Discipline Information

The following dates are in (dd/mm/yyyy) format.

Code: GSA5835 - 2 Type: POS
Name: Metamorphism and Tectonic Evolution
Concentration area: Geotectônica (44141)

Approval dates:
CCP: 02/08/2016 CPG: 11/08/2016 CoPGr:
Activation date: 11/08/2016 Inactivation date:

Workload:
Total: 90 h Theory: 10 h Practice: 10 h Study: 10 h
Credits: 6 Duration: 3 weeks

Professors: 56948 - Caetano Juliani - 11/08/2016 until today

Objectives:

The course aims to provide skills to students to recognize the geological setting and types of tectonic events responsible for the generation of metamorphic belts, based on the quantification of the physical conditions of metamorphism using geothermobarometry and the definition of its temporal evolution, through the establishment of metamorphic trajectories (P-T-t).

Rationale:

The metamorphic belts are the result of orogenic events. Their study is fundamental for the understanding of the geodynamic processes that lead to the establishment of a thermal anomaly in the Earth's crust, which may result in uplifts, drift of continents, subduction, orogenesis, and collision of tectonic plates. Deformation during the subduction and exhumation of orogenic belts results in metamorphic foliations, systems of folds, thrust folds, faults, shear zones, nappes, and crystallization of metamorphic minerals that enable the establishment of the tectonic evolution of a region. The exhumation is typically accompanied by different rates of re-establishment of the isotherms due to the different styles of deformation and emplacement of magmas that could modify the regional thermal flow through the crust. Transformations caused by these events can be recorded in microstructures, textures and chemical compositions of metamorphic minerals. Thus, the study of metamorphism, based on the quantification of the pressure and temperature (P-T) by geothermobarometric methods and the establishment of the metamorphic P-T-t-d trajectories (pressure-temperature- relative time-deformation) could effectively contribute to the understanding of the dynamic of crustal evolution, from subduction to exhumation. The geothermobarometric methods based on chemical compositions of pairs and association of minerals, as well as with the use of internally consistent thermodynamic databases and pseudo-sections, enable also the characterization of the baric types of metamorphism. On the other hand, the isotopic dating of the different minerals from distinct P-T domains also permits the characterization of the temporal evolution of the metamorphic belt. The definition of evolutionary metamorphic paths in the P-T field also allows the deduction of the thermal influence caused by the magmatism and the tectonic environment, and enables the distinction of overlapping tectono-metamorphic events due to different orogenic cycles, which justifies this course.

Content:

1) Factors that control metamorphism. Types of metamorphism and tectonic settings. Petrogenetic grids in the chemical KFASH, KMASH, CKNASH, NASH, CASH systems, and their application in the establishment of the metamorphic grade and its variation. Metamorphic trajectories and their relation with the tectonic evolution of the orogens. 2) Composition, chemical variation, compositional zoning and mineral inclusions in metamorphic minerals and their use in the establishment of metamorphic trajectories. Cationic distribution in the structural formulae of minerals. 3) Relative chronology of metamorphic paragenesis defined by the relations of blastesis with metamorphic foliations, microstructural domains, texture / equilibrium / imbalance, mosaic equilibrium, textures and microstructures and their use to define the metamorphic grade and P-T-t (Pressure-Temperature-Relative time) evolution. 4) Chemical

zonation of minerals and their use for geothermobarometry and for the establishment of P-T trajectories. 5) Thermodynamic fundamentals for geothermobarometry: metamorphic reactions, solid solutions, partition coefficient and P-T dependence. The influence of the fluid phase. 6) Methods of geothermobarometric calculations based on exchange reactions, net transfer reactions, internally consistent geothermobarometers and geothermobarometry with mass balances. Application and method limitations. Practical examples. 7) Main geothermometers and geobarometers for use in low-, medium- and high-grade metamorphic terrains, with practical studies of geothermobarometric calculations using various softwares (PT-MAFIC, GPT, TWQ, THERMOCALC, PERPLEX, etc) in pairs and mineral associations and based on internally consistent databases. Applicability, constraints and comparative analysis of different thermometers, barometers and methods. Practical activities of geothermobarometric calculations by different methods. Fundamentals for the construction of pseudo-sections. Practices with geotermobarometry. 8) Use of geothermobarometry in the definition of metamorphic trajectories. Types of metamorphic trajectories related to different tectonic environments and their application in the establishment of crustal evolution. Deduction of the tectonic models IBC, ITD, overthrusts, influence of magmas emplacement (plutons and sills) and of shear zones. Discussion of examples. 9) Definition of metamorphic trajectories with absolute time. Methods and interpretation.

Bibliography:

Brown, M. (2007) Metamorphism, plate tectonics, and the supercontinent cycle. Earth Science Frontiers, 14(1): 1-18. Brown, M. (2010) Paired metamorphic belts revisited. Gondwana Research, 18: 46-59. Bucher, K.; Frey, M. (1994) Petrogenesis of metamorphic rocks. 6th Ed., Berlin, Springer Verlag. 318 p. Ashworth; J.R.; Sheplev, V.S.; Khlestov, V.V.; Ananyev, V.A. (2004) An analysis of uncertainty in non-equilibrium and equilibrium geothermobarometry. Journal of Metamorphic Geology, 22(9): 811-824. Miller, J.A.; Buick, I.S.; Cartwright, I.; Barnicoat, A. (2002). Fluid processes during the exhumation of high-P metamorphic belts. Mineralogical Magazine, 66: 93-119. Miyashiro, A. (1994) Metamorphic petrology. London, UCL Press. 404 p. Powell, R.; Guiraud, M.; White, R.W. (2005). Truth and beauty in metamorphic phase-equilibria: conjugate variables and phase diagrams. The Canadian Mineralogist, 43: 21-33. Powell, R. & Holland, T.J.B. (2008) On thermobarometry. Journal of Metamorphic Geology, 26: 155-179 Spear, F.S. (1995) Metamorphic phase equilibria and pressure-temperature-time paths. Mineralogical. Society of America Monograph. 799 p. Vernon, R.H. (2004). A Practical guide to rock microstructure. Cambridge University Press, Cambridge, 606 p. Wakabayashi, J. (2004) Tectonic mechanisms associated with P-T paths of regional metamorphism: alternatives to single-cycle thrusting and heating. Tectonophysics, 392: 193-218.

Type of Assessment:

Tests, pratical activities and seminaries.