A Refresher Course on Mineralogy, Petrology, Thermodynamics, Sedimentology and Ore-geology conducted at the Jalahalli Campus of Indian Academy of Sciences, Bangalore during 10th to 24th December, 2015. Resource Persons: Prof. Alok K. Gupta (Course Director, Allahabad University), Prof. Mihir Deb (Delhi University) and S. K. Tandon (IIT, Kanpur): A Report

Introduction:

A comprehensive course on Mineralogy, Crystallography, Petrology, Thermodynamics, Sedimentology and Ore-geology was conducted at the Jalahalli Campus of Indian Academy of Sciences, Bangalore. The resource persons included Prof. Alok K. Gupta (Allahabad University, Course Director), Prof. Mihir Deb (Delhi University) and S. K. Tandon (IIT, Kanpur). The number of participants (mostly research scholars, University and college teachers) from all over the country was twenty.

The duration of the course was for fourteen days and on each day there were five periods of one and a half hour duration with tea breaks between two periods (see Table-1). There was also a field trip to Mysore, on 20th December. During this field trip the participants were shown various Archean formations prevalent in and around Mysore. There used to be rigorous interaction between participants and the teachers while working out on thermodynamics problems, interpretation of phase diagrams, Eh-Ph calculations, interpretation of sedimentary structure and problems related to ore-ogenesis. In order to complete the entire courses on Sedimentology, Ore petrology, and different aspects of Mineralogy, Petrology, Crystallography and Thermodynamics many classes were taken even during the evening and late night hours. Prof. Tandon also spoke on sedimentary processes in Mars, while Prof. Mihir Dev covered processes of Ore genesis in type localities throughout the world.

Inaugural Function

There was an inaugural function on 11th December at 9:00 AM, where participants were addressed by Prof. N. Mukunda (since Professor K.L. Sebastian could not make it), Dr. T.D. Mahabaleswar, Prof. Alok K. Gupta and Prof. S.K. Tandon. The participants introduced themselves, and briefly spoke about their expectations from the course. The inaugural function was of half an hour duration. The function was followed by registration and distribution of course materials.

The contents of the course are given below:

Syllabus:

1. Thermodynamics

Physical concept and derivation of the 1st three laws of thermodynamics; Gibbs free Energy function, Free energy changes as a function of pressure and temperature. Physical concept

2. **Phase equilibria Relations**

Concept of phase, component, system, degrees of freedom, one component system, binary systems with eutectics, binary system with peritectic and eutectic, binary system with complete solid solution relationship, Pseudo binary systems. Ternary systems with eutectic, ternary system with Alkemade line having peritectic and eutectic. Effect of pressure on phase diagrams, complex ternary systems with thermal barriers. Ternary systems, having one of the binaries with solid solution relationship. Multi-component systems, construction of flow-sheet diagrams. Extensive use of phase diagrams on the genesis of basalts, granites, carbonatite, nepheline syenites, ultramafic rocks like kimberlite, komatiits, phase relations relevant to K-rich mafic and ultramafic rocks, phase relations in sodium-rich mafic and ultramafic rocks, anorthosites. Use of phase diagrams on the genesis of important rock systems.

3. **Mineralogy**

Relationship between radius ratios and coordination number. Crystal structure, phase ratios under variable P-T conditions on minerals belonging to following mineral groups: Olivine, melilitite, pyroxene, amphibole, mica, silica-group of minerals, Feldspars, Feldspathoid (nepheline, leucite and kaisilite), garnet, epidote zeolites, spinels and important sulphides. Construction of Eh-Ph diagrams and their relevance. High P-T phase relations of minerals and their co-relation with crustal, mantle and core discontinuities.

4. **Crystallography**

Definition of a crystal, formation of different faces by translation, rotation and roto-inversion, mirror planes parallel or perpendicular to the axes of rotation. 32 classes of symmetry, Miller indices, absence of 4, 5 symmetry: mathematical deduction, 14 Bravis lattices, study of crystal models, different types of twinning.

5. **Sedimentology: Introduction to some basic concepts**


The Rock Cycle and definition of the sedimentary domain; why study sedimentary rocks? regolith development; distinguishing soil and sediment systems; overview of sedimentary rocks-composition, texture, geometries, facies and sedimentary environments (2 lectures).
Terrigenouslastic sediments; sediment routing systems, clastic sediments and detrital modes; facies concepts- facies analysis and elaboration of Walther’s Law (3 lectures)
Chemical and biochemical sediment systems (focus on carbonate systems and their depositional environments) (2 lectures)
Lithification and diagenesis of siliciclastic and carbonate rocks; Porosity- origins and measurement (2 lectures) Fluid flow and sediment transport, fluid gravity flows, flow regimes, introduction to physical sedimentary structures and palaeocurrent indicators (3 lectures)
Introduction to lithospheric mechanics and McKenzie’s uniform stretching model; formation of sedimentary basins, tectonic classification of sedimentary basins (2 lectures).
Free Discussion on approaches to teaching sedimentology in UG and PG courses (1 lecture).

6. **Ore Petrology & Genesis:**
Mode of occurrence, origin, classification of ore deposits (magmatic, metamorphic, contact metasomatic, sublimation, hydrothermal, oxidation and supergene enrichment and sedimentary), Prophyry and skarn mineralisation. Fluid inclusion studies. Mineralisation associated with

I. Ultramafic, mafic and acidic rocks,

II. Greenstone belts,

III. Komatiites, anorthosites and kimberlites and

IV. Submarine volcanism, Straiform and stratabound ores.

**Valedictory Function**

The Valedictory Function was held on 24th of December at 11:00 A.M, when the students were addressed by Prof. E. Arunan (Department of Inorganic and Physical Chemistry, IISc., Bangalore), Prof. Alok K. Gupta (Course Director), Prof. Mihir Dev (Delhi University) and Dr. T.D. Mahabaleswara (Course Coordination). All the participants came forward and gave their opinion regarding the course. Each of them opined that such courses would be of great value for the future participants and they urged that in future many such courses should be conducted by the three academies in Bangalore. All the participants were distributed certificates, following which they were all invited to a lunch organized by the academy in Bangalore.

**Acknowledgements**

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Course Director