Novosibirsk State University
*THE REAL SCIENCE

METAMORPHIC PETROLOGY

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Research Interests: Metamorphic rocks and processes, granulite and ultra-high temperature metamorphism, metamorphism of orogenic belts, metamorphism of cratonic areas, metamorphic minerals and reactions, and age of metamorphic processes.

The course **"Metamorphic Petrology"** is designed for students who have a Bachelor's Degree and have taken the courses "Fundamentals of Geology" and "Petrography of Metamorphic Rocks". The course will introduce students to basic knowledge in metamorphic petrology and up-to-date methods and approaches to studying metamorphic complexes. Students will be introduced to the main types of metamorphism in different tectonic settings, fundamentals of mineralogical geothermometry, and geobarometry, reconstruction of P-T-t – paths of metamorphism and thermochronology, basics of dating metamorphic processes, metamorphism in extreme P-T conditions (UHT and UHP types), secular changes in metamorphism during the earth history, the role of metamorphism in ore deposit formation etc. The course has a lecture and a lab component.

Course Outline

1. Introduction
   Definition of metamorphism. Types of metamorphism. Metamorphic facies. Diagnostic mineral assemblages. Metamorphic textures. Tectonic settings of metamorphism. Collisional and accretionary complexes. Subduction zones. Metamorphism of fold belts and cratonic areas. Secular changes in metamorphic types.
2. Geothermometry in Metamorphic Rocks: Pitfalls and New Approaches
   Fundamentals of geothermometry. Fe-Mg exchange and other types of geothermometry. Geothermometry on the basis of a thermodynamic database. Thermometric approaches for low, medium, and high-temperature metamorphic complexes. Main pitfalls in geothermometry of granulites. Natural examples.

3. **Isotopic Dating of Metamorphic Processes**
   Fundamentals of isotopic dating. U-Pb, Ar-Ar, Rb-Sr, and Sm-Nd isotopic systems. Minerals appropriate for dating. Zircon. Behavior of zircon in metamorphic processes. Inner structure of zircon and its significance for the interpretation of age data. Approaches for dating low, medium, and high-temperature metamorphism. P-T-t paths and thermochronology.
4. **P-T Paths of Metamorphism**
   The definition of PT-path. The role of PT-path reconstruction in studying metamorphic complexes. Approaches to PT-paths reconstruction. Mineral zoning. Mineral reaction microtextures and its significance. Metamorphic PT-path in different tectonic settings. Natural examples.
5. **Melting in the Continental Crust**
   Terminology. Water-fluxed and dehydration melting. Melting reactions. Role of water in melting reactions. Peritectic minerals. Melt composition. Rates of melting. Volume of melt produced. Morphology of neosome. Natural examples of water-fluxed and dehydration melting.
6. **Ultra-high Temperature (UHT) Metamorphism**
   The definition of UHT metamorphism. Mineral assemblages diagnostic of UHT metamorphism. Mineralogical geothermometry and geobarometry at UHT conditions. The age distribution. The duration of UHT metamorphism and relation to granulites. The PT-path and proposed tectonic scenarios for the generation of UHT conditions in the deep crust.
7. **High-pressure and Ultra-high-pressure (UHP) Metamorphism**
   Metamorphic facies series. Indicative mineral assemblages. Thermal regime and metamorphic PT-path. Geodynamic implications. Kokchetav dimoniferous rocks, unique examples of UHP metamorphic complex.
8. **Metamorphic Ore Deposits**
   Main types of deposits. Deposits of sillimanite-group minerals. Orogenic gold deposits. Pre-enriched source rocks. Gold upgrading during late diagenesis, metamorphism, and deformation. Gold Depletion Zones. Tectonic Environments and Favorable Basins.