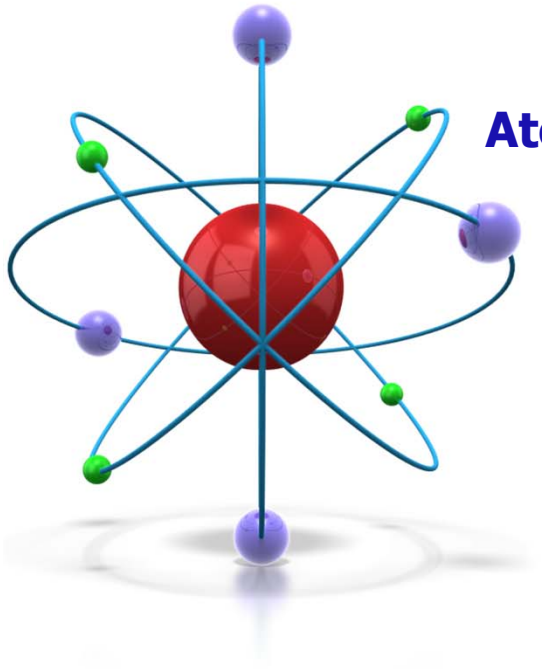
AN OVERVIEW OF URANIUM-RARE METAL-REE MINERALISATION, SONBHADRA DISTRICT, UTTAR PRADESH, INDIA



P. S. PARIHAR

Director

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Department of Atomic Energy

India

Cratons of India

1. Schist belts within nuclei
2. Tonalitic Gneiss
3. Granodiorite, gneisses and granulites of EPMB
4. K-granites in EPMB
5. Granulites and gneisses of MPMB
6. Middle Proterozoic Sedimentary Basins
7. Gondwana Sediments (Godavari Rift Valley)
8. Anorthosites along EPMB-MPMB contact
9. Eastern Ghat-Sukinda-Singhbhum Thrust
10. Deccan Trap Cover

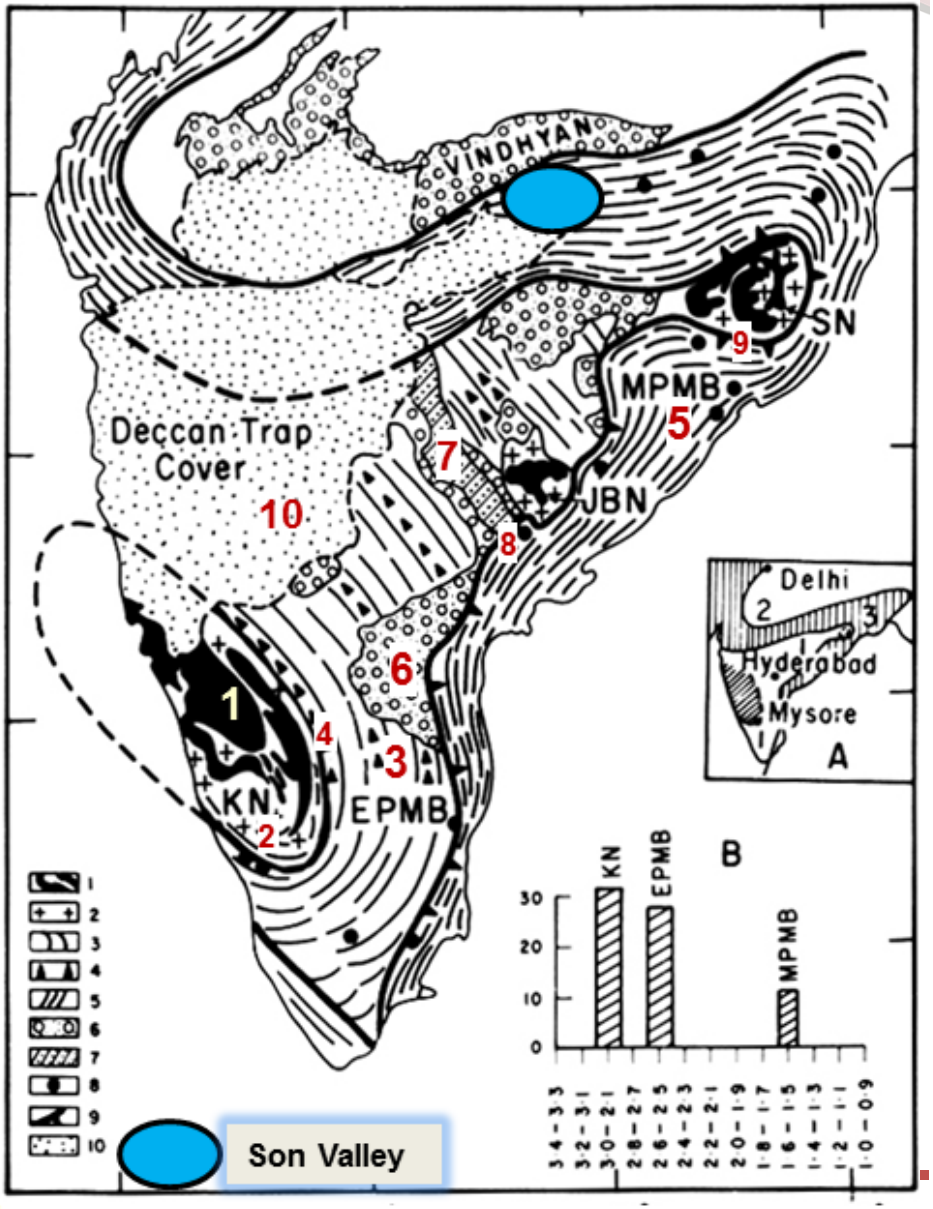
KN: Karnataka Nucleus

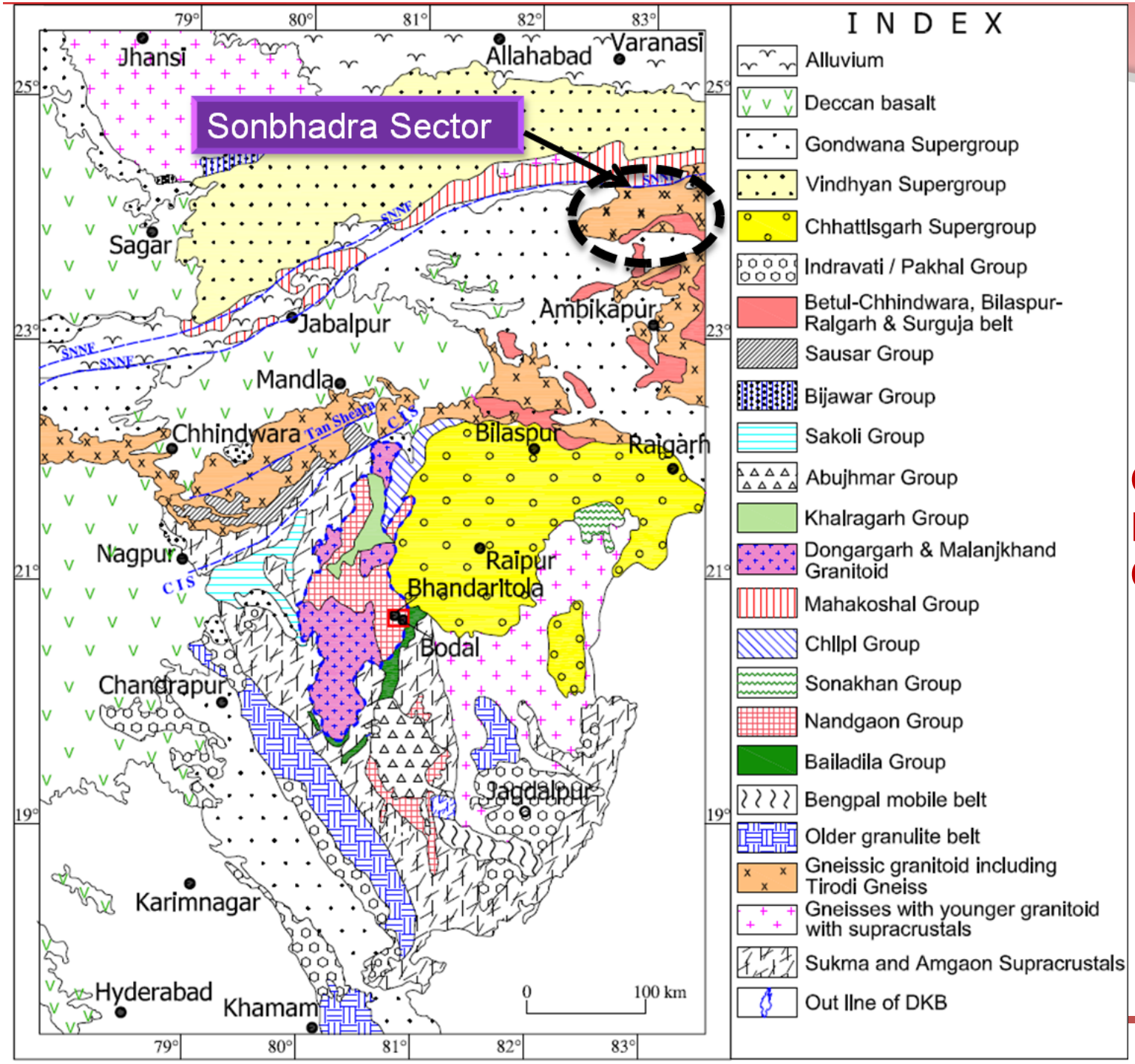
JBN: Jeypore-Bastar Nucleus

SN: Singhbhum Nucleus

EPMB: Early Proterozoic Mobile Belt

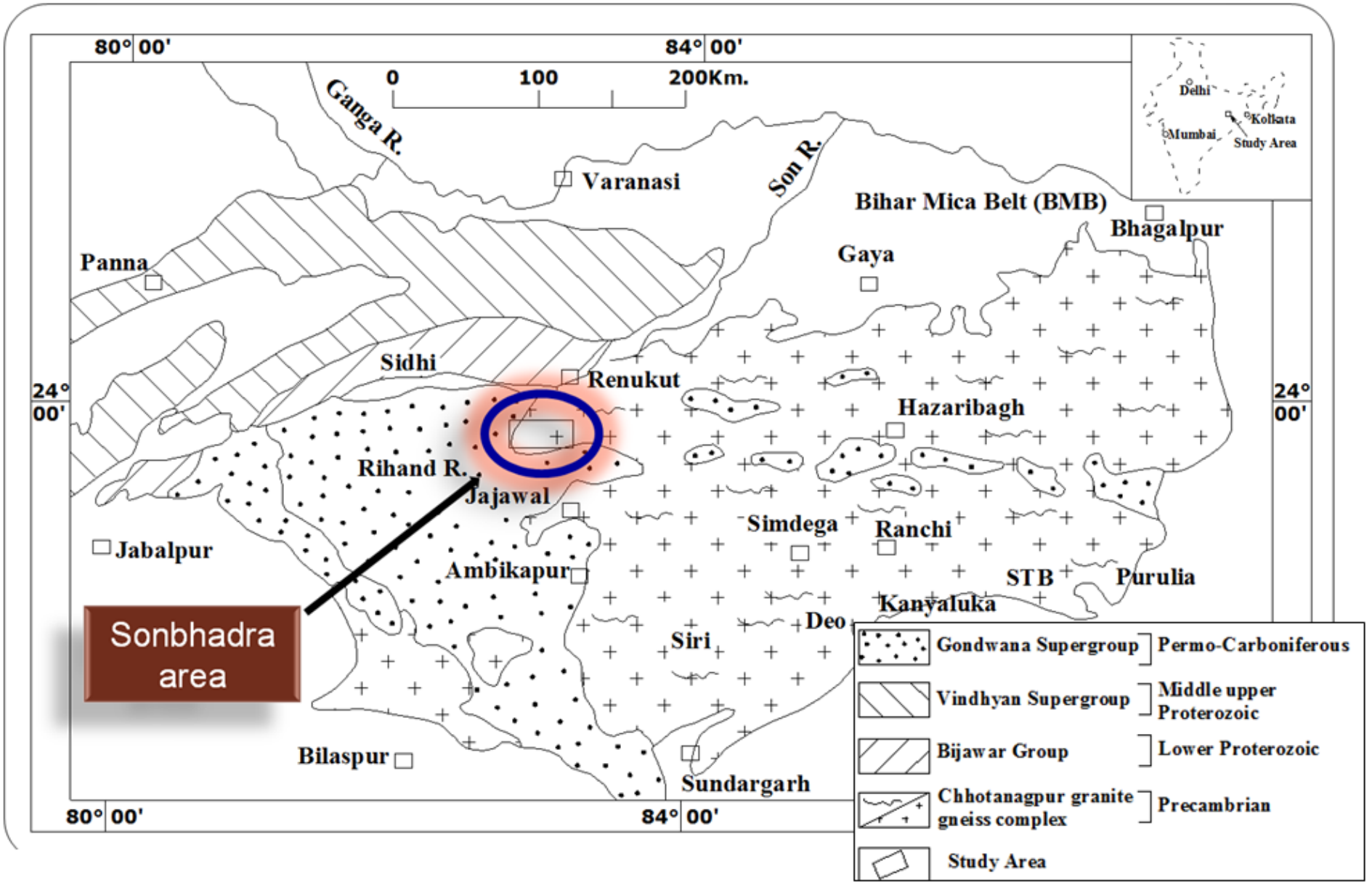
MPMB: Middle Proterozoic Mobile Belt





Geological Map of Central India

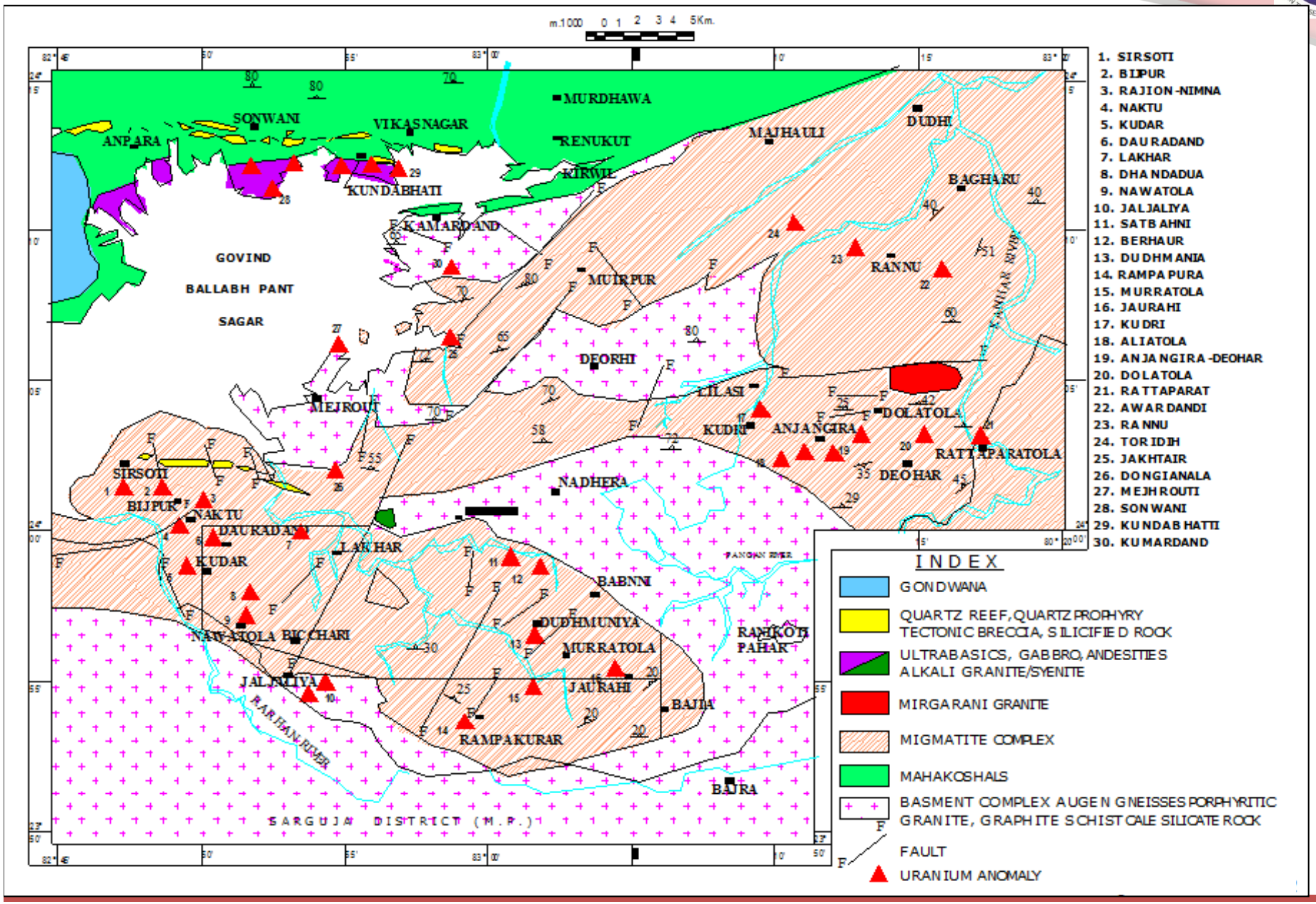
Geological Map of Chotanagpur Gneissic Complex (CGGC)



Migmatite Terrain, Son Valley

- Northwestern extensions of Chotanagpur Granite Gneiss Complex (CGGC)
  - Banded gneisses and metasedimentary enclaves, overlain by Mahakoshal supracrustals and Vindhyan Supergroup in the North and Gondwana Supergroup in the south
  - E-W, NE-SW and NW-SE faults and fractures
    - Youngest is E-W and is sympathetic to the Son-Narmada rift
  - Intense fracturing, brecciation and mylonitisation resulting in the development of dilated cataclastic breccia
- U-Nb-REE Mineralisation hosted by migmatites and younger intrusives over 350 sq km

Son valley


m.1000 0 1 2 3 4 5Km.
MURDHAWA
RENUKUT
KIRWIL
SONWANI
VIKASNAGAR
ANPARA
KUNDABHATI
KAMARDAND
GOVIND
BALLABH PANT
SAGAR
MUIRPUR
MAJHAULI
DUDHI
BAGHARU
RANNU
KANHAR RIVER
DEORHI
LILASI
MEJROUT
KUDRI
ANJANGIRA
DOLATOLA
RATTAPARATOLA
DEOHAR
SIRSOTI
BIJPUR
NAKTU
DAURADAND
LAKHAR
KUDAR
NADHERA
BABNNI
DUDHMUNIYA
MURRATOLA
JAURAHI
BAJIA
RAMPAKURAR
BAJRA
NAWATOLA
BICHARI
JALJALIYA
RAMPA KOTH PAHAR
SARGUJA DISTRICT (M.P.)
1. SIRSOTI
2. BIJPUR
3. RAJION-NIMNA
4. NAKTU
5. KUDAR
6. DAURADAND
7. LAKHAR
8. DHANDADUA
9. NAWATOLA
10. JALJALIYA
11. SATBAHNI
12. BERHAUR
13. DUDHMANIA
14. RAMPA PURA
15. MURRATOLA
16. JAURAHI
17. KUDRI
18. ALIATOLA
19. ANJANGIRA -DEOHAR
20. DOLATOLA
21. RATTAPARAT
22. AWARDANDI
23. RANNU
24. TORIDIH
25. JAKHTAIR
26. DONGIANALA
27. MEJHROUTI
28. SONWANI
29. KUNDABHATTI
30. KUMARDAND
INDEX
GONDWANA
QUARTZ REEF, QUARTZ PROPHYRY TECTONIC BRECCIA, SILICIFIED ROCK
ULTRABASICS, GABBRO, ANDESITIES ALKALI GRANITE/SYENITE
MIRGARANI GRANITE
MIGMATITE COMPLEX
MAHAKOSHALS
BASMENT COMPLEX AUGEN GNEISSES PORPHYRITIC GRANITE, GRAPHITE SCHIST CALE SILICATE ROCK
FAULT
URANIUM ANOMALY

Stratigraphy

Recent	Alluvium			Alluvium	
				Gondwana Cover Sediments	
Upper Vindhyan	-------Unconformity-----				
	Bhander Group (500-400 Ma)				
	-------Unconformity-----				
	Rewa Group (1150-750 Ma)				
	-------Unconformity-----				
	Kaimur Group (1150-750Ma)				
		Post Jungel Extrusives (919±21Ma)		Syenite, Alkali Feldspar Granite (Kundabhati-Sonwani)	
		Post Bijawar Acid Intrusive Phase II (1200-1100Ma)		Tourmaline Granite, Leucogranite (1200-1100Ma)	
L. Vindhyan	Semri Group (1400-1150Ma)		**DUDHI Gr.**		
				Mirgarani Formation	Granite
				Migmatite Complex	
		Post Bijawar Acid Intrusive Phase II - Jhirgadandi granite (1860±180Ma)		Metamorphites	
	Jungel Molasse			Transition sediments with QPC	
Upper Bijawar	Turbidite Group				
Middle Bijawar	Chemogenic Group				
Lower Bijawar	Greenstone Group				
---------- Fault/Unconformity----------					
Archaean Complex	Augen gneiss, porphyritic granite, granite gneiss, amphibolite, BHQ, Hornblende schist, dolomite, graphite schist, pyroxene granulite, leptynite & Calc-silicate rocks				

Uranium Mineralisation

- First reported in 1977-78
  - Asnahar in granite-gneiss,
  - Kushmahar in brecciated granite gneiss
  - Bammani-Bari in granite-syenite.

- Concerted exploration during 1988-1998
  - Naktu, Kudar, Nawatola, Lakhar, Sirsoti, Kudri, Kundabhati, Jaurahi, Anjangira

Categories of Mineralisation

A. Mineralisation within CGGC

- Pegmatoid Leucosome Mobilizate (PLM) within migmatite complex. e.g. Naktu, Kudar, Kudri etc.
- U-Nb-Ta-REE mineralisation associated with pegmatite injections within granitoids, e.g. Jaurahi
- Associated with surface breccia over migmatites, e.g. Kudar

B. Mineralisation within Mahakoshals

- Associated with anorogenic high potassic granites and episyenites, e.g. Kundabhati, Sonwani

Types of Mineralisation

- Based on host-rock Characteristics

1. Pegmatoid Leucosome Mobilizate (PLM) and Biotite Melanosome Mobilizate (BM) hosted
   - ❖ Soda-metasomatism is ubiquitous
   - ❖ U-Rare metal-Mineralisation
2. Potassic Granite and Syenite hosted
   - ❖ Rift-related anorogenic granites with episyenitisation
   - ❖ Extreme K-metasomatism
3. Brecciated Rock Hosted
4. Pegmatite Hosted
   - ❖ Rare-Metal and REE bearing

1. PLM and BMM Hosted Mineralisation

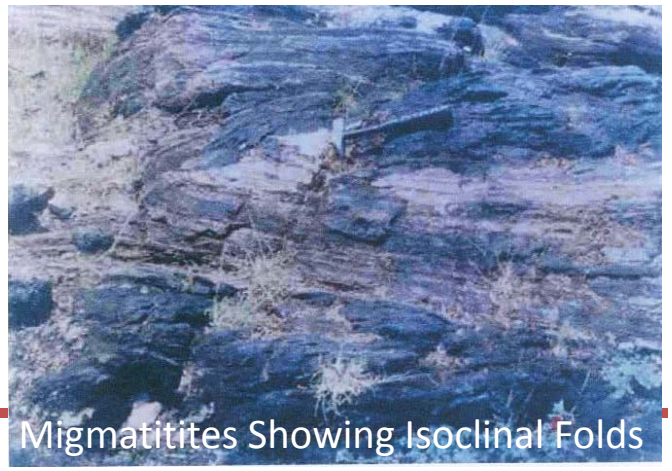
- Naktu, Kudar and Kudri
- Ore Minerals
  - Uraninite, Uranophane, Coffinite, Uranothorite, Samarskite, Fergusonite
  - Trace xenotime
    - Two types of uraninite: (a) rounded and euhedral crystals along biotite-albite interface and (b) as inclusions within albite and quartz.
- Imprints of Soda metasomatism
  - Replacement of alkali feldspar by albite
- Metallogeny
  - By the remobilization and concentration of the intrinsic U of the antecedent sediments, during migmatisation through anatectic processes

Migmatite

- Banded rocks of composite nature, constituted by paleosome, neosome, and melanosome
- Leucosome:
  - Hypidiomorphic texture, myrmekitic
    - Quartz, microcline, albite (minor biotite)
    - Accessories: zircon, apatite, sphene, hornblende, garnet
- PLM:
  - Medium grained to very coarse grained (pegmatoid) quartz-rich leucocratic suite
    - Quartz, sodic plagioclase, microcline, perthite and biotite
    - Zoned zircon, muscovite, apatite, purple fluorite, garnet and pyrite as accessories
    - Hypidiomorphic and myrmekitic texture
- Melanosome
  - Mainly biotite
  - Occasional quartz, microcline, plagioclase and graphite.


Dictyonitic Structure, Balsotha


Phelbitic Structure, Lakhar

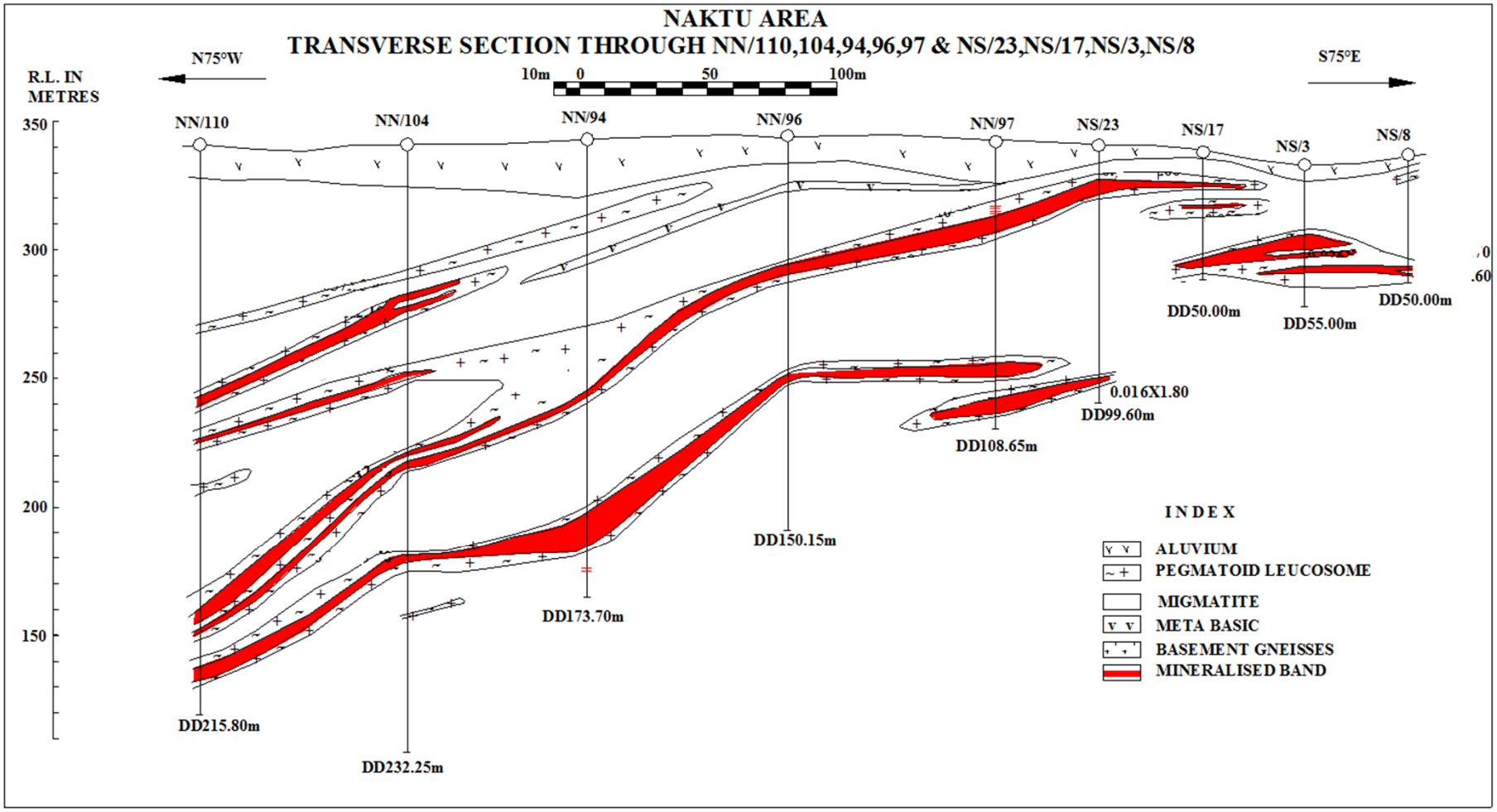

Migmatitites Showing Isoclinal Folds

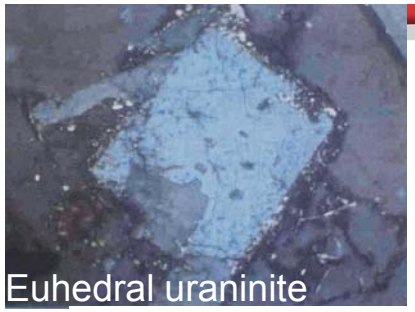
Naktu

Host Rock	Mode of Occurrence	Mineralisation
Pegmatoid Leucosome mobilzates (PLM)	a. Radioactive zone of 2200m x 0.50-8.0m (upto 0.14%U3O8) b. Lenticular bands, disposed in en-echelon pattern with frequent pinching and swelling	0.020-0.050% U_3O_8 x 1.20-1.50m **A. <u>Northern Block</u>** Only the main lode over 400m strike at a vertical depth of 5-70m (0.032%x4.58m) **B. Southern Block** Main lode + lodes on FW and HW side. Main lode between 5-150m vertical impact.

Naktu


Radioactive core, Naktu




Euhedral uraninite

Naktu

TRANSVERSE SECTION THROUGH NN/106,92,93,99,78,11 & NS/7,
NAKTU AREA, SONBHADRA, U.P.

Nature of Occurrence

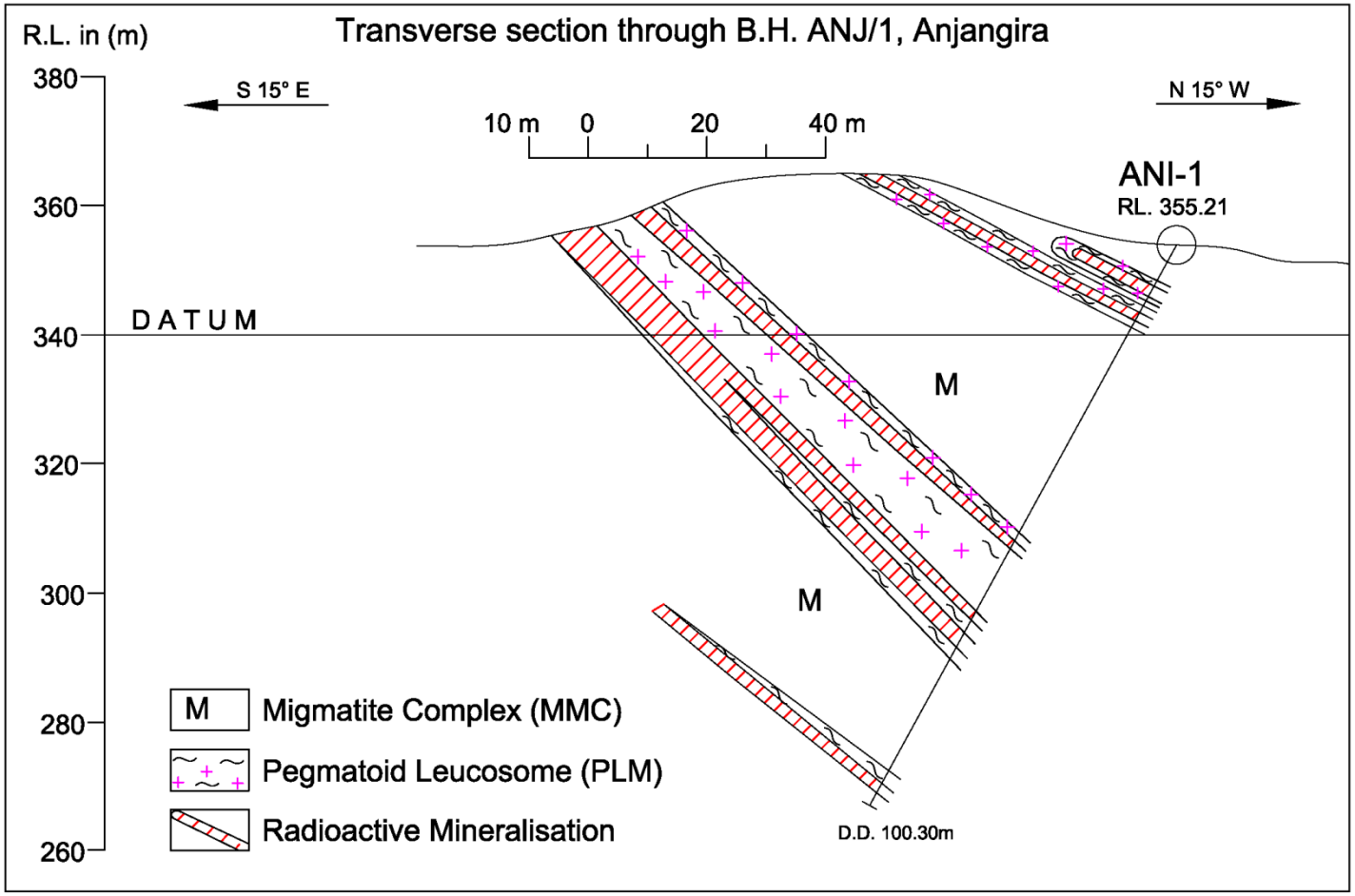
- As sheet-like mass with shallow to moderate rolling dips
- Lensoidal, in en-echelon manner
- Upto 1800m along the strike and 80-120m along the dip.
- Grade 0.010-1.00% U_3O_8

- Naktu-Kudar
  - Large thickness of Migmatite, with development of thick pegmatoid leucosome bands

- Kirwil-Kudri-Anjangira
  - Thin veneer of migmatites over basement, with thin PLM bands

Anjangira

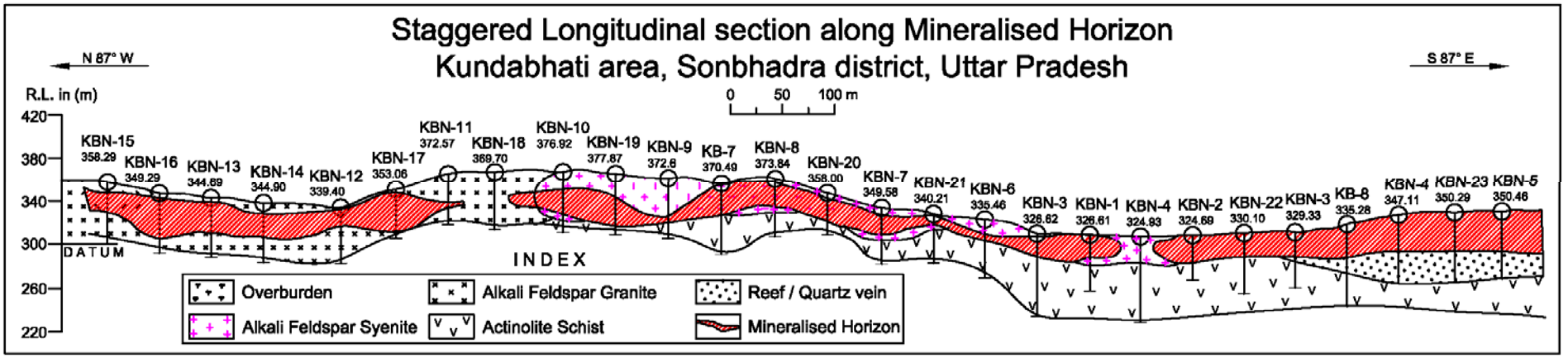
- Extends intermittently over 5km strike with 0.5-8.25m width
- 0.022-0.027%U_3O_8 x 1.60-7.90m at a depth of 7-100m
- Uranophane, phosphuranilite

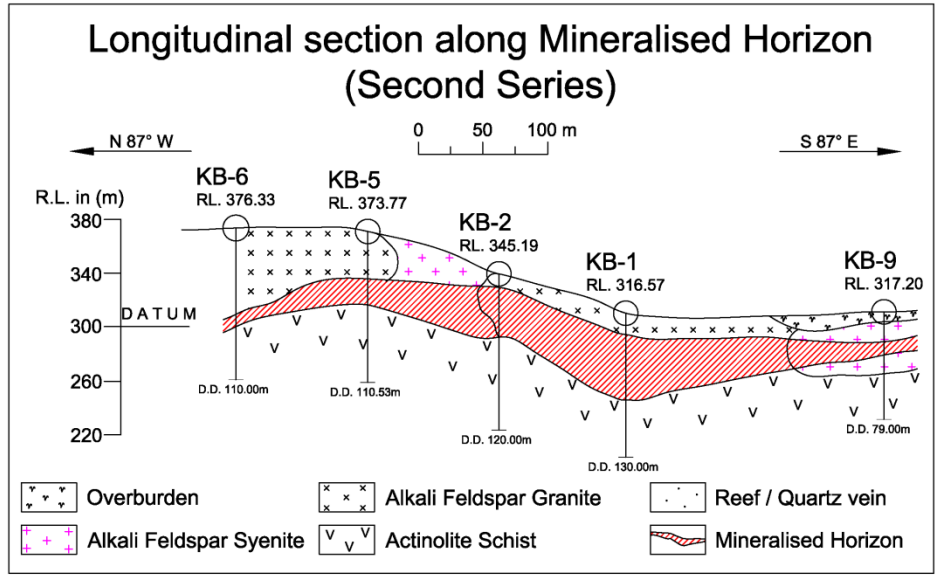


2. Potassic Granite and Syenite Hosted

- Kundabhati, Sonwani, Chitwar and Balsotha
  - Associated with rift-related plutons of anorogenic alkali granite along the Son-Narmada Fault.
  - Emplaced within Mahakoshal supracrustals
- Host:
  - Alkali feldspar granite and episyenites
    - Consisting of microcline, microcline-perthite, sericitised albite and quartz
  - Episyenitisation and desilicification
  - K-Fe metasomatism
- Ore Minerals
  - Uranophane

Kundabhati

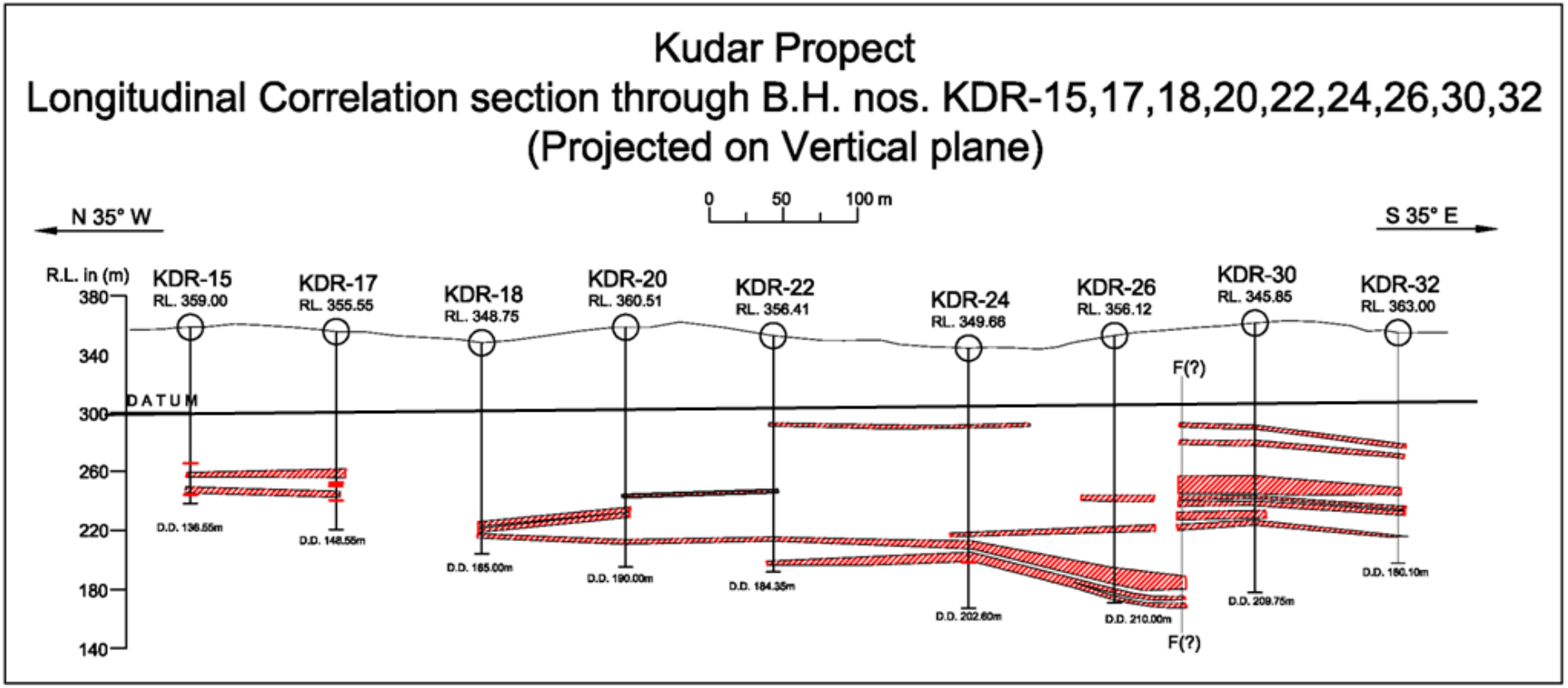

Staggered Longitudinal section along Mineralised Horizon
Kundabhati area, Sonbhadra district, Uttar Pradesh
N 87° W
S 87° E
R.L. in (m)
0 50 100 m
420
380
340
300
260
220
DATUM
KBN-15 358.29
KBN-16 349.29
KBN-13 344.69
KBN-14 344.90
KBN-12 339.40
KBN-17 353.06
KBN-11 372.57
KBN-18 369.70
KBN-10 376.92
KBN-19 377.87
KBN-9 372.6
KB-7 370.49
KBN-8 373.84
KBN-20 358.00
KBN-7 349.58
KBN-21 340.21
KBN-6 335.46
KBN-3 328.82
KBN-1 326.61
KBN-4 324.93
KBN-2 324.69
KBN-22 330.10
KBN-3 329.33
KB-8 335.28
KBN-4 347.11
KBN-23 350.29
KBN-5 350.46
INDEX
Overburden
Alkali Feldspar Granite
Reef / Quartz vein
Alkali Feldspar Syenite
Actinolite Schist
Mineralised Horizon


Longitudinal section along Mineralised Horizon
(Second Series)
N 87° W
S 87° E
0 50 100 m
R.L. in (m)
380
340
300
260
220
DATUM
KB-6 RL. 376.33
KB-5 RL. 373.77
KB-2 RL. 345.19
KB-1 RL. 316.57
KB-9 RL. 317.20
D.D. 110.00m
D.D. 110.53m
D.D. 120.00m
D.D. 130.00m
D.D. 79.00m
Overburden
Alkali Feldspar Granite
Reef / Quartz vein
Alkali Feldspar Syenite
Actinolite Schist
Mineralised Horizon

3. Brecciated Rock Hosted

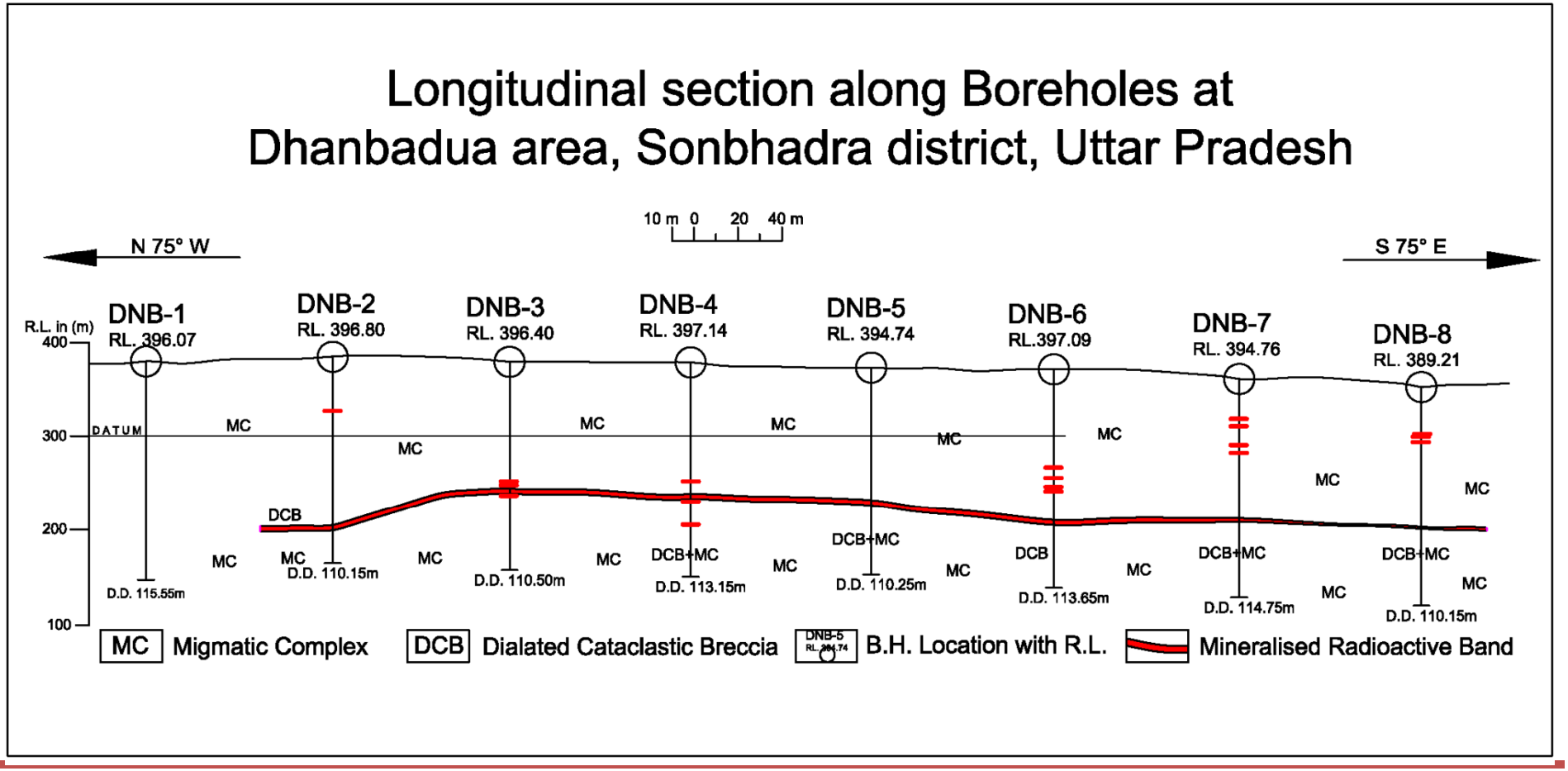
- Kudar
  - Breccia zones within migmatites
  - Surface extension of 1300m with a thickness of 1-4m.
  - Breccia hosted mineralised band (E-W) cuts across the country rock (NNW-SSE)
  - Two mineralised lenses of 250m (0.029%U_3O_8x2.90m) and 435m (0.035%U_3O_8x1.72m)
  - Ore Mineralogy:
    - Uraninite, uranophane, adsorbed U
    - Molybdenite, pyrrhotite,
    - Stilbite, secondary silica, chert, pyrite, chalcopyrite
    - Iron oxide coated

Kudar


Kudar Propect
Longitudinal Correlation section through B.H. nos. KDR-15,17,18,20,22,24,26,30,32
(Projected on Vertical plane)
N 35° W
0 50 100 m
S 35° E
R.L. in (m)
380
340
300
260
220
180
140
DATUM
KDR-15
RL. 359.00
KDR-17
RL. 355.55
KDR-18
RL. 348.75
KDR-20
RL. 360.51
KDR-22
RL. 356.41
KDR-24
RL. 349.66
KDR-26
RL. 356.12
KDR-30
RL. 345.85
KDR-32
RL. 363.00
F(?)
D.D. 136.55m
D.D. 148.55m
D.D. 185.00m
D.D. 190.00m
D.D. 184.35m
D.D. 202.60m
D.D. 210.00m
D.D. 209.75m
D.D. 180.10m
F(?)

Dhanbadua

Dialated cataclasic breccia (N80W-S80E) cutting across NW-SE trending migmatite



4. Pegmatite Hosted

- Jaurahi
- Rare-Metal and Rare earth bearing pegmatitic injections
- Ore Minerals
  - Columbite, Samarskite, Aescheynite and Thorite
  - Xenotime
  - Associated fluorite, zircon, fluor-apatite

General Characteristics of Mineralisation in Son Valley

Age	~ Paleo-Mesoproterozoic Chhotanagpur Granite Gneiss Complex (CGGC).
Host rock	Pegmatoid Leucosome mobilizate, Melanosome mobilizate, Anorogenic alkali feldspar granite
Plutonic Activity and Associated Changes	Rift related anorogenic granite, episyenitisation, Desilicification K-Fe metasomatism
Structure	E-W, NE-SW and NW-SE faults and fractures. E-W fracture system sympathetic to Son-Narmada Rift.
Mineralogy	Uraninite, Samarskite, fergusonite, columbite, aescheynite, Pyrite, Pyrrhotite Thorite, Fluorite, fluorapatite,

Genetic Aspects

- Imprints of repeated thermal tectonic and metamorphic reactivation
  - Formation of migmatites as a result of ultra-metamorphism of arkosic to psammopelitic sequence in extensional basins.
- Thermal regime in ultrametamorphism leading to anatexis led to:
  - the remobilization of intrinsic U in sediments
  - Subsequent concentration within the albite-rich pegmatoid leucosome and biotite rich melanosome
- Syn-tectonic plutonic activity also has contributed towards the mobilization and subsequent concentration of U
  - Mineralised episyenites are the product of shearing, brecciation and desilicification of anorogenic alkali granites.
- The multimetal mineralisation associated with magmatic pegmatites is a result of pneumatolytic/metasomatic activity at a later stage.

Concluding Remarks

- Low-grade, low-tonnage deposits at Naktu-Kundabhati sector
  - Anatectic and Associated Metasomatic events leading to concentration of uranium in pegmatoid leucosome
  - Presence of associated Rare metal minerals and rare earth minerals add to the potential of the area.
- The area has potential to host similar deposits.

Thank You