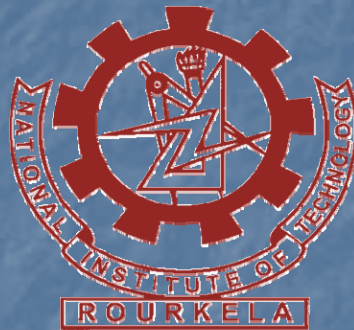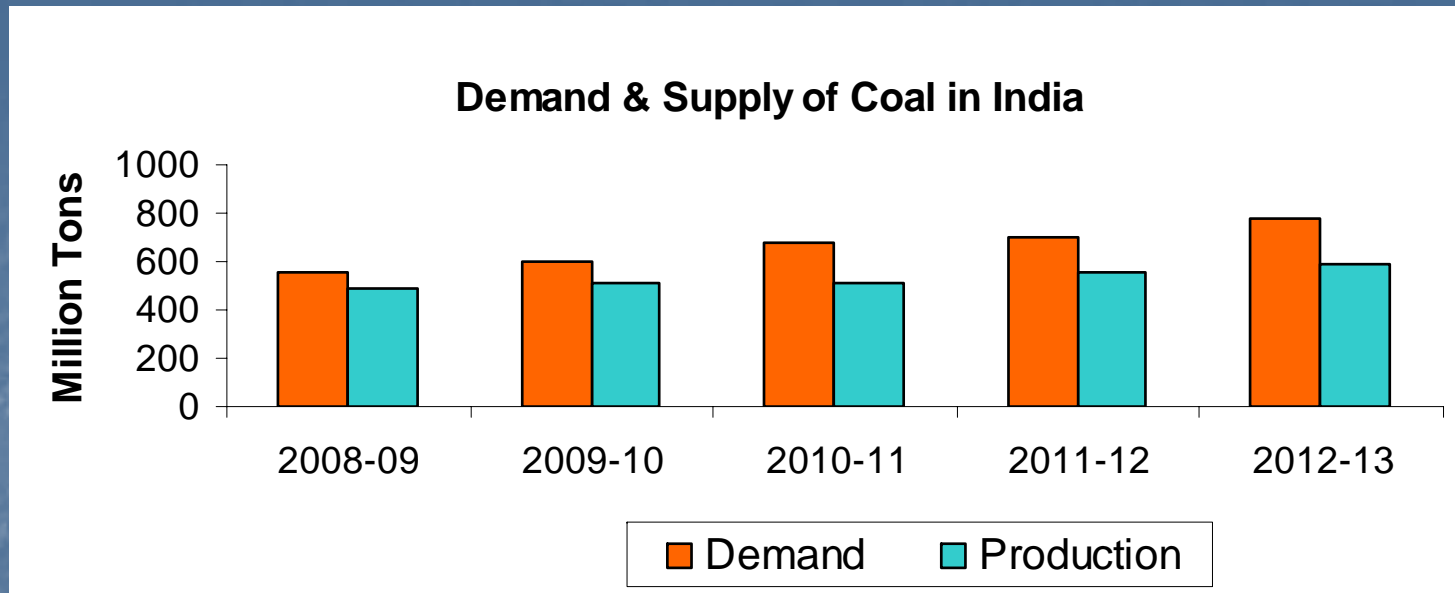# Mode of Occurrence of Trace Elements in Some Indian Coal

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Demand & Supply of Coal in India

- Coal is the most important source of energy. In India about 70% of the total electricity generation is derived from coal-based thermal power plants

- Total estimated coal reserve is 298 billion tons

- According to coal vision-2025, the coal production in 2025 is projected to 1086 million tons against 580 million tons (2012-13)

- Coal contains most of the elements in the periodic table.

- Coal combustion is one of the important anthropogenic sources, which release trace elements into the environment and increasing their concentrations above the natural background levels.

- Mobilization of elements is the major concern on ecosystems and health problems

- The mobilization and behavior during combustion is influenced by their mode of the occurrence in coal.

Effects of Trace Elements

- <u>Chromium</u>: Carcinogenic, kidney and liver damage, skin ulcers, allergies, etc.

- <u>Lead</u>: Anemia, hemoglobinuria, muscle discomfort, affects central nervous system (especially in children), embryos and fetuses.

- <u>Nickel</u>: Nausea, chest pain, headache, chronic bronchitis; hearts disorders, carcinogenic, etc.

- **Manganese:** Neurological disorder, skin problems, pneumonia, skeletal disorders, birth defects, etc

- **Copper:** Wilson's disease, Headaches, stomach aches, dizziness, vomiting and diarrhoea; liver and kidney damage & death; brain damage, etc

- **Zinc:** Stomach cramps, skin irritations, vomiting, nausea and anaemia; damage to pancreas and protein metabolism; arteriosclerosis etc
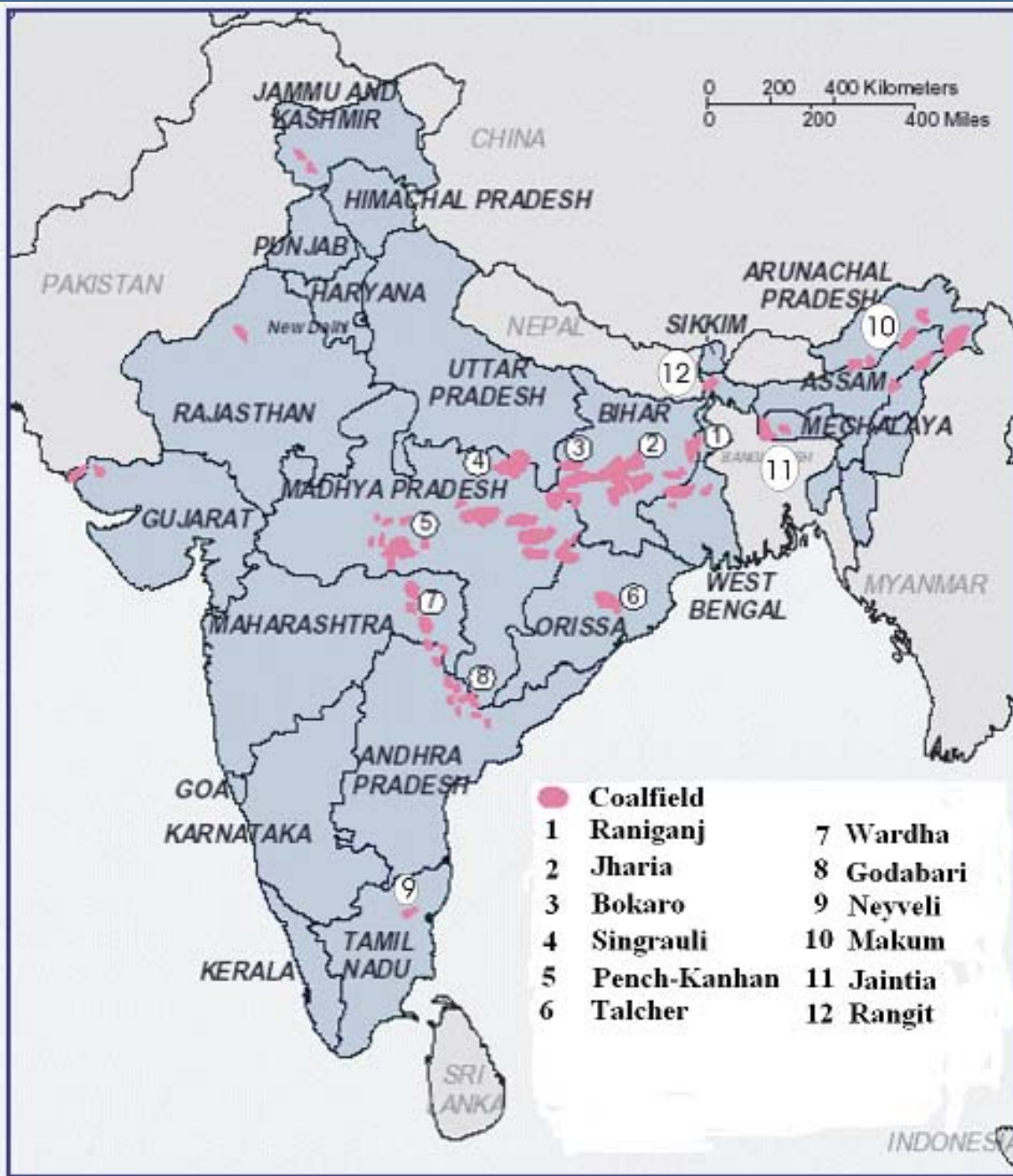
Mand-Raigarh (Central India)

Rangit valley (North-east India)

Neyveli (South India)

Geological Setting

Mand-Raigarh

Mand-Raigarh coalfield is located in Raigarh, Chhattisgarh and extends over an area of nearly 3700 km^2

Coal Reserve: 25 billion tons

Rank: Sub-bituminous

Age: Permian Coal

Moisture: 4-6%; Volatile Matter: 21-39%

Ash: 5-33; Fixed carbon: 33-59%

Rangit Valley

Located in Sikkim and some parts of West Bengal covering nearly 120 km^2

Reserve: 101 million tons

Rank: Semi-anthracite

Age: Permian coal

Moisture: 3.1-6.3%, Volatile Matter 6.4-11.8%, Ash: 15.3-25%; Fixed carbon 60-70%

Neyveli

Neyveli lignite is located in Coddalore District of Tamil Nadu and spreading over an area of nearly 480 km^2

Reserve: 3.5 billion tons

Age: Tertiary coal (Miocene)

Moisture 53%, Ash 3%, Volatile matter 24%, Fixed carbon 20.0%

Methodology

- Mineralogy: X-ray diffraction
- Powered sample (<74 µm)
- Whole coal sample for Mend-Raigarh and Rangit valley coal
- Low-temperature ashing (180 °C for 48 hours) for lignite
- Bulk chemical composition: Usin AAS after the whole coal digestion using mixture of HNO_3, HF and H_2O_2
- Fractionation study using sequential extraction method

Fraction	Reagents
Exchangeable	1 N CH_3COONH_4
Carbonates & monosulphides	3 N HCl
Silicates	48% HF
Disulphides	2 N HNO_3

Mineralogy

Neyveli Lignite

K: Kaolinite; B: Bassanite;
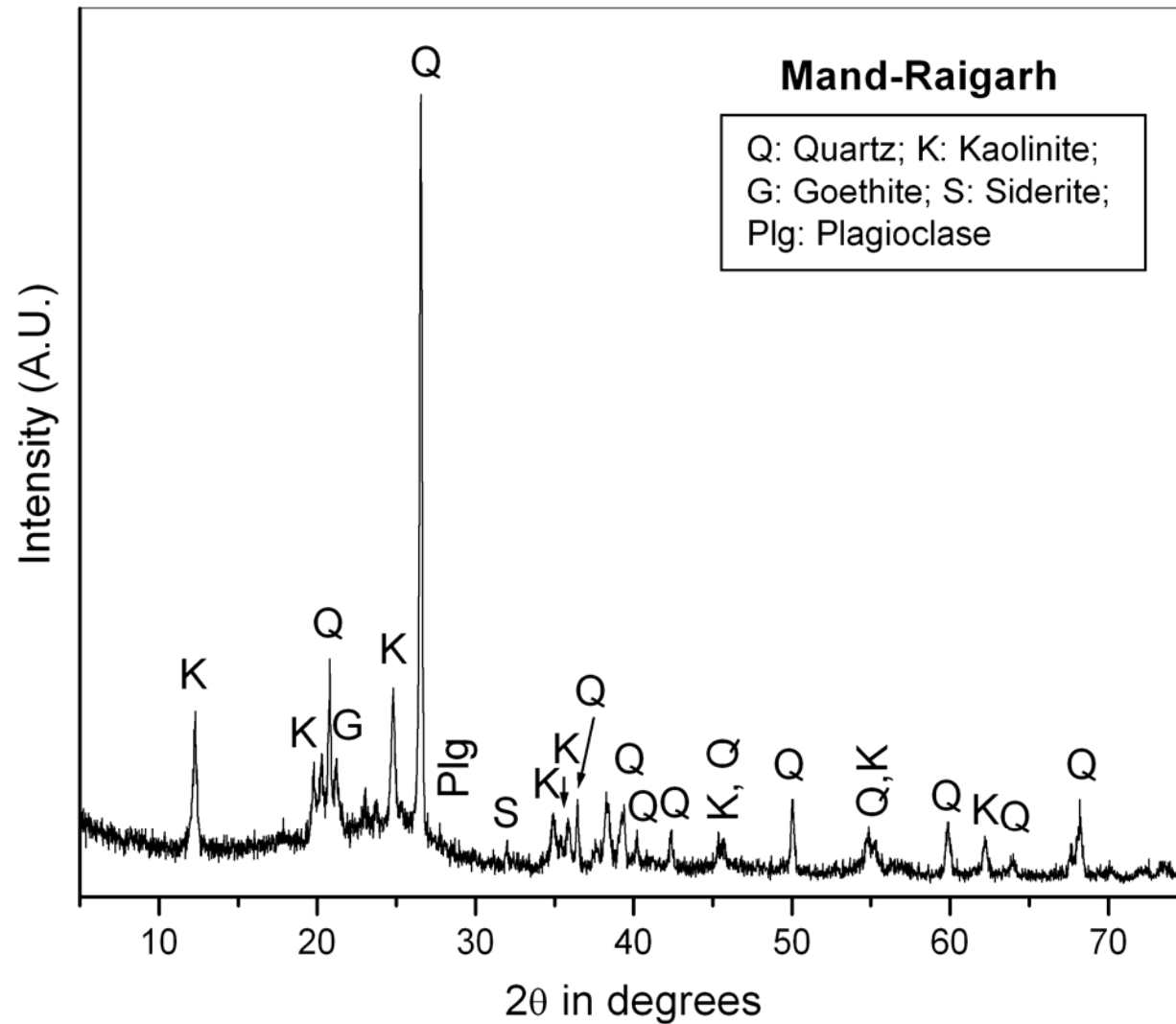D: Dolomite; S: Siderite;
P: Pyrite
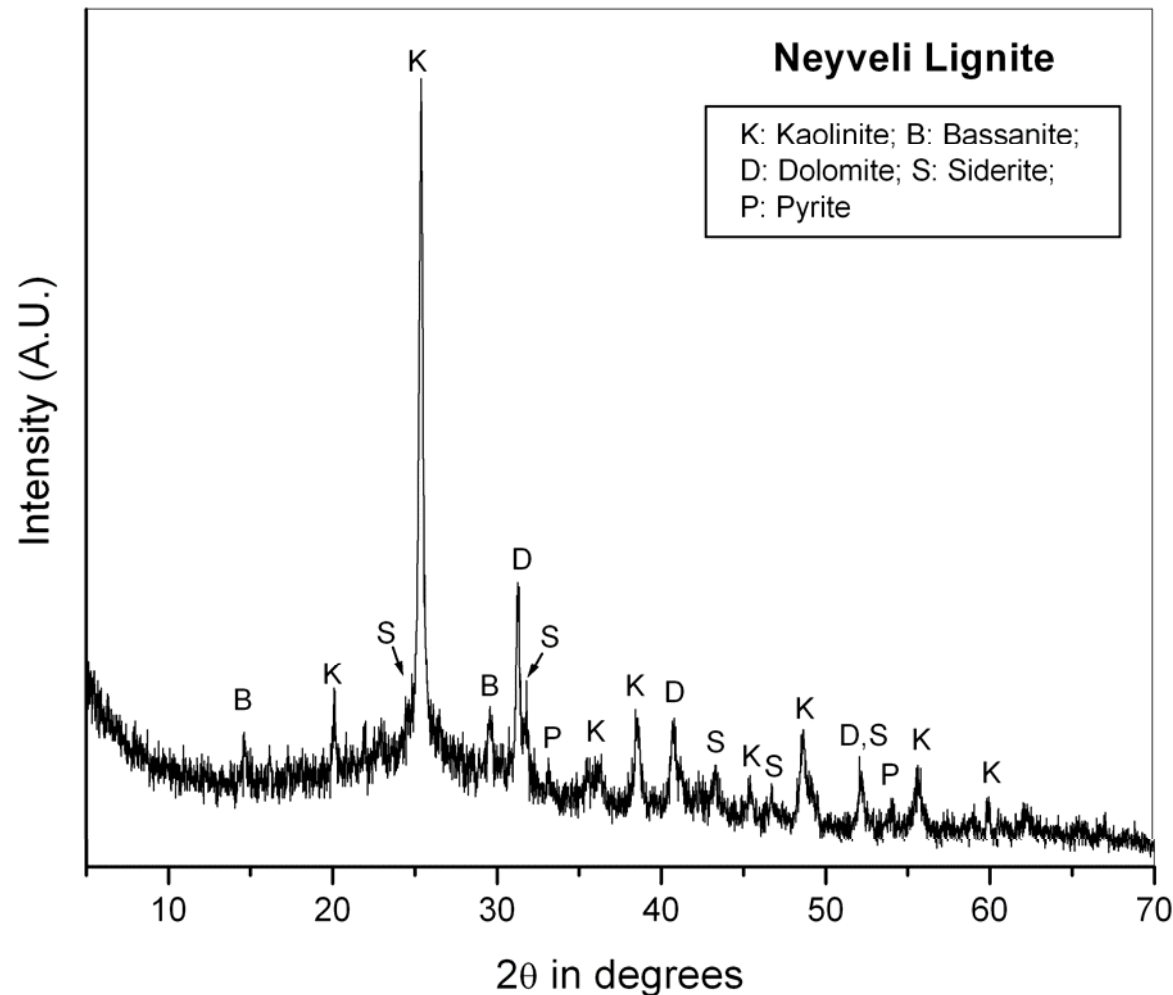
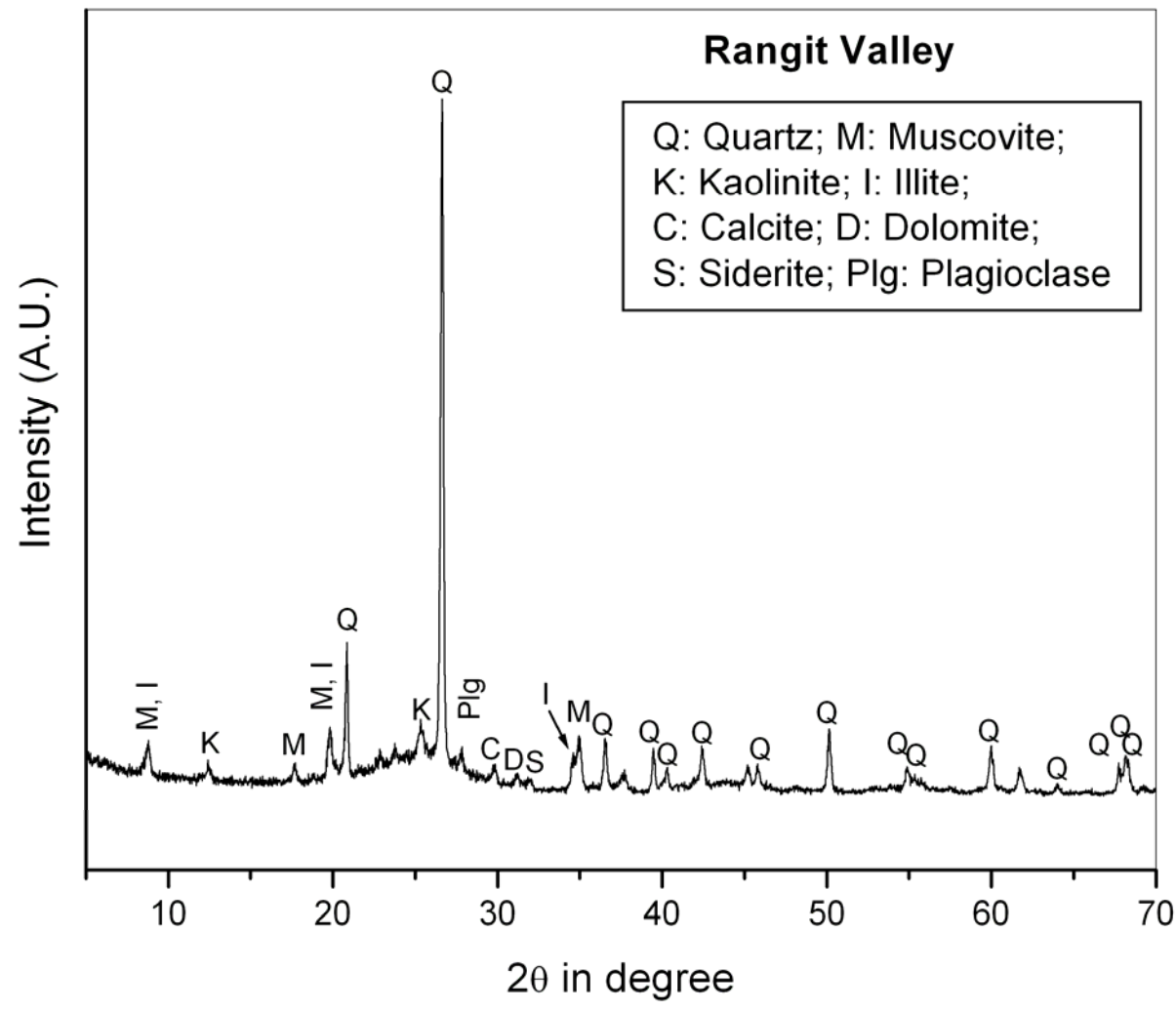Major mineral phases:
Kaolinite, Dolomite, Siderite

Intermediate mineral phases:
Bassanite, Pyrite

Major mineral phases:
Quartz, Kaolinite

Intermediate mineral phases:
Goethite, Siderite, Plagioclase
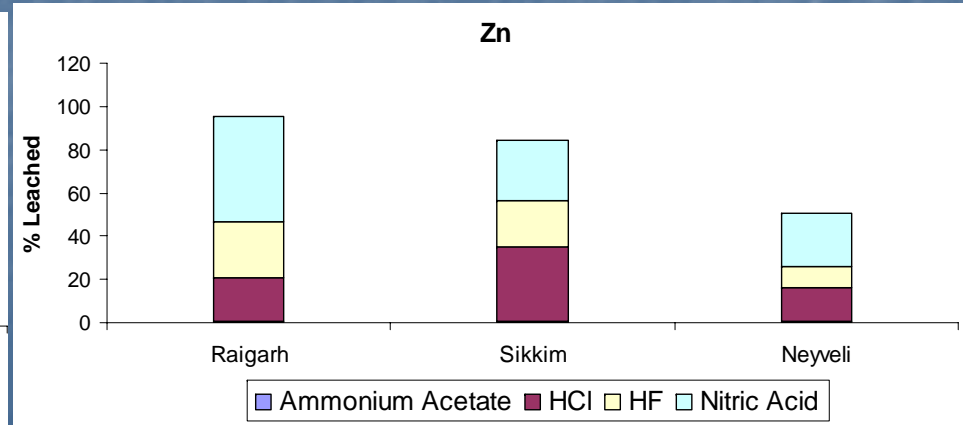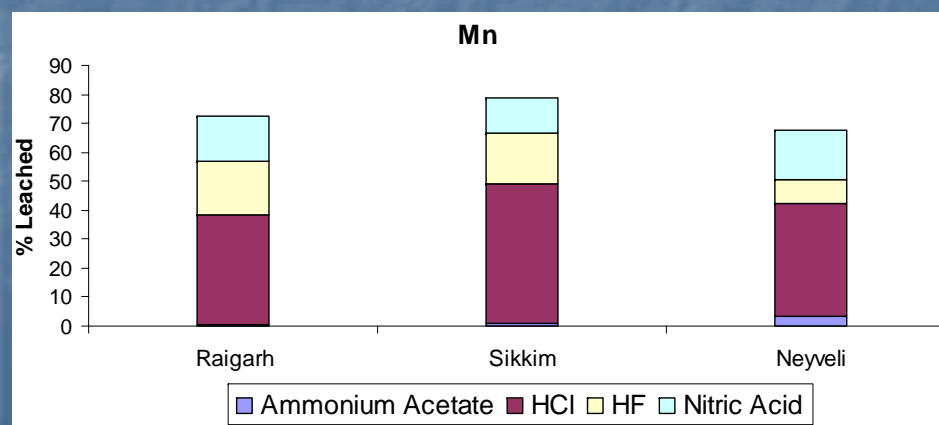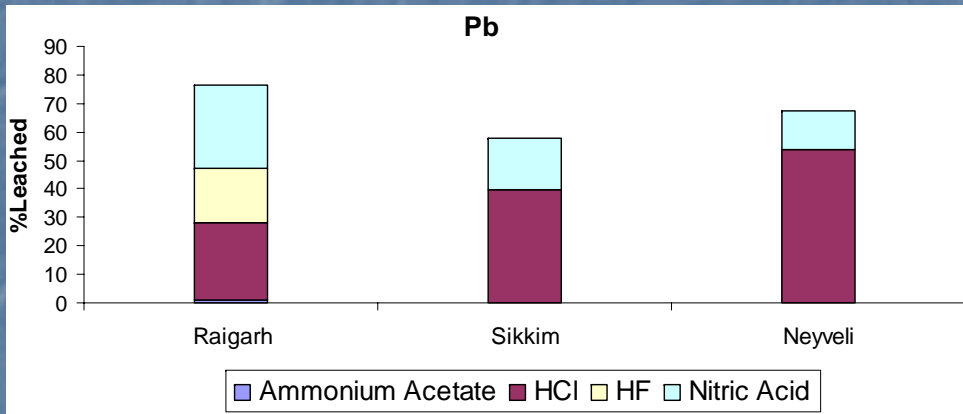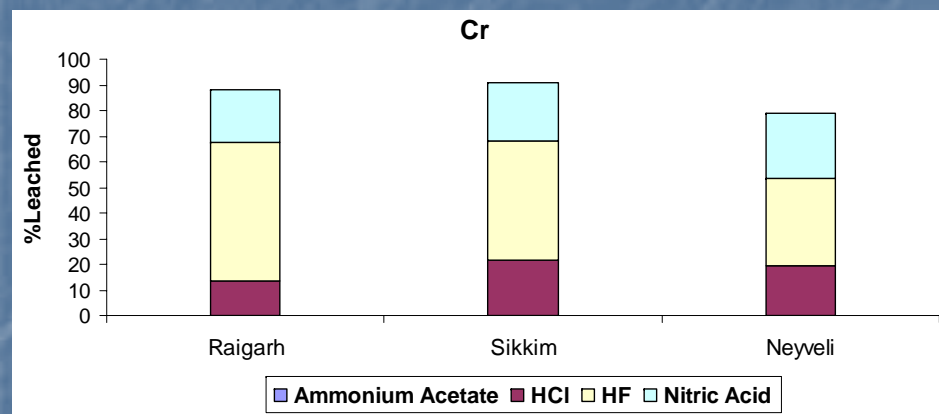
Major mineral phases:
Quartz, Muscovite, Illite

Intermediate mineral phases:
Kaolinite, Plagioclase, Dolomite, Calcite, Siderite

Trace Elements in Coal

Element	Mand-Raigarh	Rangit Valley	Neyveli	Indian Average	World Average
Cu	29.2	8.6	10.4	20	15.0
Zn	36.9	30.2	21.4	40	50.0
Ni	20.0	16.8	18.3	45	15.0
Cr	63.0	66.1	10.7	70	10.0
Pb	17.5	9.7	8.2	15	25.0
Mn	60.0	71.4	18.5	100	50.0
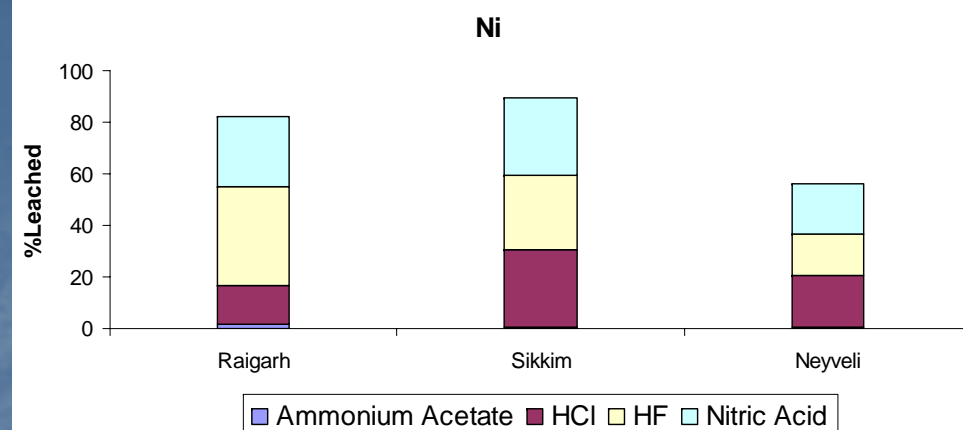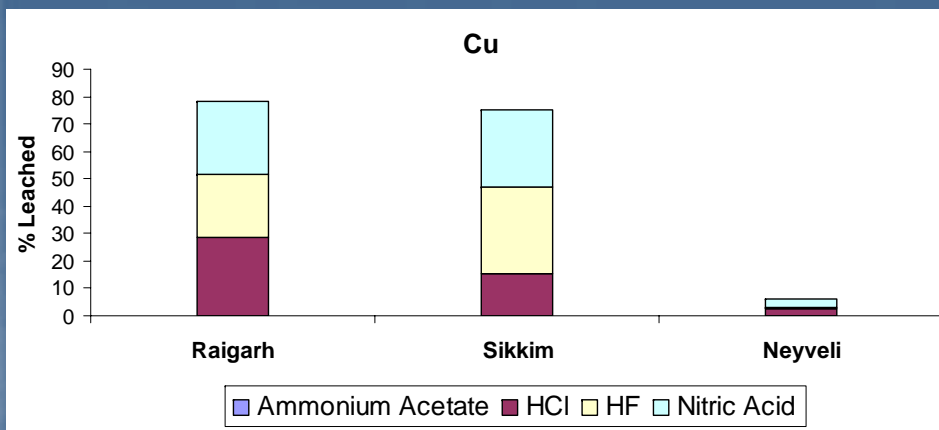
ELEMENT	Mand-Raigarh	Rangit Valley	Neyveli
Cu	Sulphides, disulphides, clay minerals	Sulphides, disulphides, clay minerals	Shielded by organic matrix, insoluble minerals, organo-metallic complex
Zn	Sulphides, disulphides, silicates	Sulphides, disulphides, silicates	Sulphides, insoluble minerals or complex
Pb	Sulphides, disulphides	Sulphides, disulphides, Shielded by organic matrix, insoluble minerals, organo-metallic complex	Sulphides, Shielded by organic matrix, insoluble minerals, organo-metallic complex
Mn	carbonates	carbonates	Carbonates, (exchangeable)
Ni	Silicates, pyrite, oxides	Silicates and sulphides, oxides	Organic, oxides
Cr	Silicates, clay association, probably pyrite	Silicates, clay association, pyrite	Organic, Silicates, clay association, pyrites

ELEMENT	Mand-Raigarh	Rangit Valley	Neyveli
Cu	Chalcopyrite, pyrite, clay minerals	Chalcopyrite, pyrite, clay minerals	Shielded by organic matrix, insoluble minerals, organo-metallic complex
Zn	Sphalerite, pyrite, silicates	Sphalerite, pyrite, silicates	Sphalerite, pyrite, Silicates, organic matter
Pb	Galena, pyrite, Silicates	Galena, pyrite, organic matrix, insoluble minerals, organo-metallic complex	Galena, pyrite,
Mn	Carbonates, silicates, pyrite	Carbonates, silicates, pyrite, exchangeable	Carbonates, silicates, pyrite, exchangeable
Ni	Silicates, sulphides	Silicates, sulphides	Silicates, sulphides Organic matter
Cr	Silicates, clay association	Silicates, clay association	Silicates, clay association Organic matter

Conclusions

- Mineralogically, the Neyveli lignite is dominated by kaolinite and dolomite whereas in Mand-Raigarh and Rangit valley quartz and kaolinite are major mineral phases

- Nickel and Cr are present in higher concentrations with respect to their world averages. Copper and Pb in the Mand-Raigarh coal only exeed the Indian averages

- Copper, Pb and Zn are associated mostly with chalcopyrite, galena, sphalerite and pyrites though silicate fractions also contribute to their occurrence. Chromium preferably occurs with clay minerals; Ni is nearly equally distributed in silicate, disulphide and sulphide minerals. Manganese primarily occurs as carbonates.

- Mode of occurrence of trace elements are found to be independence of the geological setting, rank and depositional processes