DSPMU UNIVERSITY, RANCHI.
DEPARTMENT OF GEOLOGY

B.Sc. SEMESTER-IV **DATE-07/05/2020**

PROGRADE, RETROGRADE AND POLYMETAMORPHISM

With the increase in pressure (P) and temperature (T) conditions, a rock of a given chemical composition is expected to undergo a continuous series of chemical reactions between its constituent minerals and any fluid phase present to produce a series of new mineral assemblages that are stable at these higher pressure and temperature. The increase in T-P condition thereby causes an increase in grade of metamorphism, known as Progressive or prograde metamorphism**.**

Prograde metamorphism is thus the increase in metamorphic grade with time as a rock is subjected to gradually higher pressure (P) and temperature (T) conditions.

Example-

Prograde metamorphism results in gradual conversion of slate (protolith -shale) being converted to phyllite and then into schist etc. As seen in Figure- 1 (Note how the alignment of minerals take place in each rock type as metamorphism progresses).

Figure- 1

Retrograde Metamorphism

Retrograde metamorphism is the mineralogical adjustment of relatively high-grade metamorphic rocks to temperatures lower than those of their initial metamorphism. The effect of retrograde metamorphism displays any degree of replacement of a high-temperature mineral or mineral assemblage by one stable at a lower temperature.

Many metamorphic rocks contain evidence of retrograde mineral changes, that is, alteration of higher grade minerals into lower grade ones. Many of these changes involve hydration and are the result of a decrease in temperature and increase in the activity of water. Retrograde metamorphism is normally produced by repeated regional metamorphism where a lower grade episode is superimposed on a higher grade one. Most retrogressive events are probably just a consequence of the metamorphic system cooling down after peak metamorphism has been reached (i.e. the system has to cool down with time and as the region undergoes uplift with time, both pressure and temperature are dramatically reduced). The secondary minerals produced during retrogressive metamorphism generally occur as fibrous fringes around, inclusions within, and pseudomorphous grains after, the higher grade metamorphic minerals. A good example of retrogressive metamorphism is the occurrence of serpentine (Figure-2) formed by generally low temperature hydration of ultramafic rocks containing minerals composed chiefly of magnesium and iron (eg. Olivine) commonly at subduction zones.

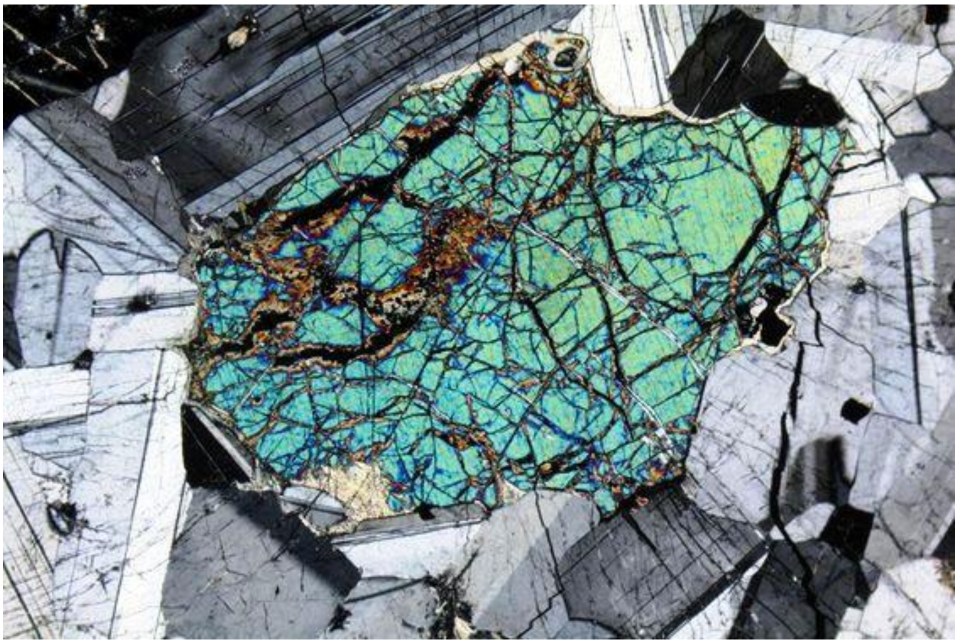

Figure 2-Thin section showing alteration of olivine into serpentine.

Polyphase / polymetamorphism-

If a metamorphic event involves only one phase of heating or pressing and then cooling or depressing, it is called **monophase metamorphism**. If a metamorphic process involves two or more climaxes in the changes of temperature and/or pressure, it is called a polyphase metamorphism (Figure-3).

Many metamorphic rocks are the result of more than one phase of metamorphism. In fact, most regionally metamorphosed rocks in orogenic belts show the effects of repeated phases of metamorphism. However the polyphase nature of regional metamorphism is clearly revealed in the textures of the rocks and textural relationships can be used to establish both successive mineral growths and the conditions of growth (static or dynamic). Within one orogenic episode this may be due to recrystallization in several separate phases during a single rise and fall in temperature, or it may be due to several separate phases of metamorphism. Thus ,the structures of these rocks are complicated because they contain folds, lineations and foliations of different ages.

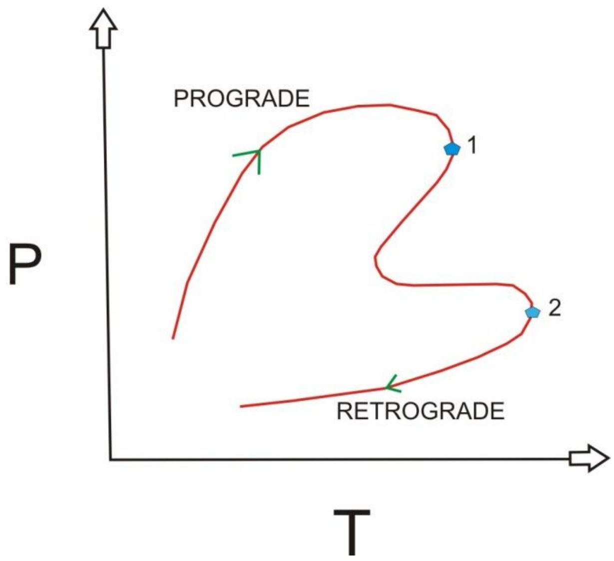

Figure 3- P-T-t path showing polyphase metamorphism [1,2-peak temperatures]