Q1. What are the host rock characteristics and different stages of mineralisation in Rajpura – Dariba region?

Ans. In the Rajpura-Dariba region metamorphosed silicious dolostone and graphite-mica schist are the main host rocks of the mineralisation and the deposit is a SMS (SEDEX) type. Most of the rocks are carbonate, siliceous dolostone, graphite mica schist hosted by mica schist with staurolite porphyroblast. Metamorphosed country rock where mineralisation taken place in two stages. Early stratiform ores and later vein ores formed by hydrothermal activities. Arsenic and antimony bearing phases came into existence in later phase of mineralisation.

Q2. Give a brief idea on the occurrence of diamond with reference to host rock and the mode of occurrence. Briefly discuss the origin of diamond in such rocks.

Ans. Diamond mostly occurs in kimberlites _ host rock. Kimberlites form through volcanic eruptions that bring high-pressure magma from the upper mantle to the surface of earth preferably under thick continental crust. The formation of natural diamonds requires very high temperatures and pressures. These conditions occur in limited zones of Earth's mantle about 150 kilometres below the surface where temperatures are at least 2000 degrees Fahrenheit. When the eruptions pass through the diamond stability field carries diamond with it from the deeper earth.

Q3. Mention three important types of Uranium deposits with their characteristics and broad geological period of formation in India, giving one example from each type.

Ans.
Unconformity – Northern and north-eastern Cuddapah basin. Middle to Upper Proterozoic age. Unmetamorphosed sediments of orthoquartzite, limestone and shale are host rock. (Richest type of deposit in the world.)

SST-hosted - Mahadek basin, Meghalaya. Phanerozoic period also account for about 16% of the Indian reserves. The sediments in the Mahadek’s range from fluvial to marginal marine and are highly immature thereby retaining the uranium content in the rocks derived from the fertile granite provenance.

Vein - type – Singhbhum shear zone. Feldspathic-schist, chlorite sericite schist with magnetite, apatite and quartzite are the host rocks for uranium mineralisation, which belongs to the Dalbhum Formation of Proterozoic age.
Q4. Mention the important specialties of mineral resources as compared to other earth resources. What are the prerequisites for formulation of an exploration programme?

Ans.

- These deposits are non-renewable. The time of exploitation is too small compared to the time of formation by the nature.
- Uncertainty about Quality/Quantity.
- Uncertainty about Usability. Uncertainty about the development of technology in the future.
- Finite Quantity.
- Depth Dimension.
- Geological Complexities.
- Locational and Distributional Peculiarities.
- Perpetuality. Not self-destructible in human civilisation time scale.
- Relationship to Geographical Boundaries.
- Relationship with Economy.

Q5. Briefly state the materials and methods in the reconnaissance and detailed survey stages of mineral exploration.

Ans. A Reconnaissance survey identifies areas of enhanced mineral potential on a regional scale based primarily on results of regional geological studies, regional geological mapping, airborne and indirect methods, preliminary field inspection, as well as geological inference and extrapolation. The objective is to identify mineralised areas worthy of further investigation towards deposit identification.

Detailed survey involves the detailed three-dimensional delineation of a known deposit achieved through sampling, such as from outcrops, trenches, boreholes, shafts and tunnels. Sampling grids are closely spaced such that size, shape, structure, grade, and other relevant characteristics of the deposit are established with a high degree of accuracy. Processing tests involving bulk sampling may be required. A decision whether to conduct a Feasibility Study can be made from the information provided by Detailed Exploration.

Q6. Explain the basis of McKelvey’s Box of classification of mineral resources and define the terms used.

Ans. McKelvey box diagram helps to explore the distinction between resources and reserves and the differences that can exist within these two broad categories. McKelvey
A diagram explores resources and reserves of different materials through the use of two distinct parameters. These two parameters are degree of certainty & Profitability.

- **Measured (Proved)** - Quantity is very certain. Amount of metal present in ore in form of ore body is accurately known.
- **Indicated (Probable)** - Degree of confidence is less than that of measured.
- **Inferred (Possible)** – Calculated by using extrapolation and speculation.

- Measured and Indicated together constitute Reserve base.
- **Economic** – Materials which were taking out as ore from that the metal of interest can be extracted at profit depending upon the advancement of current technology of the extraction.
- **Reserve** – The term resource refers to the total amount of a material that exists. This includes both discovered and undiscovered material, economically recoverable or not economically recoverable. Within this constraint whatever material is coming out to be usable and that will be taken as ore, which will be subjected to processing and further beneficiation or extraction of the metal.
- **Resource** - Reserves are deposits that are known to exist with a reasonable level of certainty based on geological and engineering studies.

Q7. Describe briefly about UNF classification. Add a note on the requirement of such a classification while there were many other established classifications.

**Ans.** Classified on the basis of Socio-economic viability, Project feasibility, and Geological knowledge. G1>G2>G3>G4 order of geological certainty. Similar in case of the other two parameters. 111- Commercially producing mines today. **Yellow boxes** – Potentially commercial projects. Geological certainty has been proved, project feasibility is high, intermediate economic viability.

- Need for common global language for energy and mineral resource estimates.
- Increasing overlap between mining and oil & gas industries.
- Increasing need to be able to compare renewable energy resources with non-renewable resources.

Q8. Briefly state the economic considerations for exploration of mineral resources. Give an outline of the different stages of exploration of mineral resources.

**Ans.**

- **What to explore - Demand** – Supply International Price, Joint supply/ Demand, Technological breakthrough, Substitute, Strategic Factor, Political Factor.
• **Where to explore** – Ancient working, Favourable Geology, Political Factors, Joint demand.

• **How to explore** – Science, Art/Practice, Methodology.

  ✓ **Reconnaissance** – Small scale geological map, Satellite Imageries, Regional Scale geographical anomaly map.

  ✓ **Detailed mapping** – All lithological units with broad structural pattern represented.

  ✓ **Target Delineation** – Geophysical and Geochemical methods.

  ✓ **Exploratory drilling and estimation mine scale map** – Driling, Assaying, 3-D modelling, Geostastical Technique, Economic analysis/evaluation.

**Q9. What is Hoteling rule and what is applicability to exploitation of mineral resources?**

**Ans.** Hoteling rule states that the most socially and economically profitable extraction path of a non-renewable resource is one along which the price of the resource, determined by the marginal net revenue from the sale of the resource, increases at the rate of interest. It describes the time path of natural resource extraction which maximizes the value of the resource stock.

**Q10. Give one example each from ‘physiographic’ and ‘structural’ guides for mineral exploration.**

**Ans.** Physiographic guide – Drainage pattern.

  Structural guide – Fold, Fault.

**Q11. What is a geochemical anomaly? What factors are responsible for the nature and intensity of such anomalies?**

**Ans.** Concentration of one or more elements in rock, soil, sediment, vegetation, or water that is markedly higher or lower than background known as geochemical anomaly. Sample selection and analytical process causes anomaly.

  ✓ Unusual or uncommon processes concentrating particular elements (e.g. an ore-forming process, weathering and element dispersion from an unusual element concentration such as an orebody).

  ✓ Element accumulation or concentration by common processes acting over long periods (e.g. scavenging and concentration of certain elements by ironstones, ferruginous regolith or manganese oxides).

  ✓ Artificial contamination of sites or samples.
✓ Analytical noise or error (e.g. poor precision of the analytical method, particularly for element concentrations close to the detection limit).

Q12. Discuss the importance of understanding the soil profile in geochemical exploration and discuss the intricacies involved in interpretation of geochemical anomaly in actual delineation of subsurface ore bodies.

Ans. The process of collecting and analysing unconsolidated soil sediments in order to locate geochemical anomalies in the underlying rock and to use these to find ore bodies. Where the loose material or soil is stable there is a geochemical balance between the original rock, weathering, pore water, and biological activity. The soil profile is usually layered, and in a geochemical soil survey the horizon giving the sharpest contrast between background and anomaly is chosen for analysis.