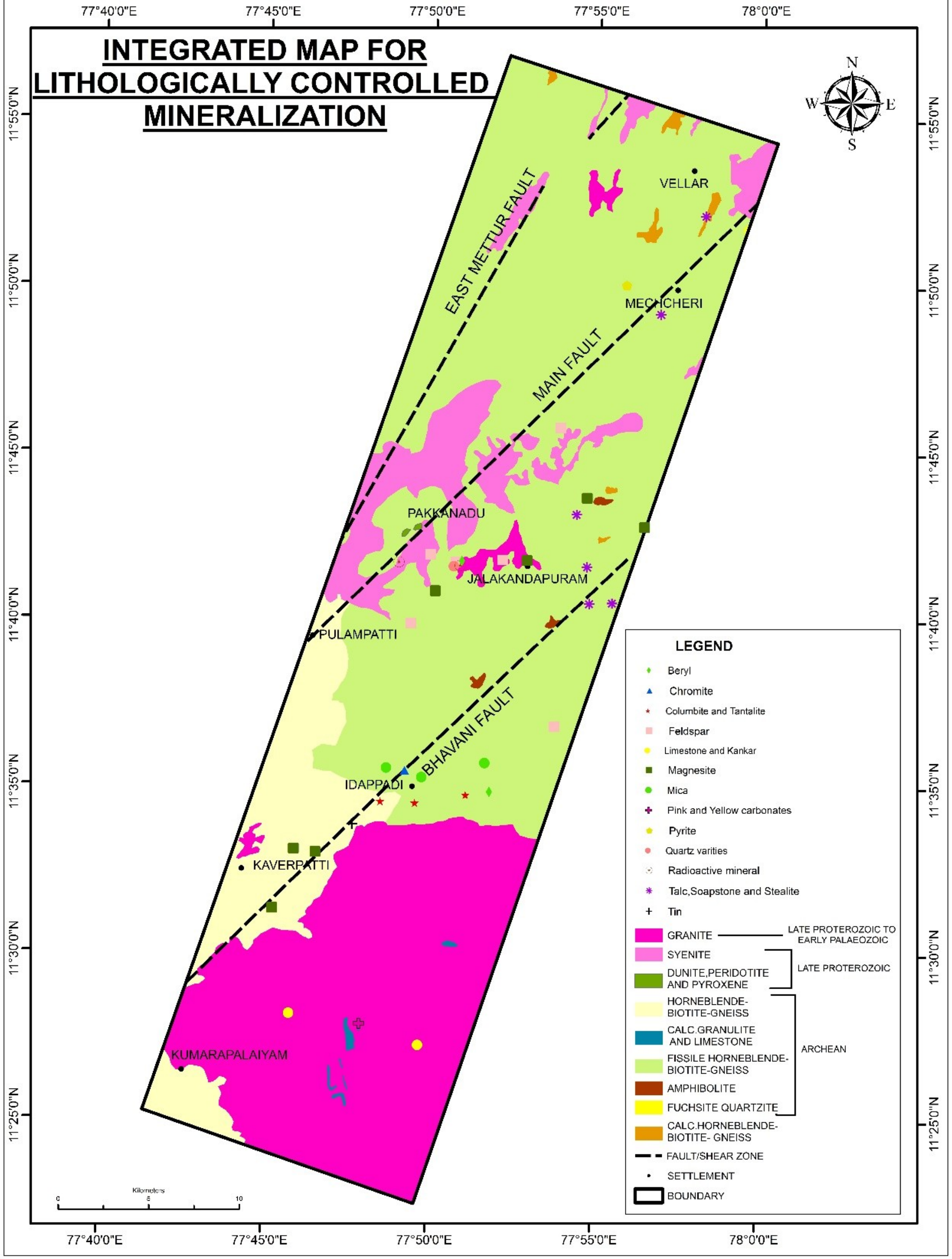
EAST METTUR FAULT
MAIN FAULT
BHAVANI FAULT
VELLAR
MECHCHERI
PAKKANADU
JALAKANDAPURAM
PULAMPATTI
IDAPPADI
KAVERPATTI
KUMARAPALAIYAM
LEGEND
GRANITE
LATE PROTEROZOIC TO EARLY PALAEOZOIC
SYENITE
DUNITE,PERIDOTITE AND PYROXENE
LATE PROTEROZOIC
HORNEBLENDE-BIOTITE-GNEISS
CALC.GRANULITE AND LIMESTONE
FISSILE HORNEBLENDE-BIOTITE-GNEISS
ARCHEAN
AMPHIBOLITE
FUCHSITE QUARTZITE
CALC.HORNEBLENDE-BIOTITE- GNEISS
FAULT/SHEAR ZONE
ATTITUDES OF JOINT
SETTLEMENT
BOUNDARY



INTEGRATED MAP FOR LITHOLOGICALLY CONTROLLED MINERALIZATION
77°40'0"E
77°45'0"E
77°50'0"E
77°55'0"E
78°0'0"E
11°55'0"N
11°50'0"N
11°45'0"N
11°40'0"N
11°35'0"N
11°30'0"N
11°25'0"N
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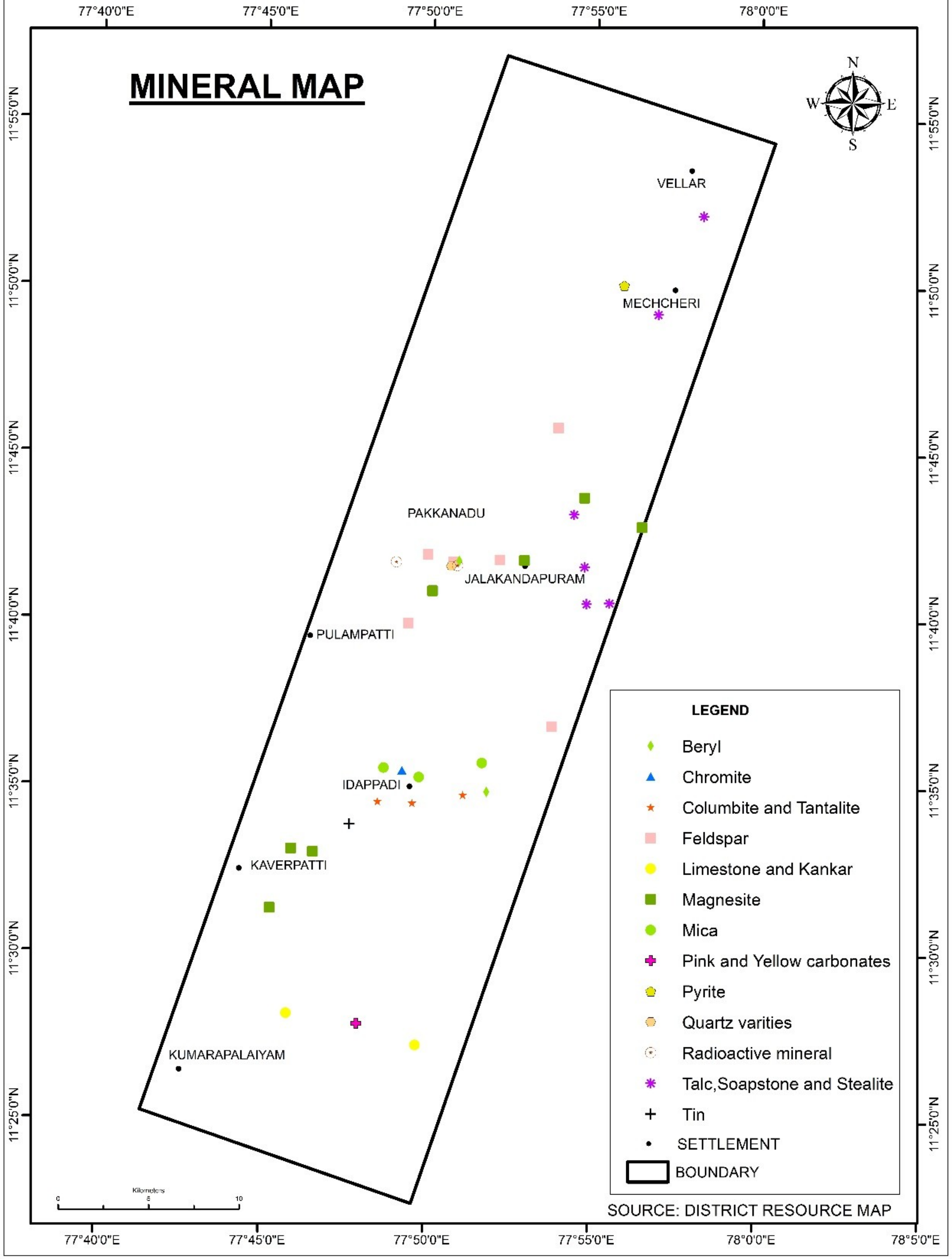
EAST METTUR FAULT
MAIN FAULT
BHAVANI FAULT
VELLAR
MECHCHERI
PAKKANADU
JALAKANDAPURAM
PULAMPATTI
IDAPPADI
KAVERPATTI
KUMARAPALAIYAM
LEGEND
Beryl
Chromite
Columbite and Tantalite
Feldspar
Limestone and Kankar
Magnesite
Mica
Pink and Yellow carbonates
Pyrite
Quartz varities
Radioactive mineral
Talc,Soapstone and Stealite
Tin
GRANITE
LATE PROTEROZOIC TO EARLY PALAEOZOIC
SYENITE
DUNITE,PERIDOTITE AND PYROXENE
LATE PROTEROZOIC
HORNEBLENDE-BIOTITE-GNEISS
CALC.GRANULITE AND LIMESTONE
FISSILE HORNEBLENDE-BIOTITE-GNEISS
ARCHEAN
AMPHIBOLITE
FUCHSITE QUARTZITE
CALC.HORNEBLENDE-BIOTITE- GNEISS
FAULT/SHEAR ZONE
SETTLEMENT
BOUNDARY
Kilometers
0
5
10


MINERAL MAP
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78°5'0"E
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11°50'0"N
11°45'0"N
11°40'0"N
11°35'0"N
11°30'0"N
11°25'0"N
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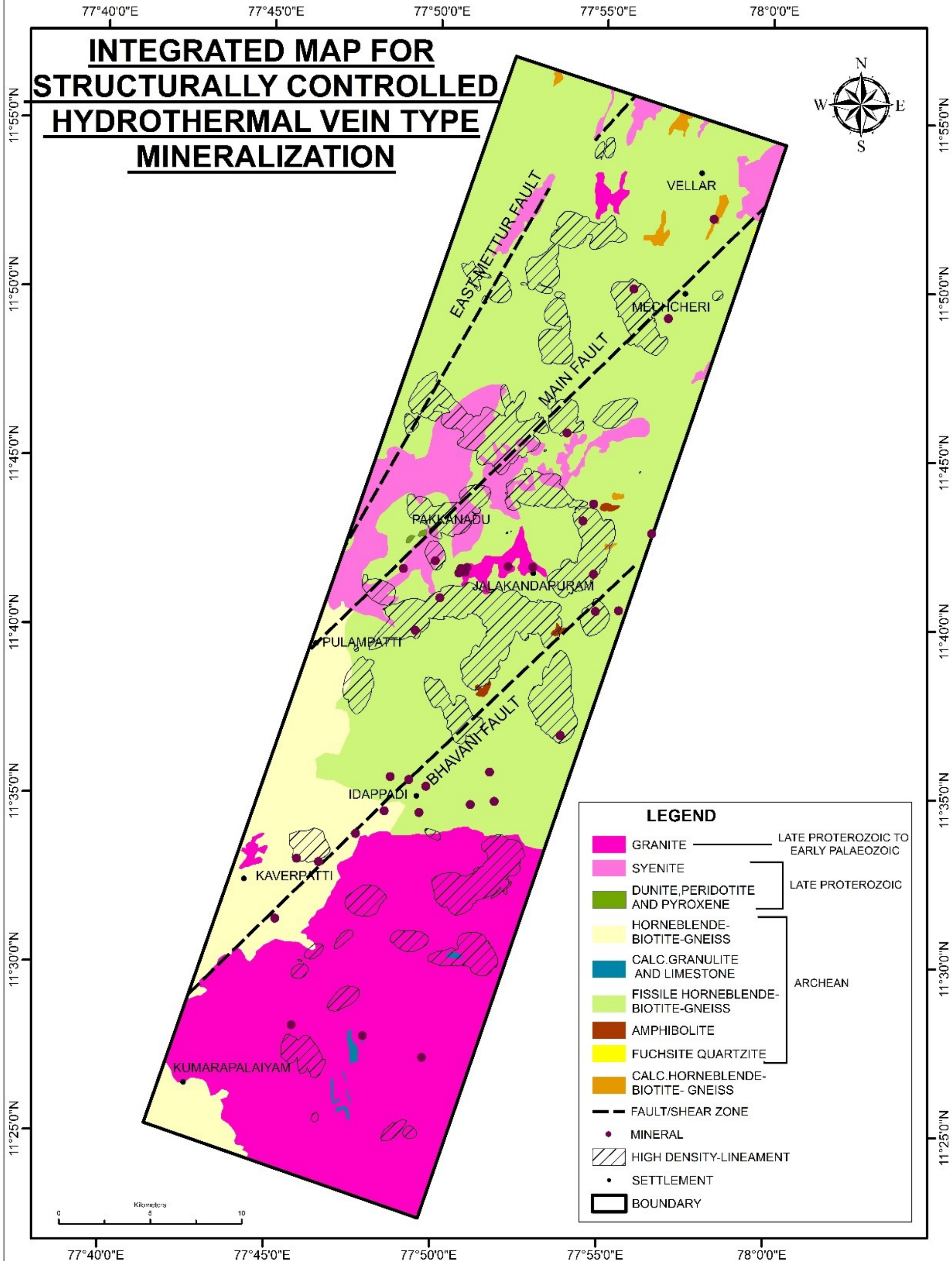
VELLAR
MECHCHERI
PAKKANADU
JALAKANDAPURAM
PULAMPATTI
IDAPPADI
KAVERPATTI
KUMARAPALAIYAM
LEGEND
Beryl
Chromite
Columbite and Tantalite
Feldspar
Limestone and Kankar
Magnesite
Mica
Pink and Yellow carbonates
Pyrite
Quartz varities
Radioactive mineral
Talc,Soapstone and Stealite
Tin
SETTLEMENT
BOUNDARY
Kilometers
0
5
10
SOURCE: DISTRICT RESOURCE MAP


INTEGRATED MAP FOR STRUCTURALLY CONTROLLED HYDROTHERMAL VEIN TYPE MINERALIZATION
77°40'0"E
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77°50'0"E
77°55'0"E
78°0'0"E
11°55'0"N
11°50'0"N
11°45'0"N
11°40'0"N
11°35'0"N
11°30'0"N
11°25'0"N
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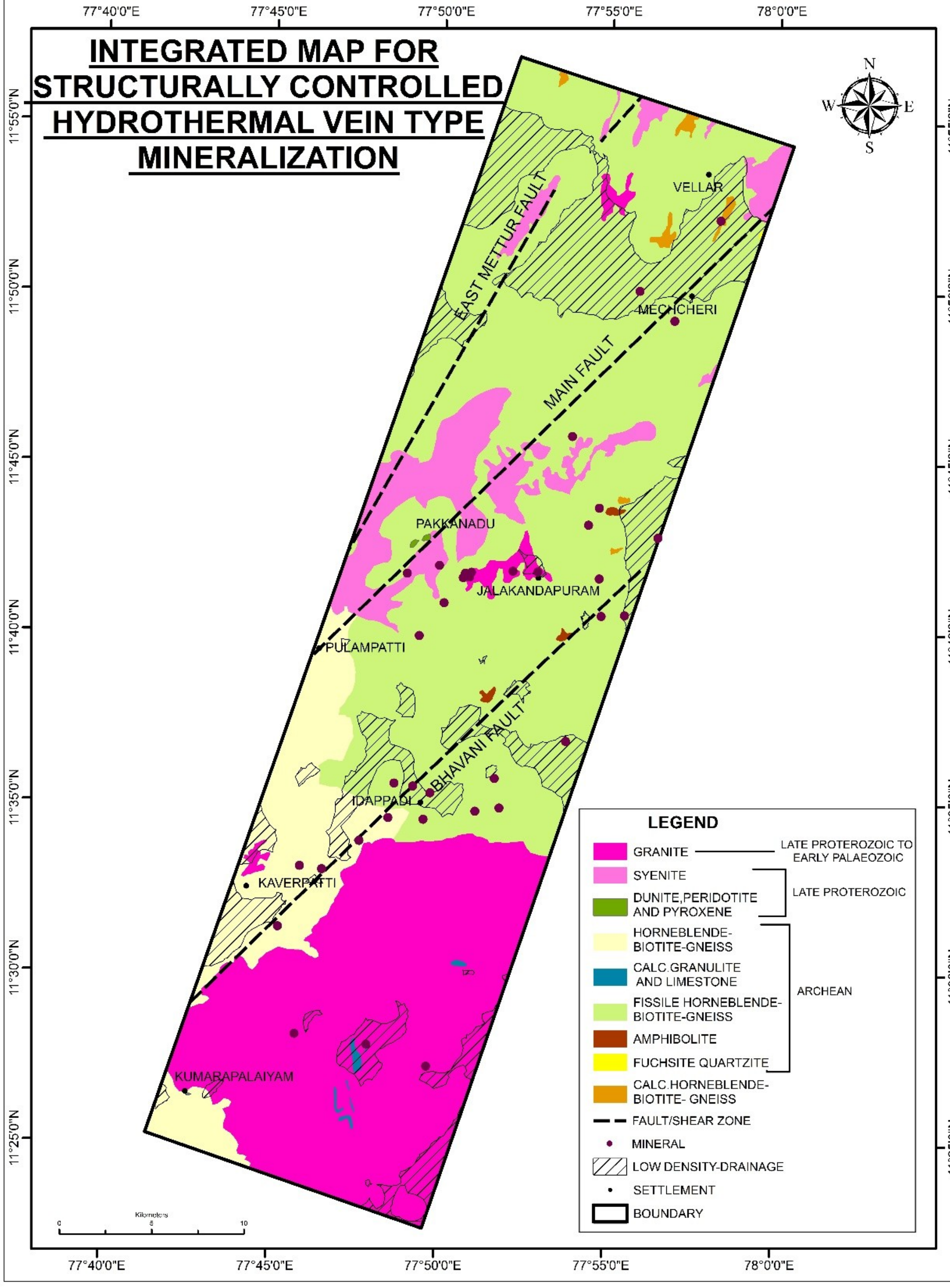
EAST METTUR FAULT
MAIN FAULT
BHAVANI FAULT
VELLAR
MECHCHERI
PAKKANADU
JALAKANDAPURAM
PULAMPATTI
IDAPPADI
KAVERPATTI
KUMARAPALAIYAM
LEGEND
GRANITE
LATE PROTEROZOIC TO EARLY PALAEOZOIC
SYENITE
DUNITE,PERIDOTITE AND PYROXENE
LATE PROTEROZOIC
HORNEBLENDE-BIOTITE-GNEISS
CALC.GRANULITE AND LIMESTONE
FISSILE HORNEBLENDE-BIOTITE-GNEISS
AMPHIBOLITE
FUCHSITE QUARTZITE
ARCHEAN
CALC.HORNEBLENDE-BIOTITE- GNEISS
FAULT/SHEAR ZONE
MINERAL
HIGH DENSITY-LINEAMENT
SETTLEMENT
BOUNDARY
Kilometers
0
5
10


INTEGRATED MAP FOR STRUCTURALLY CONTROLLED HYDROTHERMAL VEIN TYPE MINERALIZATION
77°40'0"E
77°45'0"E
77°50'0"E
77°55'0"E
78°0'0"E
11°55'0"N
11°50'0"N
11°45'0"N
11°40'0"N
11°35'0"N
11°30'0"N
11°25'0"N
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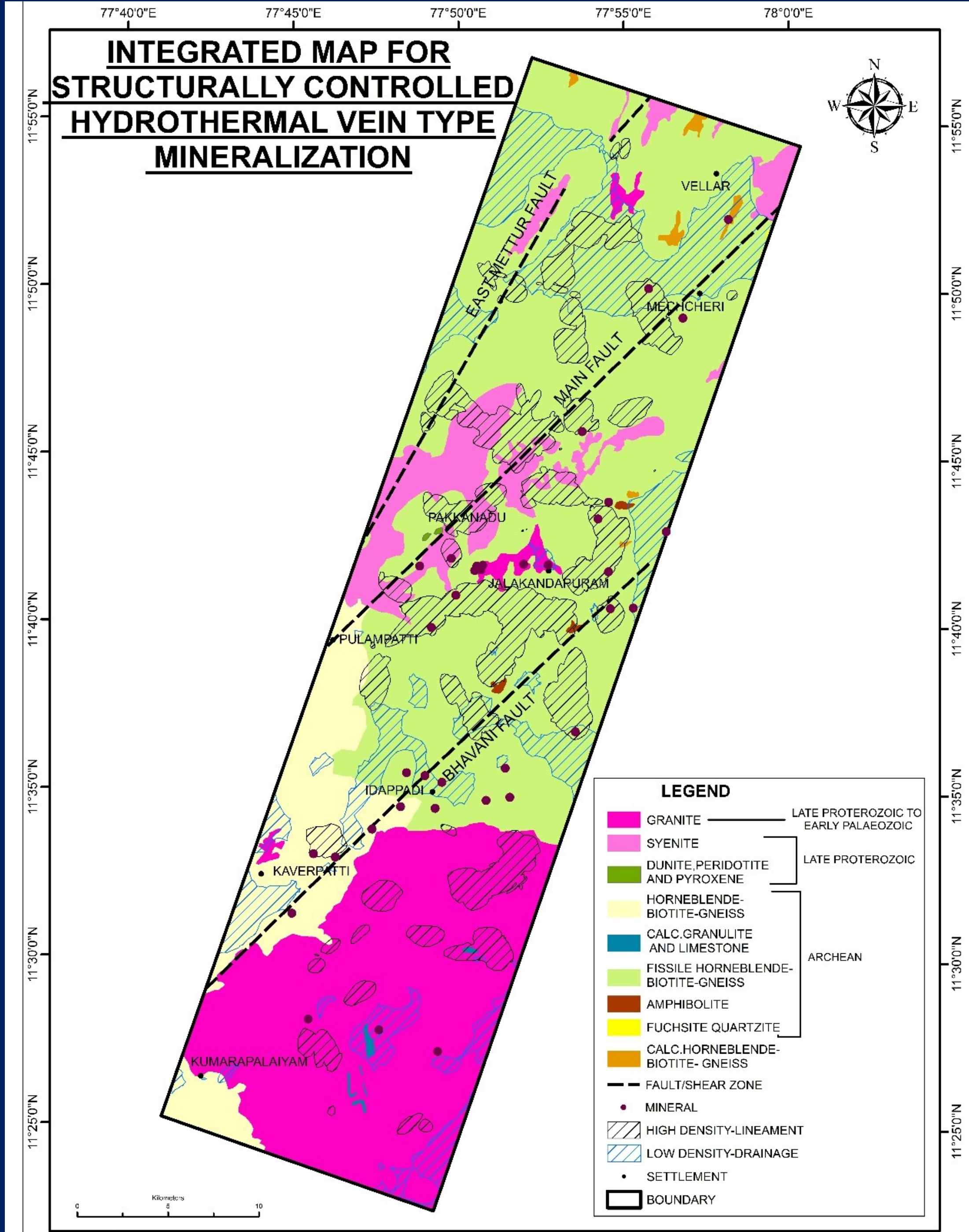
EAST METTUR FAULT
MAIN FAULT
BHAVANI FAULT
VELLAR
MECHCHERI
PAKKANADU
JALAKANDAPURAM
PULAMPATTI
IDAPPADI
KAVERPATTI
KUMARAPALAIYAM
Kilometers
0
5
10
LEGEND
GRANITE
LATE PROTEROZOIC TO EARLY PALAEOZOIC
SYENITE
DUNITE,PERIDOTITE AND PYROXENE
LATE PROTEROZOIC
HORNEBLENDE-BIOTITE-GNEISS
CALC.GRANULITE AND LIMESTONE
FISSILE HORNEBLENDE-BIOTITE-GNEISS
ARCHEAN
AMPHIBOLITE
FUCHSITE QUARTZITE
CALC.HORNEBLENDE-BIOTITE- GNEISS
FAULT/SHEAR ZONE
MINERAL
LOW DENSITY-DRAINAGE
SETTLEMENT
BOUNDARY


INTEGRATED MAP FOR STRUCTURALLY CONTROLLED HYDROTHERMAL VEIN TYPE MINERALIZATION
77°40'0"E
77°45'0"E
77°50'0"E
77°55'0"E
78°0'0"E
11°55'0"N
11°50'0"N
11°45'0"N
11°40'0"N
11°35'0"N
11°30'0"N
11°25'0"N
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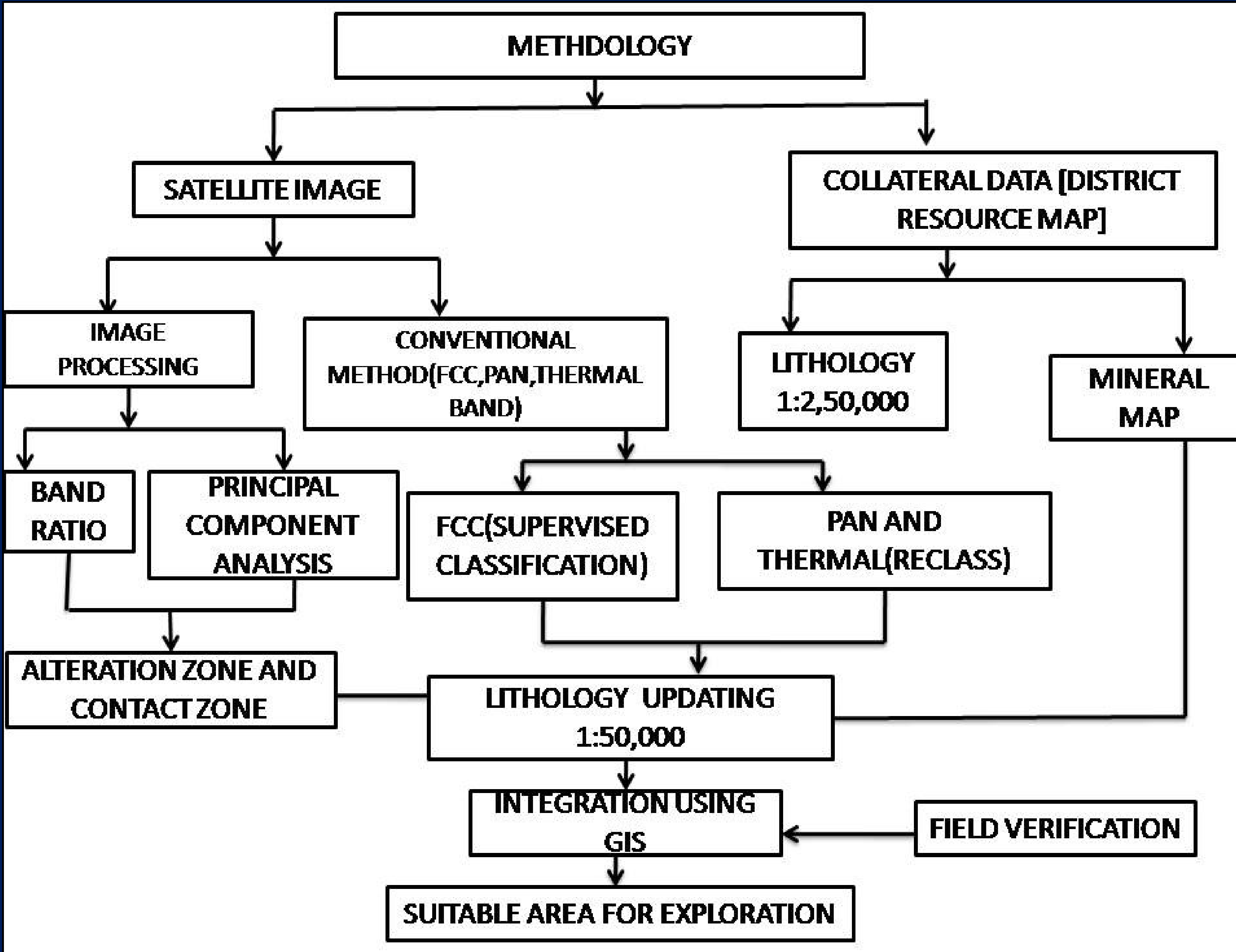
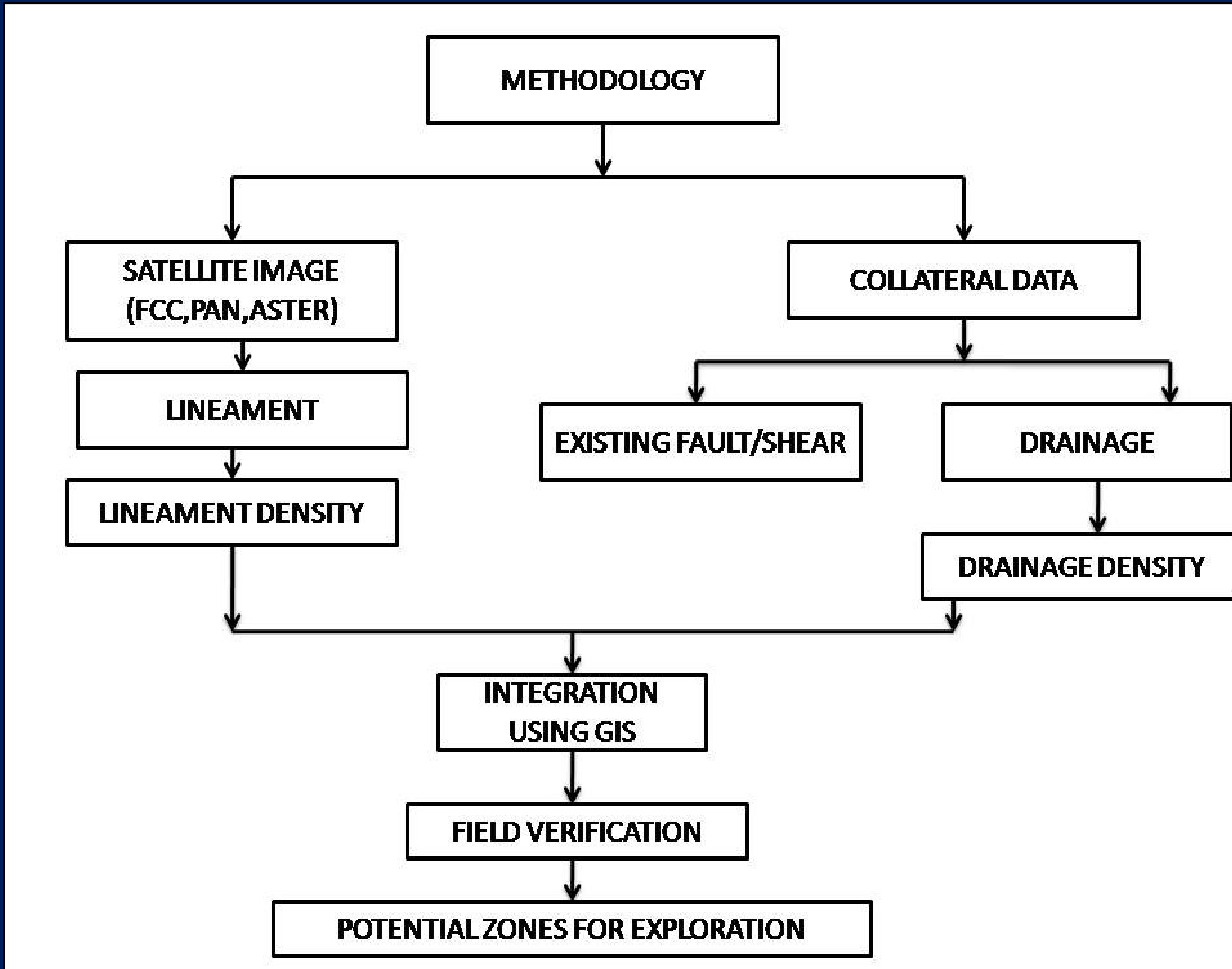
EAST METTUR FAULT
MAIN FAULT
BHAVANI FAULT
VELLAR
MECHCHERI
PAKKANADU
JALAKANDAPURAM
PULAMPATTI
IDAPPADI
KAVERPATTI
KUMARAPALAIYAM
Kilometers
0
5
10
LEGEND
GRANITE
LATE PROTEROZOIC TO EARLY PALAEOZOIC
SYENITE
DUNITE,PERIDOTITE AND PYROXENE
LATE PROTEROZOIC
HORNEBLENDE-BIOTITE-GNEISS
CALC.GRANULITE AND LIMESTONE
FISSILE HORNEBLENDE-BIOTITE-GNEISS
AMPHIBOLITE
FUCHSITE QUARTZITE
ARCHEAN
CALC.HORNEBLENDE-BIOTITE- GNEISS
FAULT/SHEAR ZONE
MINERAL
HIGH DENSITY-LINEAMENT
LOW DENSITY-DRAINAGE
SETTLEMENT
BOUNDARY

MINERAL	ASSOCIATED ROCK
BIOTITE	SCHISTS,INTRUSIVE GRANITIC ROCKS; SOME FELSIC VOLCANICS; SOMETIMES IN INTERMEDIATE AND MAFIC INTRUSIVES
MUSCOVITE	SCHISTS; PHYLLITES; GRANITES; GRANITIC PEGMATITES
TALC	SCHISTS; LOW-TEMPERATURE METAMORPHISM OF MAFIC ROCKS AND DOLOSTONES
MAGNESITE	HYDROTHERMAL DEPOSITS IN PERDOTITES AND OTHER ULTRAMAFIC IGNEOUS ROCKS; PEGMATITES; SERPENTINITES;TALC SCHICTSLIMESTONES; DOLOSTONES
COLUMBITE AND TANTALITE	GRANITIC INTRUSIVE, INCLUDING PEGMATITES
PYRITE	COMMON IN MANY LITHOLOGIES, INCLUDING INTRUSIVE IGNEOUS ROCKS, LIMESTONES, SHALES, METAMORPHIC ROCKS, AND HYDROTHERMAL DEPOSISTS; MAY ALSO REPLACE FOSSILS
ORTHOCLASE	GRNITES; GRANODIORITES; SYENITES; GRANITIC PEGMATITES; GNEISSES; ARKOSIC SANDSTONES AND CONGLOMERATES
PLAGIOCLASE	INTRUSIVE IGNEOUS ROCKS OF VARIOUS TYPES (FOR EXAMPLE, GRANITES, SYENITES, AND GABBROS); FELSIC TO MAFIC VOLCANICS; PEGMATITES; SCHISTS; GNEISSES; CONTACT METOMORPHIC LIMESTONES
BERYL	GRANITIC INTRUSIVE; PEGMATITES; BIOTITE SCHISTS
CHROMITE	PERIDOTITES; SERPENTINITES; OTHER ULTRAMAFIC ROCKS
QUARTZ	VERY COMMON;IGNEOUS ROCKS, ESPECIALLY FELSIC VOLCANICS AND GRANITIC INTRUSIVES AND PEGMATITES;SCHISTS, GNEISSES AND MOST OTHER METAMORPHIC ROCKS;SANDSTONES AND MOST SEDIMENTARY ROCKS, EVEN MANY CARBONATE ROCKS
CALCITE	LIMESTONES; MANY MARINE FOSSILS CHALK;MARBLES;HOT SPRING; CARBONITITES; VEIN IN SOME METAMORPHIC AND IGNEOUS ROCKS


METHDOLOGY
SATELLITE IMAGE
COLLATERAL DATA [DISTRICT RESOURCE MAP]
IMAGE PROCESSING
CONVENTIONAL METHOD(FCC,PAN,THERMAL BAND)
LITHOLOGY 1:2,50,000
MINERAL MAP
BAND RATIO
PRINCIPAL COMPONENT ANALYSIS
FCC(SUPERVISED CLASSIFICATION)
PAN AND THERMAL(RECLASS)
ALTERATION ZONE AND CONTACT ZONE
LITHOLOGY UPDATING 1:50,000
INTEGRATION USING GIS
FIELD VERIFICATION
SUITABLE AREA FOR EXPLORATION


METHODOLOGY
SATELLITE IMAGE (FCC,PAN,ASTER)
COLLATERAL DATA
LINEAMENT
EXISTING FAULT/SHEAR
DRAINAGE
LINEAMENT DENSITY
DRAINAGE DENSITY
INTEGRATION USING GIS
FIELD VERIFICATION
POTENTIAL ZONES FOR EXPLORATION

Greenfields and brownfields

Exploration is termed either Greenfields or Brownfields depending on the extent to which previous exploration has been conducted.

Greenfields refers to unspoilt grass, and brownfields to that which has been firmed on repeatedly.

The general meaning of brownfields exploration is that which is conducted within geological terrain within close proximity to known ore deposits. Greenfields are the remainder.

Greenfields exploration is highly conceptual, relying on the predictive power of ore genesis models to search for mineralisation in unexplored virgin ground

Greenfield exploration depend on predictive power of ore genesis models to find mineral deposits in previously unexplored areas or in areas where they are not already known to exist.

When a geologist has a conceptual idea about where a mineral deposit might be and spends money to see if the mineralization is really there, this is referred to as grassroot exploration. Common activities include: airborne satellite surveys, ground based geological and geophysical prospecting and surveying as well as determining drill target areas. Grassroot exploration projects are the riskiest projects in the mining business. Some statistics indicate that only 1 in 5,000 to 1 in 10,000 grassroot exploration projects ever reach the production stage.

Greenfields exploration is highly conceptual, relying on the predictive power of ore genesis models to search for mineralisation in unexplored virgin ground. This may be territory which has been drilled for other commodities, but with a new exploration concept is considered prospective for commodities not sought there before.

The success rate of exploration and the return on investment is low because exploration is an inherently risky business. Figures for success rates depend on the commodity in question but a good strike rate can be measured in the oil industry; the supergiant Prudhoe Bay oilfield was found on the 12th well drilled into the area. Within gold deposits a discovery hole may be one in one thousand and within some base metals commodities strike rates range from one in fifty to one in one hundred.

Greenfields exploration has a lower strike rate, because the geology is poorly understood at the conception of an exploration program but the rewards are greater because it is easier to find the biggest deposit in an area earlier, and it is only with more effort that the smaller satellite deposits are found. Brownfields exploration is less risky, as the geology is better understood and exploration methodology is well known, but since most large deposits are already found the rewards are incrementally less.

The general meaning of brownfields exploration is that which is conducted within geological terrain within close proximity to known ore deposits.

In brownfield exploration, geologists look for deposits near or adjacent to an already operating mine. As geologists are able to use existing data, the risk in brownfield exploration is considerably lower than in greenfield exploration. Because the facilities for mining and processing the ore have already been built and paid for, the additional capital cost for processing the new found ore is very low

Prognostic map indicates the only area in which to search for new mineral deposits.

A geological map showing the relative likelihood position for finding areas of ne w mineral deposits in individual regions of the territory being mapped.

A quantitative prognosis assesses the possible or geological reserves of minerals in mineral deposits on territories that appear promising.

Prognostic maps are usually compiled on a scale of 1:200,000 to 1:10,000, on the basis of metallogenic maps.

They show areas with known deposits, areas in which the prospect of discovering new mineral deposits is promising, and areas that are not promising.

Based on how favorable the chances are for discovering minerals, promising areas are usually classified as most promising, promising, and somewhat promising.

By correlation to areas with established mineral deposits, promising areas are established by mapping those geological factors that control the disclosed deposits.

It included the factors of stratigraphy, lithology, tectonics, magmatism, and metamorphism, either singly or in combination.

The geological factors that make it possible to forecast the distribution of mineral deposits are evaluated either visually or mathematically, by factor analysis.

In the latter case, the significance of each geological factor for the forecast is evaluated in points, and the total makes it possible to determine which areas are most favorable for discovering new deposits.

When prognostic maps are compiled, areas in which to search for new mineral deposits are noted that are both on the surface of the earth and that lie deep within the earth without emerging on the surface.