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METAMORFISMO REGIONAL EN CINTURONES OROGENICOS
REGIONAL METAMORPHISM IN OROGENIC BELTS

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Orogenic belts are characterized by the occurrence of metamorphic rocks of different grades and types. This is due to uplift and erosion that allow the exposure at the present-day surface of rocks that were buried, deformed and subjected to a particular P-T-t sequence during the orogenic process.

If the orogeny reactivated a preexisting basement, the resulting rocks are polymetamorphic and their overprinting can be stronger or weaker depending on many factors (tectonic reworking, introduction of water, duration of the process, etc.). The mineral parageneses tend to record the more extreme P or T conditions reached in the cycle.

When the metamorphic crystallization can be related to deformational events, like folding or flattening, a metamorphic rock, generated in a single orogeny, can be defined as polyphasic, though this does not necessarily imply that the metamorphic conditions were modified in discrete steps.

The "type" of metamorphism of a specific phase or moment of the metamorphic evolution is reflected by the parageneses whose P-T. indications give us the paleogeothermal gradient of the crust under examination. There are two main types of regional metamorphism:

1) The HP-LT metamorphism
2) The HT-low or intermediate P metamorphism

These two types can occur together in the so-called "Paired metamorphic belts", characteristical of the circum-pacific regions. The HP-LT belt consists of uplifted parts of the hanging wall (Miyashiro, 1982) of the Benioff zone fault and is built up by oceanic (sediments or basaltic rocks) as well as continental materials (scraped off parts of the continental crust). The HP-LT metamorphism is caused by the lowermost possible geothermal gradient that is actually present in the subduction zones.

The HT-low or intermediate P type belts occur parallel to the HP-LT belts on their continental side; they consist of sediments, igneous rocks or reactivated basement that underwent moderate-to-high geothermal gradients, generated by radioactive decay and by injections of basic magma above the subduction zone. The paired metamorphic belts are generally separated by a sedimentary, non-metamorphic zone, corresponding to the arc-trench gap, or by a high-angle fault dipping towards the continent. The HP-LT belts are present only in the Phanerozoic orogens; it is this the main argument against the extension to the Precambrian of the "Wilson cycle" plate tectonics.

In orogenic belts due to continental collision, like the Himalayas and the Alps, two stages may be distinguished: the first stage in which paired metamorphic belts develop along the active margin of the closing oceanic basin; the second stage in which the thickening of the continental crust due to overthrustings provokes an intermediate-pressure regional metamorphism on account of radioactive heating and magma intrusion. Precambrian orogenies differ from the Phanerozoic ones on account of the higher temperature and the lower thickness of the lithosphere and hence a more ductile behaviour of the crust. In precambrian mobile belts, metamorphism offers a wide variety of P-T-t paths; in general the maximum geothermal gradient seems to decrease with time.

The study of the relationships between deformation and metamorphic crystallization is very useful since it allows the understanding of the conditions at which strain occurred as well as to the evolution of the geothermal gradient. In the intermediate-P type belts, most of the penetrative deformation occurred at low-grade conditions below 500°C. The amount of deformation above that temperature is comparatively small; this is probably connected with a change in the mechanical properties of rocks with progressive dehydration during prograde metamorphism.

Radiometric dating can prove a very useful tool for understanding the metamorphic and post-metamorphic evolution of a belt. Rb-Sr and K-Ar mineral ages are crystallization or cooling ages, depending on the circumstance whether their crystallization occurred below or above the blocking temperature of their isotopic system. Complications may arise from subsequent radiogenic loss or from Ar overpressures; large crystals may preserve pre-metamorphic ages.

Rb-Sr whole rock isochrons are invaluable means for dating the first, even very low, metamorphism of pelitic sediments or pyroclastites, and for dating the intrusion of metaplutonic rocks.

U-Pb zircon and monazite ages give information about the solidification of meta-igneous rocks. In metasediments they show almost invariably discordant ages that are very difficult to interpret: the upper intercept reflects the age of the mineral crystallization, the lower intercept the age of the matamorphic disturbance, but this meaning is not universally accepted. Concordant U-Pb monazite ages have been interpreted also as cooling ages.

In general, cooling ages supply precious information about the uplifting and erosion rates or episodes of different parts of mountain belts; also apatite fission track age are useful for the study of very recent history.