Competitive Exams: Metamorphism

The Four Agents of Regional Metamorphism

Heat and pressure usually work together, because both rise as you go deeper in the Earth. The clay minerals of sedimentary rocks, in particular, respond to high temperatures and pressures. Clays are surface minerals, which form as feldspar and mica break down in the conditions at the Earth's surface.

With heat and pressure they slowly return to mica and feldspar. Thus the sedimentary rock shale metamorphoses first into slate, then into phyllite, then schist. The mineral quartz does not change under high temperature and pressure, although it becomes more strongly cemented as the sedimentary rock sandstone turns to quartzite. Intermediate rocks that mix sand and clay. Mudstones. Metamorphose into gneiss. The sedimentary rock limestone recrystallizes and becomes marble.

Fluids are the most important agent of metamorphism. Every rock contains some water, but sedimentary rocks hold the most. First there is the water that was trapped in the sediment as it became rock. Second is the water that is liberated by clay minerals as they change back to feldspar and mica. This water can become so charged with dissolved materials that the resulting fluid is no less than a liquid mineral. It may be acidic or alkaline, full of silica (forming chalcedony) or full of sulfides or carbonates or metals, in endless variety. Fluids tend to wander away from their birthplaces, interacting with rocks elsewhere. That process, the interaction of rock with chemically active fluids, is called metasomatism.

Strain refers to any change in the shape of rocks due to the force of stress. As fluids form and move in buried rocks, new minerals grow with their grains oriented according to the direction of pressure. Where the strain makes the rock stretch (shear strain) , these minerals form layers. In most metamorphic rocks the layers are made of mica. The presence of mineral layers is called foliation and is important to observe when identifying a metamorphic rock. As strain increases, the foliation becomes more intense, and the mineral sort themselves into thicker layers. that's what gives schist and gneiss their foliation.

Metamorphism can be so intense, with all four factors acting at their extreme range, that the foliation can be warped and stirred like taffy, and the result is called migmatite. With further metamorphism, rocks can be turned into something hard to tell from plutonic granites. These kinds of rocks give joy to experts because of what they say about deep-seated conditions during things like plate collisions. The rest of us can only admire the laboratory skills needed to make sense of such rocks.

What I've described is how regional metamorphism affects sedimentary rocks. Igneous rocks give rise to a different set of minerals and metamorphic rock types; these include serpentinite, blueschist, greenschist and other rarer species such as eclogite. If you're a mineral collector it's worth your while to learn about these, but they aren't found in most parts of the world.

Contact or Local Metamorphism

A lesser type of metamorphism, important in specific localities, is contact metamorphism. This usually occurs near igneous intrusions, where hot magma forces itself into sedimentary strata. The rocks next to the lava invasion are baked into hornfels, another subject for specialists. Lava can rip chunks of country rock off the channel wall and turn them into exotic minerals, too.

Underground coal fires can also cause mild contact metamorphism of the same degree as occurs when baking bricks.